History of Nuclear Energy and Society

WP 3

D.3.6 Validated Short Country Reports

Leading beneficiary: UPNA

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Executive summary

According to the original EU call (NFRP-12-2014), the project should be organized in different phases. In the first phase, historians shall provide the core facts and figures, based on available documents and other sources of information, complemented as appropriate by field investigations. However, HoNESt consortium went further and implemented a more integrative approach, by embedding the research process in an interdisciplinary framework combining historical accounts of nuclear developments in what we called Short Country Reports (SCRs) with social science analyses of public perceptions and stakeholder engagement. This approach creates a mutual interdependence of the research and analysis processes carried out by both disciplinary teams.

The very objective of SCRs is to provide social scientists with the empirical basis to be drawn upon for perception and engagement studies. Historians were asked to provide specific evidence for the identification of: events, actors, arguments, behaviours, and types of public engagements encountered over the past 60 years across 20 countries. This framework is simple enough to host data from very different political, social and ideological environments, while some variations in the basic structure of the SCRs are unavoidable. As a result, the SCRs are a distinct product from either what the historians or the social scientists would have produced on their own in the absence of the collaborative framework favored by the HoNESt structure.

Historical data do not speak for themselves; archives are incomplete, ambiguous, contradictory, and confusing. In practice, both the Call itself and the DoA imposed the inductive approach on data collection adopted by HoNESt. The SCR had to provide substantiation of what happened in each country by making use of the best available evidence. There was no imperative to fit the country reports into the existing literature and produce novel arguments, but rather to be systematic in the process of collecting, analyzing and interpreting the evidence in order to answer the questions at stake. For over 20 countries with widely different historiographies, ranging from non-existent to massive, produced in a score of national and regional languages, the resulting task was challenging, and implied making use of a variety of sources depending on the case.

The SCRs are a first step towards providing a long-term historical survey integrating social science analysis of nuclear energy's relation with society. Imperfect, complex and requiring further analysis and complements during the second half of the project, but the collection of country reports in itself - some of them for countries without any significant historiography so far- is, however one of HoNESt most significant exploitable results and a remarkable achievement. Here we report the process to achieve the final versions of the SCRs.

Objectives of the Short Country Reports

According to the original EU call (NFRP-12-2014), the project should be organized in different phases:

In the first phase, historians shall provide the core facts and figures, based on available documents and other sources of information, complemented as appropriate by field investigations, notably interviews of major players with regard to the selected developments and projects. This should result in a well-organised and documented database and historical record. Based on fundamental research, HoNESt historians shall analyse documentation and produce short country reports (SCRs).

The second phase shall bring-in social science specialists in order to analyse and interpret this information from the perspective of furthering the understanding of the mechanisms for effective interaction with civil society regarding nuclear applications and projects, including the factors underlying perception, participation and engagement.

However, although these were the specifications of the call, in the HoNESt project we have tried to go further and implement a more integrative approach, by embedding the research process in an interdisciplinary framework combining historical accounts of nuclear developments (SCRs) with social science analyses of public perceptions and stakeholder engagement. This approach creates a mutual interdependence of the research and analysis processes carried out by both disciplinary teams.

On the one hand, portraying the development of nuclear technologies in 20 countries, was not intended to produce a set of comprehensive histories. Instead the very objective of SCRs has been to provide social scientists with the empirical basis to be drawn upon for perception and engagement studies. On the other hand, following this approach social scientists have to make use of secondary sources mostly without being able to explore the original references, due overall to the language barriers (bear in mind that HoNESt deals with sources more than 20 national/regional official languages)

Against this background the challenge has been to develop a methodology that enables social scientists to analyse the data and reports delivered by HoNESt historians – given the differences in disciplinary norms within their respective fields. In the first place, contents of SCRs were compiled on the basis of historian's research methods, and were framed by a chapter structure commonly decided upon by historians and social scientists. To further underline the interdisciplinary character of HoNESt, and at the same time create SCRs that meet social scientists' needs, members of both disciplines developed a document containing guiding questions historians should aim to take into account when compiling their reports.

This document, the so-called 'Guiding Framework' (D.3.1), was devised to help historians in creating SCRs that enables social scientists to understand how different societies have reacted to nuclear developments. The framework requires historians to consider and report on the broader political and societal context within their particular country and the changes that have occurred over time. This provided social scientists with a deeper understanding of why certain events took place and why decisions were taken. Besides emphasizing the need for important facts and figures, e.g. key dates, list of reactors, or data on electricity production, the document specifies the following four issues to be addressed by historians:

- **Events:** For each country, historians should provide a succinct narrative of the course of specific civil nuclear developments that affected this country and citizens since 1950, emphasizing and discussing the key events during this time. Ideally each report should cover five events referring to occasions when important decisions were made or when citizens became engaged in the issue.

- **Actors:** This topic is interested in who the main actors were that have been involved in the civil development of nuclear energy in the time since 1950. Actors can be understood as collective groups sharing interests, positions, cultural features, etc. They can be sometimes represented by individuals holding social, community or institutional positions, or stand out by their active engagement with the issue. Possible actor types encompass *'promotors'* (e.g. companies, interest organizations, political parties), *'receptors'* (e.g. civil society organisations, public in general, being affected by nuclear developments in positive and/or negative ways), and *'regulators' or public authorities* (policy makers on different levels).

- **Arguments and behaviours:** This issue is about the kinds of discussions that took place within a country about nuclear developments since 1950. These discussions may have been verbal or written and may have taken place at a specific event, or be associated with a distinctive point in the historical development of nuclear energy. Of specific interest are the behaviours of different actors regarding the event. Here it is important to reflect the messages as they were conveyed at the time.

- **Public engagement:** Since the limitations of a one-way information process from institutions to society more and more has become visible, interacting with the public seems to be the means of choice to make (energy) policy decisions socially acceptable. Against this background, historians should provide information on four types of engagement: *'public communication'* (information is conveyed by promoters to the public), *'public initiated communication'* (information is conveyed by the public to regulators or nuclear companies), *'public consultation'* (following a process initiated by the promoters, information is conveyed from members of the public to the promoters), and *'public participation'* (dialogue-based exchange between members of the public and the promoters). Besides depicting what type of engagement was characteristic for it, for each event historians should convey information when it took place, and who was involved.

Based on these guidelines to data collecting and structuring the reports, country reports were produced that served the needs of social scientists both with respect of analysing engagement activities of actors seeking to support or oppose nuclear power, and drawing conclusions on how social actors perceive and evaluate nuclear energy – in a country and a cross-country perspective.

The present deliverable, D.3.6, offers the 20 SCR that had achieved both internal validation by the partners involved in WP3 regarding the objectives set by HoNESt, and external validation by stakeholders and experts. The SCR reports are designed to assemble information and research results on the history of the relations between nuclear energy and society in a structured, accessible manner, and to document the findings with references. The purpose of the country reports is threefold, addressing three different audiences:

1. to provide basic elements of narrative and analysis for further historical research by HoNESt researchers
2. to provide information, context and background for further analysis for HoNESt's social science researchers
3. to provide accessible information on nuclear-societal relations in the various countries for the purposes of outreach and communication with stakeholders (civil society, industry, associations, policy makers, journalists).

Consequently, the SCRs have been used as the basis for further research within HoNESt both by historians and social scientist in working packages 2, 3 and 4, and in the interaction with stakeholders (see external validation section below). Concretely, the following consortium deliverables make explicit use of the findings of the SCRs validated here:

Deliverable #	Title
2.11	Comparative and transnational analysis on preliminary identification of key factors underlying civil nuclear developments and applications
2.12	Case studies reports: In-depth understanding of the mechanisms for effective civil nuclear developments and applications: selected case studies
3.7	In-depth case studies reports (main reports) (External Deliverable)
4.2	Comparative cross-country analysis on preliminary identification of key factors underlying public perception and societal engagement with nuclear developments in different national contexts
4.3	Case studies reports: In-depth understanding of the mechanisms for effective interaction with civil society: selected case studies
4.4	Integrated comparative report for in-depth understanding of the mechanisms for effective interaction with civil society

A key feature of HoNESt is the intensive collaboration of historians and social scientists. The ultimate aim of this interdisciplinary endeavour is to explore nuclear-society interactions in a historical perspective in terms of both public engagement and public perception and discover mechanisms that shape the interaction.

Validation processes (internal and external)

Both the Call itself and the DoA imposed the inductive approach on data collection adopted by HoNESt. Before HoNESt could venture to explain why something happened (in its second phase), HoNESt had to provide substantiation of what happened by making use of the best available evidence. There was no imperative to fit the country reports into the existing literature and produce novel arguments, but rather to be systematic in the process of collecting, analyzing and interpreting the evidence in order to answer the questions at stake. For over 20 countries with widely different historiographies, ranging from non-existent to huge, the resulting task was challenging, and implied making use of a variety of sources depending on the case. The SCR had undergone successive validation processes, internally within the consortium, and externally once the SCRs were made available for discussion with stakeholders, which feedback has now been included in the SCRs.

The internal process of validation included a series of scoping pilot exercises and draft elaborations which were subsequently evaluated within the consortium. The scoping-pilot exercises for data gathering (D.2.2) and short country reports (D.2.3) showed the feasibility of the approach taken by HoNESt by month 6. The scoping-pilots were evaluated by WP3 (D.3.2 and D.3.3), allowing for the fine-tuning of the strategy. For instance, from the interaction of Historians and Social Scientists, it emerged that, while the historical context was well covered in most of the early drafts by historians, the societal aspect needed more emphasis and a more detailed description and classification in the SCR in order to be of use for the social scientist analysis in subsequent phases of the project. Successive drafts approached these objectives. The SCR drafts elaborated by month 12 were subject to an individual evaluation process (D.3.4). The evaluation paid particular attention to the fact that, the reports constitute the primary sources for the social sciences phase of the project in WP4 and WP5. As such, the fulfilment of the Guidance Framework (D.3.1) constituted the main criteria of the evaluation. By month 12 some of the short country reports achieved a higher degree of usability than others from a social science perspective, but in general most of the reports were found to be satisfactory. During the final months before the first version of the SCR, the WP2 partners in charge of the elaboration of the reports had received detailed feedback for the final harmonization, with a focus on structure and technical correction of the texts.

As expected, the process has been one of learning by doing. The time and resources spent on scoping exercises, e.g. for data gathering (D2.2, D3.2) or pilot country reports (D2.3) provided important lessons to refine the guidance issued. Thanks to these interactions, and in response to comments from the social science team mediated through WP3, the SCR and the GF itself have been through two major structural and analytical changes. It is possible to see the transformation in structure and analysis by comparing the preliminary and final versions of the reports which are available in M-Files, the Databank of the HoNESt project (https://honest.cloudvault.m-files.com/).

To some extent, variations across the SCR were unavoidable. These variations enrich HoNESt historical accounts. The heterogeneity issue was raised in WP3 reports (specifically in WP3.4). Yet, we need to emphasize that the process of convergence of the SCRs has been huge following the successive rounds of revisions and cross validation. Table 1 provides an overview of how the SCRs converged towards a far more homogeneous set in D.3.6 as they kept including the requested sections and data as the work progressed. This was direct result of the collaboration between historians and social scientist in WP3, and of the multiple rounds of revisions.

Table 1 Short country reports convergence

	Scoping pilots	Preliminary versions	Validated Version
Deliverable(s)	2.2 and 3.2	2.4 and 3.4	3.6
DoA date	31/12/15	31/8/16	28/2/17
Submitted	31/12/15	31/8/16	17/3/17
Nº of country reports	4	21	20
Word count (mean)	10252	13448	20355
standard dev	7606	9655	7002
CV	**74%**	**72%**	**34%**

Sources: HoNESt M-files.

Note: the coefficient of variation (CV) is a statistical measure of dispersion of a data series around the mean. It is calculated as the ratio of the standard deviation to the mean. In this case it reflects the fact that the length of the SCR reports varied less from each other in each consecutive version.

The collaboration between social scientists and historians provided structure, direction and meaning to the compilations produced by historians. The Guidance Framework has been practical and productive; it has helped us to understand the mechanisms that shape the interaction between nuclear industry and civil society. The framework is also simple enough to host data from very different political, social and ideological environments. In other words, the SCRs produced by HoNESt (D.3.6), through the many interactions procured in WP3, are a distinct product from what the historians or the social scientists would have produced on their own in the absence of the collaborative framework favored by the HoNESt structure.

The external validation process began before the first submission of the SCRs. Some of the SCRs received external feedback from stakeholders already during their initial writing process (for instance Sweden, Spain or the UK some the interviewees gave feedback on the early drafts which included members of supervisory authorities, industry, government and activist).

All of the SCRs were reviewed by an external reader prior to its first submission to the Commission in 2017. This expert reviewer had a background in nuclear engineering and a career in the nuclear field for many years. Yet, the authors of individual SCRs remain responsible for the final content of the reports, which are not necessarily the views of the Consortium or the Commission.

The 2017 versions of the SCRs were made available to the public on the website of HoNESt since September 2017 seeking to collect feedback from the stakeholders. The existence of the SCRs have also been brought to the attention of the stakeholders present at the stakeholder events that the Consortium held in Barcelona (for Southern Europe), London (for Central and Northern Europe) and in Munich (for Eastern Europe). The collected feedback from these and other interactions has now been introduced in the SCRs, all of which have been revised. These updated versions (July 2018 update) are the ones included in this deliverable.

At the MidTerm Review, the Project Officer requested the involvement of more stakeholders who have experienced these facts from different perspectives to make sure that HoNESt document/statements remain supported by evidence. A number of independent nuclear experts covering different fields of expertise, suggested by CIEMAT, have expressed interest in becoming part of the Reading Group, which together with several of the Working package leaders of HoNESt, and the authors of the SCRs, have been working during the second half of 2018 to achieve a version of the SCRs, with such aims in mind. This process has resulted only in small changes of style and detail. The final versions (after introducing the Reading Group changes) will be published on the website of the project www.honest2020.eu as they become available.

Final Structure of the Short Country Reports (SCR)

As the reports are designed to fulfil both the needs of historians and social scientists within HoNESt, and as they reflect various research cultures and writing styles, considerable efforts were required to generate a common structure for the SRC. It responds to a process that began with guidelines provided by the Guidance Framework (D.3.1) back in September 2015. The scoping exercises and the first drafts of the SCR revealed the need for further adaptations and upgrades of the structure in order to meet the several objectives the SCRs had to achieve. The updated Guidance Framework (D.3.1 issue 4) clarified issues of terminology, scope and provided some empirical examples for each of the sections. This allowed WP2 leadership to adjust the instructions to historians - agreed in Berlin in January 2016- about the structure and contents of the short country reports. After several rounds of interaction, the final structure was fixed at the consortium meeting held in Barcelona in October 2016. It just slightly altered the original design followed in previous drafts. The 20 SCRs available at the HoNESt webpage, and to which this deliverable refers, have an identical structure shown in Figure 1.

Figure 1. Structure of HoNESt SCRs

Executive summary
1. Historical context (narrative)
2. Showcase
3. Events
4. Facts and Figures
5. References

For dissemination purposes, each SCR is designed as a stand-alone document. As a consequence, all of them are introduced with identical initial paragraphs in their Executive Summary section about their shared nature within HoNESt, before succinctly summarising the specific contents of each report.

The Historical Context (narrative) section (Section 1) provides the basic historical context to the interaction between nuclear industry and civil society in each country case. Because HoNESt focuses on the interaction between nuclear industry and society, the contextual narrative draws attention to how the nuclear sector related to society, how society perceived the nuclear sector, and how citizens participated in these debates (broadly referring to what the social science team highlighted as engagement, perception and participation). This section also includes a specific section listing the main actors involved with nuclear developments in each case, which is essential for the accessibility of the report. Unifying the actors under a single heading facilitates the analysis for the social sciences team besides helping stakeholder readers who may not be familiar with actor constellations in different countries.

Nuclear industry has developed differently in every country. The Showcase (section 2 of the report) introduces one case that demonstrates the peculiar character of the interaction between nuclear industry and civil society in each country. The reasons behind the choice of each case are made explicit at the beginning of the section. The showcase is described and analysed in greater detail and with somewhat more context than the five events of the next section. The showcase illustrates nuclear-societal relations for each country in a particularly compelling manner. When choosing the showcases, the historians were asked to bear in mind the following considerations: a) the case provides valuable information to either comparative or transnational analyses of the interaction between nuclear industry and civil society. b) The case is well documented and there is enough evidence demonstrating the interaction between nuclear industry and civil society.

In section 3, for each country, historians provide a selection key events that affected the relationship of nuclear energy and society in each of the countries since 1950. Historians are inherently reluctant to select specific events in their historical analyses, but in order to facilitate the work of the social scientist, it was agreed that every SCR must include a selection of up to 5 events. We relied on the specific expertise our partners had about their cases, and aimed for a broad coverage of nuclear history, benefiting from an open inductive approach to our event selection. Thus, partners had the freedom to choose the list of events, with no explicit instruction to include any particular type of event in their selection of events. Historians tend to avoid absolute statements about what definitely happened in the past, since that is generally impossible except on trivial points (e.g., there is no doubt when the first nuclear plant connected to the grid). Historians instead prefer to present the argument that best accounts for the largest amount of relevant evidence with the least number of suppositions. Historians favour the most parsimonious interpretation that takes account of the most available evidence. Thus, their choice of events, leads to the construction of arguments that builds on the historical evidence collected. Yet, it is important that all choices are transparent and there is a reason why this set of events was chosen and not another one. To made explicit the reasons behind the choices made, section 3 begins with a critical view of the selection process of the five events. Subsequently, the five events are analysed in depth one by one zooming in on the specifics of actors, engagement and communication activities, etc. The analyses are done through the lens of the analytical framework provided by the social science team (D.3.1 issue 4). The common framework guarantees that there will be enough comparative material available for the next step of the project.

WP2 partners came forward with almost a hundred events, which have been important for understanding the evolution of the relationship of society and nuclear energy in each of the countries, according to their deep knowledge of the nuclear history of each case. The picture that emerges provides full historical coverage with events proposed expanding across the whole timeline of the development of civil uses of nuclear energy in Europe and beyond (from the early 1950s to 2016). The events also cover a rich variety of occasions marking the development of the nuclear sector, including purely national events, events impacted to a varying degree by international/transnational events and factors, and events leading to support for, or rejection of, nuclear power. Events also varied with regard to technological, sociological and political aspects.

Section 4 of the SCRs, includes a basic set of facts and figures about the nuclear industry and the electricity/energy sector in each country. In most cases, it also includes a brief chronology of events and abbreviation list. The Facts and Figures section was unified for all countries thanks to the efforts made by Dr. Aisulu Harjula from the LUT team.

Finally, all reports include a reference section including the bibliography, archives and interviews utilized by the researchers in the elaboration of the report. We must highlight the breadth and depth of the sources used by the members of the consortium in the preparation of their reports: Consortium partners carried out research in almost 100 archives, including industry, government and other national agencies, private foundations and, scientific institutions. Special mention should be made of the section of oral history. Over 200 interviews have been carried out within the HoNESt project, adding to the over 100 pre-existing interviews which views had also been included in the reports. Interviews include members of the nuclear industry, politicians, scientists, activists, and civil society representatives.

Preferred citation for SCRs

The preferred citation is to individual SCRs, acknowledging the authorship to the responsible partners, but recognising the nature of the document as a HoNESt Consortium deliverable output. As a general guideline, we propose the following:

[Author (s)], [Country] *Short Country Report* [Version], in History of Nuclear Energy and Society (HoNESt) Consortium Deliverable 3.6.

Indicating the version is required given that we anticipate potential updates to the contents of the SCRs as the interaction with stakeholders develop in the subsequent phases of the project. Shall these occur, the updates to the SCRs will be published on the website of the project www.honest2020.eu, making clearly visible the date of the update.

Yet, some of the SCRs have been subsequently reworked and published elsewhere. When this happens, the published version, rather than the deliverable shall be cited.

Validated SCRs

Austria

Forstner, C. (2018) "Austria Short Country Report (vesion 2018)" in *History of Nuclear Energy and Society (HoNESt) Consortium Deliverable* Nº 3.6. [available at: http://www.honest2020.eu/sites/default/files/deliverables_24/AU.pdf]

Published as:

Forstner, C. (forthcoming 2019): "The Failure of Nuclear Energy in Austria: Austria's Nuclear Energy Programs in Historical Perspective." *Deutsches Museum Studies 3*. Available from: https://www.deutsches-museum.de/verlag/aus-der-forschung/studies/

Belarus

Stsiapanau, A. (2018) "Belarus Short Country Report (version 2018)", in *History of Nuclear Energy and Society (HoNESt) Consortium Deliverable* Nº 3.6. [available at: http://www.honest2020.eu/sites/default/files/deliverables_24/BY.pdf]

Bulgaria

Tchalakov, I. and Hristov, I. (2018) "Bulgaria Short Country Report (vesion 2019)" in *History of Nuclear Energy and Society (HoNESt) Consortium Deliverable* Nº 3.6. [available at: http://www.honest2020.eu/sites/default/files/deliverables_24/BG.pdf]

Denmark

Meyer, J-H. (2018) "Denmark Short Country Report (vesion 2018)" in *History of Nuclear Energy and Society (HoNESt) Consortium Deliverable* Nº 3.6. [available at: http://www.honest2020.eu/sites/default/files/deliverables_24/DK.pdf]

Published as:

Meyer J-H. (forthcoming 2019): "'*Atomkraft, nej tak*': How Denmark did not introduce commercial nuclear power plants" *Deutsches Museum Studies* 3. Available from: https://www.deutsches-museum.de/verlag/aus-der-forschung/studies/

Finland

Michelsen, K.E. and Harjula, A. (2017) "Finland Short Country Report (vesion 2017)" in *History of Nuclear Energy and Society (HoNESt) Consortium Deliverable* Nº 3.6. [available at: http://www.honest2020.eu/sites/default/files/deliverables_24/FI.pdf

France

Lehtonen, M. (2018) "France Short Country Report (vesion 2018)" in *History of Nuclear Energy and Society (HoNESt) Consortium Deliverable* Nº 3.6. [available at: http://www.honest2020.eu/sites/default/files/deliverables_24/FT.pdf]

East Germany/GDR

Helmbold, B. (2018) "German Democratic Republid (GDR) Short Country Report (vesion 2018)" in *History of Nuclear Energy and Society (HoNESt) Consortium Deliverable* Nº 3.6. [available at: http://www.honest2020.eu/sites/default/files/deliverables_24/GDR.pdf]

West Germany/FRG

Kirchhof, A.M.and Trischler, H. (2018) "Federal Republic of Germany Short Country Report (vesion 2018)" in *History of Nuclear Energy and Society (HoNESt) Consortium Deliverable* Nº 3.6. [available at http://www.honest2020.eu/sites/default/files/deliverables_24/FRG.pdf]

Published as:

Kirchhof, A., Trischler, H. (forthcoming 2019): "The History behind West Germany's Nuclear Phase-Out", *Deutsches Museum Studies* 3. Available from: https://www.deutsches-museum.de/verlag/aus-der-forschung/studies/

Greece

Arapostathis, S., Fotopoulos, Y, Vlantoni, K and Tympas, A.(2018) "Greece Short Country Report (vesion 2018)" in *History of Nuclear Energy and Society (HoNESt) Consortium Deliverable* Nº 3.6. [available at: http://www.honest2020.eu/sites/default/files/deliverables_24/GR.pdf]

Hungary

Adamsom, M. and Pallo, G. (2017) “Hungary Short Country Report (version 2017)” in *History of Nuclear Energy and Society (HoNESt) Consortium Deliverable* Nº 3.6. [available at: http://www.honest2020.eu/sites/default/files/deliverables_24/HU.pdf]

Italy

Gerlini, M. (2017) “Italy Short Country Report (vesion 2017)” in *History of Nuclear Energy and Society (HoNESt) Consortium Deliverable* Nº 3.6. [available at: http://www.honest2020.eu/sites/default/files/deliverables_24/IT.pdf]

Published as:

Gerlini, M. (forthcoming 2019): “The Rise and Fall of Nuclear in Italy” *Deutsches Museum Studies* 3. Available from: https://www.deutsches-museum.de/verlag/aus-der-forschung/studies/

Lithuania

Stsiapanau, A. (2018) “Lithuania Short Country Report (version 2018)”, in *History of Nuclear Energy and Society (HoNESt) Consortium Deliverable* Nº 3.6. [available at: http://www.honest2020.eu/sites/default/files/deliverables_24/LT.pdf]

Netherlands

Berkers, E. (2018) “The Netherlands Short Country Report (vesion 2018)” in *History of Nuclear Energy and Society (HoNESt) Consortium Deliverable* Nº 3.6. [available at: http://www.honest2020.eu/sites/default/files/deliverables_24/NL.pdf]

Portugal

Gaspar, J. (2018) “Portugal Short Country Report (vesion 2018)” in *History of Nuclear Energy and Society (HoNESt) Consortium Deliverable* Nº 3.6. [available at: http://www.honest2020.eu/sites/default/files/deliverables_24/PT.pdf]

Russia

Melnikova, N., Bedel, A., Artemov, E., Volochin, N., Mikheev, M. (with the participation of Tatiana Kasperski and Paul Josephson) (2018) “Russia Short Country Report (vesion 2018)” in *History of Nuclear Energy and Society (HoNESt) Consortium Deliverable* Nº 3.6. [available at: http://www.honest2020.eu/sites/default/files/deliverables_24/RU.pdf]

Published also as:

Melnikova, N.V., Artemov, E.T., Bedel, A. E. Voloshin, N. P. Mikheev, M. V. *The History of Interaction between Nuclear Energy and Society in Russia (in Russian and English).* Ekaterinburg: Ural University Press 2018. Available from: http://www.ihist.uran.ru/news/428/_aview_b523

Spain

Rubio-Varas, M., De la Torre, J., Espluga, J., Presas i Puig, A. “Spain Short Country Report (version 2018)”, in *History of Nuclear Energy and Society (HoNESt) Consortium Deliverable* Nº 3.6. [available at: http://www.honest2020.eu/sites/default/files/deliverables_24/ES.pdf]

Sweden

Kaijser, A. (2018) "Sweden Short Country Report (vesion 2018)" in *History of Nuclear Energy and Society (HoNESt) Consortium Deliverable* Nº 3.6. [available at: http://www.honest2020.eu/sites/default/files/deliverables_24/SW.pdf]

Published as:

Kaijser, A. (forthcoming 2019): "The Referendum that Preserved Nuclear Power and other Critical Events in the History of Nuclear Power in Sweden." *Deutsches Museum Studies* 3. Available from: https://www.deutsches-museum.de/verlag/aus-der-forschung/studies/

United Kingdom

Butler, S. and Bud, R. (2018) "United Kingdom Short Country Report (version 2018)" in *History of Nuclear Energy and Society (HoNESt) Consortium Deliverable* Nº 3.6. [available at: http://www.honest2020.eu/sites/default/files/deliverables_24/UK.pdf]

Ukraine

Kasperski, T. (2018) "Ukraine Sweden Short Country Report (vesion 2018)" in *History of Nuclear Energy and Society (HoNESt) Consortium Deliverable* Nº 3.6. [available at: http://www.honest2020.eu/sites/default/files/deliverables_24/UA.pdf]

United States of America

Josephson, P.R. (2018) "United States Short Country Report (vesion 2018)" in *History of Nuclear Energy and Society (HoNESt) Consortium Deliverable* Nº 3.6. [available at: http://www.honest2020.eu/sites/default/files/deliverables_24/USA.pdf]

WP2

Austria

Short Country Report

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HoNESt History of Nuclear Energy and Society

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DIALOGIK

EHU Europos humanitarinis universitetas

TU/e Technische Universiteit Eindhoven University of Technology Where innovation starts

Friedrich-Schiller-Universität Jena

Swedish Defence University

GRE

KTH

LUT Lappeenranta University of Technology

upna Universidad Pública de Navarra

UPMC Sorbonne Universités

The University Of Sheffield.

Science Museum

spi Sociedade Portuguesa de Inovação

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Executive summary

This report belongs to a collection of 20 short country reports on the History of Nuclear Energy and Society (HoNESt, project Ref.662268). The reports tackle the complex sociotechnical system around nuclear energy. Nuclear developments, notably nuclear energy, are closely intertwined with social, economic, environmental, political and cultural spheres. Nuclear energy is also a globalized system involving transnational transfers of knowledge, materials, technologies, people and products including electrical power, medical elements, toxic wastes and other environmental hazards, materials, capacities and knowledge that must be carefully safeguarded. Nuclear energy is a complex social and technological phenomenon that influences societies but is also shaped by societies.

The short country reports are designed to assemble information and research results on the history of the relations between nuclear energy and society about all the different country cases in an accessible manner, and to document the findings with references.

The purpose of the country reports is threefold, addressing three different audiences:

1. to provide basic elements of narrative and analysis for further historical research by HoNESt researchers;
2. to provide information, context and background for further analysis for HoNESt's social science researchers;
3. to provide accessible information on nuclear-societal relations in the various countries for the purposes of outreach and communication with stakeholders (civil society, industry, associations, policy makers, journalists).

This report focuses on the history of the relations between nuclear energy and society in Austria. The main findings are:

Austria planned to construct three nuclear power stations from the 1970s onwards. Austria had a long tradition of radioactivity and nuclear research dating back to the beginnings of the 20th century, and transnational knowledge transfer was crucial for Austria's plans. The transfer started in the 1950s with the United States' Atoms for Peace program. Industry and utilities, academia, and government struggled for the leadership in the process of implementation of this knowledge. Industry and government collaborated leading to the founding of the Austrian Research Centre for the Peaceful use of Nuclear Energy in Seibersdorf. Austrian universities received their own TRIGA reactor from the USA, located in Vienna. The Seibersdorf institute took a leading role together with industry as consultant during the construction of the NPP in Zwentendorf from 1971 onwards. At the beginning of that decade local anti-nuclear protest groups emerged which remained ignored before forming a broad national movement. These increasingly public concerns led the Austrian Chancellor Bruno Kreisky to call for a referendum in mid-1978, which resulted in stopping the power plant at Zwentendorf before it went critical.

1. Historical Context (narrative)

1.1. Introduction to the historical context

Austria is better known for its hydropower and "green" energy production after 1945 than for the implementation of nuclear energy. For instance, the completion of the large-scale project of the Alpine hydropower plant in Kaprun in 1955 against the objections of the Allied Forces after World War II became one of the founding myths of the second Austrian Republic. The construction of the hydropower plant started shortly after the Nazis had seized power in Austria but could not be finished before the end of WWII and was then resumed after its conclusion. Likewise, many Austrian physicists were engaged in the first Austrian attempt to establish nuclear energy after the annexation by Germany in the German nuclear weapons project (*Uranverein)* after 1941. This Austrian-German cooperation and therefore the whole program failed with the defeat of the German Reich and its allies of the Axis Powers in 1945. After the war Austria was divided like Germany into four occupation zones. Despite this, the idea of generating energy from nuclear fission was still present in Austria's post-war politics. However, lack of sufficient funds prevented the development of a national nuclear energy program. This situation changed after the launch of Atoms for Peace with Eisenhower's famous speech in December 1953. Immediately after Austria regained its national sovereignty in March 1955, the Austrian Council of Ministers decided to build a research reactor with American support. But it took another seven years until the research reactor finally went into operation. This corresponds to Austria's second attempt to implement nuclear energy, specifically, nuclear energy research. In the course of this attempt, three research reactors were brought into service with the aim of developing a nuclear energy production program in Austria. This third attempt resulted in the decision of the Austrian government under Chancellor Bruno Kreisky in 1971 to build a nuclear power plant near Zwentendorf in Upper Austria. However, this plant never went into operation. After its completion in 1978 the Austrian population voted against the start-up of the plant in a referendum with a small majority (50.47%). As a result, this third attempt to implement nuclear energy in Austria failed, and even today, the image of a "nuclear free" country is central to Austria's identity.

1.2. Contextual narrative

1.2.1. The beginning of the Austrian program

In contrast with the dominant German role in the Uranverein, the Austrian contribution has attracted only little attention. It was Austria's first attempt to acquire nuclear energy. Therefore a brief sketch of the Austrian activities will be given here (Fengler 2014; Fengler and Forstner 2008; Fengler and Sachse 2012).

In Vienna two centres of nuclear research existed, one was located at the 2nd Institute for Physics of Vienna University and the other at the *Institute for Radium Research* of the *Austrian Academy of Science*. The *Radium Institute* was opened in 1910 and became (due to Austria's monopoly on pitchblende, the raw material for radium production) one of the major centres of the international network of the so called "radium-activists". One astonishing feature of the Institute at that time was the high percentage of female staff, which the historian Maria Rentetzi tried to trace back to the social and political milieu of the "Red Vienna" of the 1920s and 1930s (Rentetzi 2004a).

After the *Anschluss* (reconnection) of Austria to Germany in 1938 about a fourth of all Austrian nuclear researchers lost their jobs, principally due to anti-Jewish sanctions, and the number of women, which were employed at the Radium Institute plummeted by half within the course of a year. Two positions for full professors and two for associate professors at the physics departments of University of Vienna were subsequently filled by the appointment of National Socialist-scientists or opportunistic fellow travellers. These individuals assured themselves of the support of the Third Reich, and then proceeded to reorganize nuclear research in Vienna: the 2nd Institute for Physics and parts of the Institute for Radium Research were merged, creating the *Four-Year-Plan Institute for Neutron Research* in 1943 (Reiter 2004a; Reiter 2004b; Reiter 2001a).

Already before the founding of the Four-Year-Plan-Institute the discovery of nuclear fission attracted the interest of Austrian physicists and the German *Uranverein* opened new possibilities for their research, which were embraced by the Austrians. The Austrian research carried out in the *Uranverein* had mainly the character of fundamental research, sometimes specifying the *Uranmaschine* (uranium nuclear reactor) as the aspired application.[1] Scattering cross sections of neutrons in uranium and the increase of neutrons in fission reactions were a central topic of the investigations. For this analysis spherical symmetric geometries with layers of paraffin and uranium were used in the experiments. Also (n, 2n)-processes in lead were analysed and extrapolated to reactions in uranium.[2] It can be noted that, later in the post-war era, the same experimental setups and geometries were used, e.g. in the Habilitation of Karl Lintner (Lintner 1949), the assistant of Georg Stetter at that time. However, besides all kinds of fundamental research, building a nuclear reactor was the core aim behind the Austrian nuclear activities as the application for a patent for a reactor from Georg Stetter, the head of the Four-Year-Plan Institute, shows.[3] This thesis is supported by a statement at the end of a report about the engagement of the 2nd Physical Institute of the University of Vienna in the German *Uranverein* where the authors claim that, for a continuation of large-scale experiments for the uranium machine, about two tons of uranium metal, one ton of paraffin and possibly 500kg heavy water were needed.[4]

[1] In the course of the American ALSOS mission the reports of the Uranverein were confiscated and transferred to the United States. Today the "G-reports" are disclosed for research in the Archives of the *Deutsches Museum* in Munich and enlighten the Austrian role in the *Uranverein*. Josef Schintlmeister, „Die Aussichten für eine Energieerzeugung durch Kernspaltung des 1,8 cm Alphastrahlers," Bericht vom 26.2.1942, Archiv des Deutschen Museums München, Museumsinsel 1, 80538 München, und Willibald Jentschke und Karl Kaindl, „Vorläufige Mitteilung über die Abhängigkeit der Größe der Resonanzabsorption bei verschiedenen Temperaturen," Bericht vom 5. September 1944. Archiv des Deutschen Museums, München, sowie „Bericht über die Tätigkeit des II. Physikalischen Institutes der Wiener Universität und des Institutes für Radiumforschung der Wiener Akademie der Wissenschaften." Bericht vom Juli 1945, Archiv des Deutschen Museums, München.

[2] Georg Stetter und Karl Lintner, „Schnelle Neutronen in Uran (I). Der Zuwachs durch den Spaltprozess und der Abfall durch unelastische Streuung", „Schnelle Neutronen in Uran (II): Genaue Bestimmung des unelastischen Streuquerschnittes und der Neutronenzahl bei „schneller" Spaltung", „Schnelle Neutronen in Uran (III.): Streuversuche," Berichte vom September 1942, sowie Georg Stetter und Karl Kaindl „Schnelle Neutronen in Uran (VI): Der (n,2n)-Prozess in Blei und die Deutung der Vermehrung schneller Neutronen in Uran," nicht datiert, vermutlich Ende 1942. Alle Archiv des Deutschen Museums, München.

[3] Patent application of Georg Stetter at the Reichspatentamt 14. Juni 1939, Nachlass Georg Stetter, Sondersammlung der Österreichischen Zentralbibliothek für Physik, Boltzmanngasse 5, A-1090 Wien. After the war Stetter made demands because of his patent application, however they were denied in the lawsuit. See also Archiv der Österreichischen Akademie der Wissenschaft, Ignaz-Seipl-Platz 2, A-1010 Wien, Bestand Institut für Radiumforschung, Karton 55, Fiche 812.

[4] G-Report 345, p. 23. Archiv des Deutschen Museums, Museumsinsel 1, 80538 München.

At the end of WWII large parts of the equipment and staff were transferred to the Western zones of the Allied-occupied Austria to protect them from bombings and, presumably, from the Soviet troops. The reasons for the failure of this program are the same as for in Germany (Walker 1989; Walker 2007): in comparison to other war projects the priority level on the nuclear energy program was low and at the end of the war the lack of resources led to important delays. For example in November 1940 the Austrian Academy of Science decided to build a neutron generator for the Radium Institute. The generator was ordered in 1941 with a delivery period of 36 months. In June 1942 a new priority level was granted and the delivery time was reduced to 22 months. Delivery problems from German suppliers delayed the project again and again. Finally the City of Vienna refused the building license for the necessary modification of the Institute building and at the end of 1944 a new place for the generator had to be found. In March 1945 a gym in Krems, a city about 60km to the west of Vienna, was chosen as the new location for the neutron generator. However, the Liberation by the Allied forces ended all plans installing the generator and stopped other parts of Austria's first attempt to develop nuclear energy[5].

Another often overlooked chapter of Austria's nuclear history concerns the production of heavy water. In 1950 Colonel Goussot, a member of the French forces in Tyrol, asked the theoretical physicist Ferdinand Cap from Innsbruck University for his expertise concerning the production of heavy water in Tyrol during the war. In his report Cap described an "apparatus" for the production of heavy water on the basis of electrolytic separation similar to the method of Norsk-Hydro A.G. in Norway. Furthermore he mentioned test plants for the production of heavy water in Tyrol that were built during the war. From the report it seems that these test plants never reached the level of a large scale production. However, as Prof. Cap, who provided the report to the author, stated that all production facilities were destroyed by the French forces and no further evidence for the existence of the production of heavy water in Tyrol could be found.[6]

1.2.2. Liberation, Reorganization and Reconstruction

[5] Correspondence of Gustav Ortner with the Helmholtz-Gesellschaft, Düsseldorf, the C.H.F. Müller AG, Hamburg, and the Reichsamt für Wirtschaftsaufbau in Berlin (1940–1945), Archiv der Österreichischen Akademie der Wissenschaft, Ignaz-Seipl-Platz 2, A-1010 Wien, Bestand Institut für Radiumforschung, Karton 32, Fiche 444-447.

6 Bericht von Ferdinand Cap für Colonel Gousset über eine Anlage zur Produktion von schwerem Wasser in Tirol, 24. November 1950. Kopie im Archiv des Autors, freundlich überlassen von Prof. Dr. Ferdinand Cap. Interview mit Ferdinand Cap conducted by the author, Innsbruck, August 3, 2007. Archive of the author.

The efforts that were made after the Liberation by the Allied forces in 1945 can be described best as "back to 1938" before the *Anschluss* – not to mention that there was an authoritarian state with political repression in Austria from 1934 onwards. These efforts regarded personnel changes in the course of "denazification" and changes in the structure and organization of research. One of the first tasks was the dissolution of the Four-Year-Plan Institute for Neutron research and the restoration of the former organization of the university and academy institutes. In the course of the "denazification", former members of the National Socialist party were removed from the institutes, among them Georg Stetter, the head of the 2nd Institute for Physics and Gustav Ortner, the head of the Radium Institute, who both got their jobs after 1938 because of the anti-Jewish measures of the Nazis. At the same time, some of the forced Austrian emigrants from WWII were invited to come back. Stefan Meyer, the former head of the Radium Institute before 1938, was appointed as director of the institute again, while Berta Karlik became the managing director of the institute (Reiter and Schurawitzki 2005). In 1947 Stefan Meyer retired and Berta Karlik was appointed as new director, which also marked the beginning of a new era for the institute. She had finished her PhD at the University of Vienna in 1928 and started her research at the Radium Institute in 1928/29 and became a graduate assistant in 1933. In the intervening time she studied a year under William Bragg at the Royal Institution in London with the help of a fellowship of the *International Federation of University Women* from November 1930 to December 1931. In 1935 she was invited to Sweden for several months to undertake research. After finishing her Habilitation the University of Vienna awarded her the *venia legendi* in 1937. She received several fellowships until she was appointed as lecturer with remuneration (Dozentin mit Diäten) in 1942. She never took part in the research program of the German *Uranverein* and tried to develop her own line of research within the institute. It was not clear at all whether she could continue her work after the Nazis had seized power in Austria. Her request for an extension of her fellowship was denied by the German watchdog for the Viennese University (Kurator der wissenschaftlichen Hochschulen in Wien) with the argument, that there were no chances for females in academia. Thanks to an intervention of the Director of the institute Gustav Ortner, it was made possible for her to stay at the Radium Institute with regular benefits. In a report of the NS-Dozentenführer (Leader of the NS organization for university lecturers) she is described as non-politicised. All in all it seems that she tried to find her own scientific way without attracting any political attention – neither positive nor negative for the NS-government.[7] Her unobtrusive behaviour during the NS-era made her post-war career possible.

In contrast to the situation in Germany, there seemed to have been no formal restrictions for nuclear research in Austria after the Liberation in 1945. Moreover the Allied and, in the first instance, the American troops supported the Austrian scientists in the reorganization of their research facilities especially in safe transport of the radium standard compounds and instruments, that were stored in the Western zones of Austria at the end of the war.[8] Contemporary witnesses, like Karl Lintner, who was the assistant of Stetter during the war, do not remember any restrictions for nuclear research, e.g. Lintner finished his Habilitation thesis in 1949 on the interaction of fast neutrons with the heaviest stable nuclei (Hg, Tl, Bi and Pb) (Lintner 1949). His post-war research was mainly based on the work that was carried out in the German Uranverein.[9] Prof. Cap does not recall restrictions either.[10] The testimonials of the contemporary witnesses are supported by the documents found in the Archive of the Austrian Academy of Science. For example in 1947 Berta Karlik asked the German contractor of the above mentioned neutron generator to fulfil their commitments and deliver the generator. However, this request was denied due to the restrictions for nuclear research in Germany and some parts of the equipment had already been dissembled and confiscated by the Allied forces.[11] In 1966 Karlik offered 400kg of pure uranium nitrate for sale, which was owned by the Radium Institute since the war and was at that time supplied by the Germans for the extraction

[7] Archiv der Universität Wien, Postgasse 9, A-1010 Wien, Personalakte Berta Karlik, Aktnr. 2152.

[8] Adrienne Janisch: Wie das Radium nach Wien zurückkam. Ein 10-Tonnen-Lastkraftwagen war zum Transport von zwei Gramm nötig (Radio Wien, 18. Mai 1946), Archiv der Österreichischen Akademie der Wissenschaft, Ignaz-Seipl-Platz 2, A-1010 Wien, Bestand Institut für Radiumforschung, Karton 8, Fiche 138. See also the correspondence between Berta Karlik and the allied forces, Karton 55, Fiche 812.

[9] Interview with Karl Lintner conducted by the author, Vienna June 9, 2007.

[10] Interview with Ferdinand Cap, conducted by the author, Innsbruck, August 3, 2007.

[11] Letter from Hans Suess to Berta Karlik April 20th 1947, and letter from C.H.F. Müller Aktiengesellschaft to Berta Karlik June 8, 1949, Archiv der Österreichischen Akademie der Wissenschaft, Ignaz-Seipl-Platz 2, A-1010 Wien, Bestand Institut für Radiumforschung, Karton 32, Fiche 448.

of uranium isotopes.[12] Considering all these aspects it seems plausible that there were no legal restrictions for nuclear research in Austria after the war.

While the reconstruction of the Radium Institute was still in progress the re-appointed Director Stefan Meyer started to reactivate his old networks from the pre-war era. The Radium Institute in Vienna was, in addition to Paris, the second depository of a primary radium standard and Stefan Meyer was elected as secretary of the International Radium Standard Committee after its foundation in 1910 and later as its president (Reiter 2001b, 113–14). Whereas networks are based on mutual confidence and trust in the competence, professional skills, methods and reliability of each member, measurements and a publication of a member of the German Physikalische-Technische Reichsanstalt in Berlin seemed to challenge the exactness of the Austrian radium standard and the competence of the members of the Radium Institute.[13] Therefore Meyer's first task was to restore the reliability and credibility of the Institute as keeper of the second radium standard. In the course of this project he hired two PhD students asking them to probe the exactness of the Viennese radium standards. In the end the exactness was proved and the credibility of the Radium Institute was re-established (Meyer 1945; Kremenak 1948). The success of Meyer's, as well as Karlik's, endeavours can be recognized in the appointment of the Radium Institute as Austrian distribution centre for radioactive isotopes, which controlled the import and distribution of radioactive material in Austria from Harwell (UK) since 1949 and from the US since 1952 (Karlik 1950).

Nevertheless, cold winters, lack of resources and funds created delays in this regular business at the Institute until the end of the 1940s. This situation led to reduce the chances of establishing a new nuclear energy program in any foreseeable future. This issue was also illustrated by a speech on international research in nuclear physics given by the experimental physicist Fritz Regler from the Technical University of Vienna before the Industrialists' Federation in 1949. Regler emphasized in the new possibilities of nuclear physics and its

[12] Letter from Berta Karlik to the Austro-Merck G.m.b.H., October 7, 1966. Archiv der Österreichischen Akademie der Wissenschaft, Ignaz-Seipl-Platz 2, A-1010 Wien, Bestand Institut für Radiumforschung, Karton 50, Fiche 722.

[13] Archiv der Österreichischen Akademie der Wissenschaft, Ignaz-Seipl-Platz 2, A-1010 Wien, Bestand Institut für Radiumforschung, Karton 31, Fiche 427-428. See also the correspondence between Stefan Meyer and Gustav Ortner, Karton 17, Fiche 271.

application, e.g. in the non-destructive examination of materials. However, implementing a nuclear energy program seemed to him unrealistic because of the amount of necessary investments (Lackner 2000; Regler 1949).

1.2.3. Atoms for Peace in Austria

The peaceful use of atomic energy was one of the central ideas in the 1950s characterized by a public discourse and opinion dominated by a positive view over technology and progress at that time (Lackner 2000). However, it required an external incentive to translate these ideas into real opportunities for a small country like Austria. This ignition spark was given by the US President Eisenhower's famous "Atoms for Peace" speech before the UN General Assembly in December 1953 (Krige 2008; Krige 2006; Krige 2010; Hewlett and Holl 1989).

Eisenhower's envisioned program had to face the practical difficulties raised during discussions with engineers. Already before Eisenhower's speech, the Austrian Electro-Technical Society (Elektrotechnischer Verein Österreichs, EVÖ) had initiated a series of lectures on nuclear physics in 1953 and 1954. From those, it seemed that the establishment of a study group had already been planned at that time but practical aspects, like the transfer from the Society to another building, and probably the absence of a concrete perspective for such a group, delayed the constitution of the group. Nevertheless, in December 1954, a formal study group was finally founded with members of the Technical University, among them Heinrich Sequenz the former president of the TU until 1945, and members of the University, like Georg Stetter, the former head of the Four-Year-Plan Institute for Neutron, the physicists from Vienna University Hans Thirring, Erich Schmid, Karl Lintner, and of course Berta Karlik, the head of the Radium Institute, who had been a co-organizer of the first meeting, and Ministerialrat Alexander Koci as the government representative.[14]

Only five days after the constitution of the study group at the EVÖ the first government meeting on international cooperation for the peaceful use of atomic energy took place with participants of several ministries, except military or defence, but with only one representative of academia,

[14] Sitzungsbericht über die Gründung einer „Studiengruppe Atomenergie im EVÖ“ am 16.12.1954 vom 10.01.1955, Archiv der Österreichischen Akademie der Wissenschaft, Ignaz-Seipl-Platz 2, A-1010 Wien, Bestand Institut für Radiumforschung, Karton 51, Fiche 750.

namely Berta Karlik from the Radium Institute. No representative of the Austrian industry was invited. In this meeting it was decided to establish an advisory expert commission for the peaceful use of atomic energy, which was assigned to evaluate the possibilities and costs of a research reactor made in cooperation with the USA. Electricity production from nuclear energy was also discussed. However, at that time it seemed to be only a future possibility to complement other forms of electricity production.[15] After a meeting of the Council of Ministers in January 1955 and several other inter-ministerial discussions, the Minister of Education sent out a circular letter to all Austrian Universities in February 1955, in which he asked expert reports on a research reactor and on the possibility for energy production from nuclear fission.[16]

Another month later the universities had named the delegates for the commission and it was founded with subcommittees for experimental and theoretical nuclear physics, the application for nuclear energy in physics, chemistry, medicine, biology and one for the technical aspects of a nuclear energy reactor. This time all the delegates came from the universities except the one for the technical application and therefore one may imagine strong debates and opinion between the different institutions over the progress and vision of the project. Berta Karlik was assigned to conceptualize all the necessary memoranda, which underlined her central role again.[17] At that time still no representative of industry or the utilities was present.

In her report concerning the expediency of a construction of a nuclear reactor in Austria, Karlik expounded the different types of nuclear reactors, their purposes, and the costs involved. Furthermore, she gave a short analysis of the situation in other European states like France, Norway, the Netherlands, Sweden, Switzerland, Italy, West Germany, and Belgium. However, Great Britain and the United States were explicitly excluded from this analysis because of the engagement of the military in their nuclear research programs. Karlik pointed out that all these

[15] Archiv der Republik, Österreichisches Staatsarchiv, Nottendorfer Gasse 2, A-1030 Wien, Bestand BMU Atom, Zahl 157.959-INT/54.

[16] Rundschreiben des Bundesministeriums für Unterricht an die Rektorate der österreichischen Universitäten und Hochschulen vom 11. Februar 1955, Archiv der Österreichischen Akademie der Wissenschaft, Ignaz-Seipl-Platz 2, A-1010 Wien, Bestand Institut für Radiumforschung, Karton 56, Fiche 829.

[17] Correspondence between the Ministry for Education and the University of Vienna, February and March 1955, Archiv der Österreichischen Akademie der Wissenschaft, Ignaz-Seipl-Platz 2, A-1010 Wien, Bestand Institut für Radiumforschung, Karton 56, Fiche 829.

European states installed or aspired to only research reactors and the financial situation in Austria would only allow the construction of a research reactor. However, she considered the financial requirements too high for the Ministry of Education even in the case of a research reactor. Therefore, she recommended an alliance of all concerned ministries, academia and industry. Besides she pointed out to another problem concerning the lack of qualified personnel for operating a reactor. For this reason she recommended again the construction of a research reactor, where specialists could be trained in light of a possible future assignment in a nuclear power plant.[18]

The lack of qualified personnel was one of the main problems for the implementation of the project. Therefore, the Ministry of Education initiated a search for Austrian nuclear physicists abroad. Among them one of the central figures of Austrian nuclear research was eager to come back. Gustav Ortner, the former director of the Radium Institute from 1939-1945, was suggested by Karlik as coordinator of the project.[19] Ortner had held since 1950 a position as professor for experimental physics in Cairo and was in regular correspondence with Karlik even to the point of exchanging of material samples, which Karlik had sent to Ortner in Cairo.[20] Concerned about the possibility of missing this opportunity Ortner wrote a very gentle letter to the Ministry abstaining from any salary claims and Karlik on the other hand refused a request of the Ministry to name a second candidate.[21] Ortner, who finally got selected for the position of project coordinator, was sent to the US for training courses on the technique of nuclear reactors and

18 Gutachten über die Zweckmäßigkeit der Errichtung eines Reaktors in Österreich, verfasst von Berta Karlik im April 1955, Archiv der Österreichischen Akademie der Wissenschaft, Ignaz-Seipl-Platz 2, A-1010 Wien, Bestand Institut für Radiumforschung, Karton 49, Fiche 706.

19 Letter from Berta Karlik to the Bundesministerium für Unterricht, April 28, 1955. Archiv der Österreichischen Akademie der Wissenschaft, Ignaz-Seipl-Platz 2, A-1010 Wien, Bestand Institut für Radiumforschung, Karton 56, Fiche 829.

20 Correspondence between Berta Karlik and Gustav Ortner, Archiv der Österreichischen Akademie der Wissenschaft, Ignaz-Seipl-Platz 2, A-1010 Wien, Bestand Institut für Radiumforschung, Karton 46, Fiche 665.

21 Letter to the Bundesministerium für Unterricht, April 28, 1955. Letter from Berta Karlik to the Bundesministerium für Unterricht, May 4, 1955 and Letter from Gustav Ortner to Berta Karlik, May 17, 1955. Archiv der Österreichischen Akademie der Wissenschaft, Ignaz-Seipl-Platz 2, A-1010 Wien, Bestand Institut für Radiumforschung, Karton 56, Fiche 829.

was belatedly nominated as Austrian expert for the atomic energy conference in Geneva in August 1955.[22]

The Austrian Council of Ministers, the highest decision-making body of the second republic, accepted the suggestions of the expert committee based on Karlik's recommendations shortly after Austria regained its full sovereignty in March 1955 and made the decision to build a research reactor, most probably with American support. One has to remember that these developments happened during the Cold War and Austria, which was occupied by the Allies until then, regained its sovereignty only for political neutrality. As a matter of fact, Austria also received offers for building a nuclear reactor from the Soviet Union. However, although these offers were notified and forwarded to the scientists, they remained without responses, probably as a result of the conditions for the aspired integration of Austria into the Western bloc.[23] Karlik recommended the American technology for the comprehensive offer of training, supply of fuel elements and disposal of nuclear waste.[24] However, already in December 1954, in an inter-ministerial meeting only the American option was discussed even before the scientific advisory group was formed and the scientists were interviewed.[25] This indicates that the scientists may have been asked to follow the political orientation of their government.

Berta Karlik was from the beginning the central figure in the whole organization of the project and, around her, the Radium Institute and the members of the university. The Technical University only seemed to play the role of supporting actor in this project. This development led to the foundation of a separate study group at the Technical University in December 1955 to

[22] Letter from Berta Karlik to the Bundesministerium für Unterricht, Juli 16, 1955. Archiv der Österreichischen Akademie der Wissenschaft, Ignaz-Seipl-Platz 2, A-1010 Wien, Bestand Institut für Radiumforschung, Karton 56, Fiche 830.

[23] Letters from the Bundeministerium für Unterricht to Berta Karlik, June 21 and July 5, 1955. Archiv der Österreichischen Akademie der Wissenschaft, Ignaz-Seipl-Platz 2, A-1010 Wien, Bestand Institut für Radiumforschung, Karton 56, Fiche 830.

[24] Letter from Berta Karlik to H. Küpper, November 10, 1955. Archiv der Österreichischen Akademie der Wissenschaft, Ignaz-Seipl-Platz 2, A-1010 Wien, Bestand Institut für Radiumforschung, Karton 56, Fiche 830.

[25] Letter from Bundeskanzleramt – Auswärtige Angelegenheiten to Bundesministerium für Unterricht, December 6, 1954. Archiv der Republik, Österreichisches Staatsarchiv, Nottendorfer Gasse 2, A-1030 Wien, Bestand BMU Atom, Zl. 157.605-INT/54

articulate the interests of the university on the prospects of new research resources.[26] These interests were clearly formulated half a year later in a letter of this study group to the Ministry of Education, where the author Sequenz stated the importance of engineers for the new developments in nuclear energy and that a new institute equipped with a research reactor should not be assigned only to the Viennese University but that the Technical University should benefit at least from the same equipment.[27] This latent conflict created a phase of tensions in the 1960s over the question of the access to the new resources.

However, before this internal conflict broke up, Austrian scientists demonstrated unity to the rest of the world at the *First International Conference on the Peaceful Uses of Atomic Energy* in Geneva in 1955. In the preparation for the conference, the Ministry of Foreign Affairs asked for a memorandum "that shows the world, that Austria is using for many years atomic energy for peaceful purposes and is one of the leading nations in that area."[28] In comparison to the debates about Austria's accession to CERN it seems like scientists were successful with their reasoning, as it was now taken over by the politicians. Berta Karlik was asked again to prepare a report. Most of the report discussed the use of radioactive isotopes in all kind of fields: from medical to scientific and industrial applications. The last section focused on the plans concerning a reactor, where she stated:

> Austria is considering the building of a research reactor as a joint project of science and industry and is engaged in preparations. It is expected that within a period of one year it will be possible to clear the major problems as there are the juridical form of cooperation of partners in the project, the financial problem, the coordination of the research

[26] Sitzungsprotokoll vom 19.12.1955, Archiv der Technischen Universität Wien, Karlsplatz 13, A-1040 Wien, R.Z. 2787/55, p. 31.

[27] Letter from Heinrich Sequenz to the Bundesministerium für Unterricht, July 6, 1956. Archiv der Technischen Universität Wien, Karlsplatz 13, A-1040 Wien, R.Z. 2787/55, p. 32-33.

[28] „Der Welt soll gezeigt werden, dass Österreich seit Jahren Atomenergie für friedliche Zwecke verwendet und auf diesem Gebiet zu den führenden europäischen Nationen gehört." (English translation from the author), Bundeskanzleramt für Auswärtige Angelegenheiten to Institut für Radiumforschung, January 27, 1955. Archiv der Österreichischen Akademie der Wissenschaft, Ignaz-Seipl-Platz 2, A-1010 Wien, Bestand Institut für Radiumforschung, Karton 50, Fiche 727.

> programs as well as the reactor type, a time schedule, etc. – The construction of a power reactor is not considered advisable at the moment.[29]

The conference was a catalyst on Austrian developments, but not in the way it was hoped for by the scientists. In parallel to the academic study groups an alliance between energy utilities, industry and politicians had been formed. This alliance led to the founding of the *Österreichische Studiengesellschaft für Atomenergie GmbH* (Austrian Society for Atomic-Energy Studies Ltd.) on May 15, 1956. The Ssociety held a capital stock of 6 Mio öS (Million Schillings) with 51% from the state and 49% from the industry. The alliance was made up of more than 80 companies, although in the board of management of the society only one scientist (Gustav Ortner) was present. However, scientists were invited to participate in the newly founded research groups, e.g. on biology, medicine, safety issues, research and power reactors, metallurgy, physics, chemistry, legal questions etc.[30] In June 1956 a contract concerning the cooperation for the civilian uses of atomic energy was signed between the United States and Austria and it was decided to construct a rector centre with an ASTRA swimming-pool reactor in Seibersdorf near Vienna. 40% of the required 102 Mio öS investment were covered by the European Recovery Program fund and 9 Mio öS were directly subsidized by the American Atomic Energy Commission (Müller 1977, 83–87; Lackner 2000, 209–12).

In the course of planning, the scientists' views were heard but they had the weakest position in the struggle for financial and personnel resources and in the question of who would define the areas of future research. Finally the close cooperation between academia and industry failed in May 1957 when the decision was made that the new reactor centre should no longer be coordinated by a university's institute.[31] On their side, however, the universities enforced their claims for the construction of their own research reactor project, which was finally approved at

[29] Draft of a memorandum, Archiv der Österreichischen Akademie der Wissenschaft, Ignaz-Seipl-Platz 2, A-1010 Wien, Bestand Institut für Radiumforschung, Karton 55/56, Fiche 825.

[30] Bundesministerium für Unterricht to Berta Karlik, August 23, 1956. Archiv der Österreichischen Akademie der Wissenschaft, Ignaz-Seipl-Platz 2, A-1010 Wien, Bestand Institut für Radiumforschung, Karton 56, Fiche 832.

[31] Bundesministerium für Unterricht an die Rektorate aller wissenschaftlichen Hochschulen. May 24, 1957. Archiv der Österreichischen Akademie der Wissenschaft, Ignaz-Seipl-Platz 2, A-1010 Wien, Bestand Institut für Radiumforschung, Karton 56, Fiche 832.

the end of August 1957[32] and led to the foundation of the *Atomic Institute of the Austrian Universities* in 1959, which received a TRIGA MARK II reactor supplied by General Dynamics for $258.625 US called “Austria 30”.[33] The location of the Atomic Institute and the research reactor of the Austrian universities was heavily debated in the public spheres, because the scientists’ first choice was a flak tower, an above-ground bunker built during the NS era in the Augarten, a central pleasure ground in Vienna. The proposal sparked massive public protest, and it was relocated to the Prater, which is a green area on the periphery of the city.[34] The new institute was formally attached to the Technical University for administration but the rules of procedure determined that the new Atomic Institute should be opened for research to members of all Austrian universities.[35] Nevertheless, the two directors, Gustav Ortner and Fritz Regler who were nominated in March 1961 when the construction was still in progress, came from the Technical University.[36] The discussions about the rules of procedures, especially about the access to the new research and teaching resources, led to strong debates between the Technical University and the other universities up to the point where the University of Vienna asked its Faculty of Law for legal support. This fight resulted however in having the Atomic Institute incorporated into the Technical University at the beginning of the 21st century.[37]

[32] Bundesministerium für Unterricht an die Rektorate aller wissenschaftlichen Hochschulen und das Dekanat der Katholisch-theologischen Fakultät in Salzburg, August 30, 1957. Archiv der Österreichischen Akademie der Wissenschaft, Ignaz-Seipl-Platz 2, A-1010 Wien, Bestand Institut für Radiumforschung, Karton 56, Fiche 833

[33] Vertrag zwischen dem Bundesministerium für Unterricht und der General Dynamics Cooperation. Archiv der Österreichischen Akademie der Wissenschaft, Ignaz-Seipl-Platz 2, A-1010 Wien, Bestand Institut für Radiumforschung, Karton 56, Fiche 834/835.

[34] Gedächtnisprotokoll über die Sitzung des Aktionskommitees für Atomenergie, Dienstag 1. April 1958 im kleinen Sitzungssaal des Bundesministeriums für Unterricht, verfasst von Fritz Regler, April 2, 1958. Archiv der Technischen Universität Wien, Karlsplatz 13, A-1040 Wien, R.Z. 1250/58, p. 70.

[35] Entwurf eines Erlassen des Bundesministeriums für Unterricht betreffend der Zuordnung des Atominstituts, February 2, 1959, Erlass des Ministeriums vom February 20, 1959. Archiv der Österreichischen Akademie der Wissenschaft, Ignaz-Seipl-Platz 2, A-1010 Wien, Bestand Institut für Radiumforschung, Karton 56, Fiche 834.

[36] Protokoll der 5. Sitzung der Atomkommission der österreichischen Hochschulen am 11. März 1961 um 10:00 Uhr im großen Sitzungssaal der Technischen Hochschule Wien. Archiv der Österreichischen Akademie der Wissenschaft, Ignaz-Seipl-Platz 2, A-1010 Wien, Bestand Institut für Radiumforschung, Karton 56, Fiche 836.

[37] Akademie der Wissenschaft, Ignaz-Seipl-Platz 2, A-1010 Wien, Bestand Institut für Radiumforschung, Karton 56, Fiche 836/837/838, darin insbesondere: Gutachten des Dekans der Rechts- und staatswissenschaftlichen Fakultät der Universität Wien vom 27. März 1962, Fiche 838.

Finally, three research reactors went into operation: The ASTRA reactor of the industry dominated *Studiengesellschaft* at Seibersdorf in 1960, the TRIGA MARK II of the Austrian universities at the Prater in Vienna in 1962, and a small sub-critical reactor of the technical universities in Graz in 1963. The latter was financed by the federal state Styria and the local industry and was developed independently from the main negotiations in Vienna.

1.2.4. The Nuclear Power Plant in Zwentendorf

Energy production in Austria was until the late 1980s a government monopoly. Besides the central *Verbund* Corporation (Österreichische Elektrizitätswirtschafts-Aktiengesellschaft, Austrian Industry Electricity Stock Corporation) which was controlled by the federal government there was one electricity provider in every state that was controlled by the particular federal state government. When the research reactors were constructed and started up at the beginning of the 1960s electrical energy production from nuclear fission was still a dream of the future as the necessary investments seemed too high for a profitable energy production in comparison to hydropower and fossil-fuelled thermal power plants. Even a predicted doubling of the energy consumption in Austria in the decade from the mid-fifties to the mid-sixties was not enough to make nuclear energy a profitable endeavour. Nevertheless, as early as 1960 the *Verbund* Corporation asked for a report about possible locations for a nuclear power plant (Schaller 1997, 112–14). However, even though the predictions concerning the consumption of electricity were relatively accurate, the main problem remained that hydropower could not cover the increasing consumption and therefore there was no other choice than increasing the share of electricity production from fossil fuels (Lackner 2000, 216f).

By the end of the 1960s the electricity companies started together with the conservative government an initiative for nuclear energy production in Austria. In October 1967 the Ministry of Transport and State-owned Companies (Bundesministerium für Verkehr und verstaatlichte Betriebe) arranged a hearing concerning atomic energy in Austria with explicit reference to electricity production from nuclear fission. The positions in the electricity companies were heterogeneous at that time, especially about when a nuclear plant might be necessary; in particular contrast to the conservative government that forced a quick start on the beginning of construction (Forstner 2016b).

One of the results of the experts' hearing was the foundation of the *Kernkraftwerksplanungsges. m.b.H* (Nuclear Power Plant Planning Corporation Ltd.) in April 1968 and later, after the location was chosen, a construction company named after the area Tullnerfeld the *Gemeinschaftskraftwerk Tullnerfeld Ges. m.b.H.* (Corporation Power Plant Tullnerfeld Ltd) was founded. Problems in the demarcation of the responsibilities of the two companies led to the decision that the latter was in authority for the concrete planning of the plant in Zwentendorf while the former was to plan all future Austrian nuclear power plants. The central *Verbund* held 50% of each corporation; the other 50% were divided among the seven federal state companies. Quarrels between these companies considerably delayed the start of construction. Three years later the Austrian government under Chancellor Kreisky made the planning and building decision in March 1971 and a consortium of the Austrian *Siemens Ges. m.b.H*, the Austrian Elin Union AG and the German Kraftwerk Union AG was chosen to build the plant. Their offer for a turnkey boiling water reactor of the consortium was not considered the best (the government thought that the Swedish ASEA made the best offer) but it was regarded as a chance for the Austrian industry to prove their abilities in the construction of nuclear power plants and, more broadly, it may also be seen as a part of the Keynesian economic policy in place at that time in the Kreisky era (Forstner 2016b; Lackner 2000, 219f).

After several hearings the building permission was granted and construction started in March 1972 and in 1976 two further nuclear power plants were planned for 1990. Just after the Swedish Social Democrats lost their majority at the national parliament elections in 1976 probably because of their atomic policy, a public discussion process was initiated and supporters as well as opponents were heard. The start-up of the plant in Zwentendorf was delayed several times and finally Kreisky initiated a referendum about the launch, promising to resign should the referendum fail. The referendum resulted in 50.47% of votes against the start-up coming from opponents to nuclear power as well as probably also conservatives supporting the technology but hoping to get rid of Kreisky, hence voting against Zwentendorf NPP for political reasons. However this strategy failed altogether. Kreisky quickly reacted and about one month after the referendum the Parliament passed without any dissentient vote the *Atomsperrgesetz*, a law that forbade the use of nuclear fission in Austria for energy production. A two-thirds majority rule in parliament and another referendum protected the law from being easily revoked. Nevertheless, nuclear research was excluded from this ban. Following the Three Mile Island accident in the USA in 1979, as well as several failed attempts to withdraw the *Atomsperrgesetz*, the Austrian plans to establish nuclear energy were finally cancelled. In 1986, the Chernobyl accident in Ukraine helped the anti-nuclear movement to receive more and more public attention and acceptation, although the accident had no direct effect on the Austrian decision (Forstner 2016b).

This development led to a new law, now part of the Austrian Constitution:[38] The *Bundesverfassungsgesetz für ein atomfreies Österreich* (Constitutional law for an Austria free of nuclear tasks) determined that in Austria:

- Nuclear weapons cannot be produced, tested, stored or transported;
- Nuclear power plants cannot be constructed anymore and those that are already built cannot start operation;
- Transport and storage of compounds for nuclear fission are forbidden, except those for peaceful uses although not those for energy production;
- The Republic of Austria is liable for any injuries due to accidents with radioactive compounds or has to enforce the claims from foreign causers;
- The Federal Government is responsible for the implementation of the law.

Today it seems evident that there is no intention for further developing nuclear power in Austria in any foreseeable future. After a legislative initiative of the Social Democrats failed in 1985 it was decided to use the Zwentendorf power plant in the best way possible. In the further course the power plant was transformed into a stock of spare parts for West German plants of the same type and used as a training area for nuclear engineers. Today's criticism focuses on the high cost (14 billion öS) for such a training plant paid for by the Austrian taxpayers. Anecdotally, the power plant was also used for a film setting with the Swedish actor Dolph Lundgren,

[38] Bundesgesetzblatt für die Republik Österreich, ausgegeben am 13. August 1999, 149. Bundeverfassungsgesetz für ein atomfreies Österreich, eingesehen unter http://www.salzburg.gv.at/1999a149.pdf am 26.03.2009.

although the production company ran out of money and the film was never finished.[39] This makes an interesting parallel with the actual fate of the nuclear power plant.

1.3. Presentation of main actors

Academia

Academia had a long tradition in radioactivity and nuclear research. The Institute for Radium Research was founded in 1910 and was the first Institute of this kind. It was financed by the Austrian Academy of Science and the University of Vienna. Until the Institute was split up in the 1970s there was a close cooperation between the Institute and Vienna University.

In the early discussion until 1956 academia was the driving force for the construction of a nuclear reactor in Austria. All committees were manned by scientists from academia, especially the Radium Institute, the University of Vienna, and the Technical University of Vienna. Other Austrian universities were engaged in the discussion, but played only a minor role. The central figure of the whole discussion was Berta Karlik. She served as director of the Radium Institute, and was the first woman at Vienna University who got a full professorship. She drafted all the memoranda and reports for the conference in Geneva, as well as a feasibility study on a nuclear reactor in Austria in 1955. Academia lost their central position in 1955 when industry and the Austrian utilities entered the discussion treating directly with the government. In the course of the construction of Austria's first NPP academia took only a minor role.

Industry and utilities

Before 1955, early interest in the nuclear technology concerned very few companies, including Waagner-Biro (steel, machine building industry), the Osterreichischen Stickstoffwerken AG (chemistry), Elin AG/ ELIN-UNION AG (electrical engineering), and the Simmering-Graz-Pauker AG (machine building, motor, and electrical engineering). A meeting at the central Autrian utilities (Verbundgesellschaft) led to a union of the industrial interests, and to the founding of the Österreichische Studiengesellschaft für Atomenergie m.bes.H. In this corporation Austrian utilities took a leading role, as well as the above mentioned companies. However, Austrian

[39] Tageszeitung *Die Presse* vom 13. Oktober 2008.

government kept a slight majority (50.48%) of the corporation's share. It is the industry that convinced the government to develop nuclear energy production at the end of the 1960s.

Government

The Austrian government welcomed the US offer in the context of the Atoms for Peace program. Soviet offers circulated among the main actors, but no further discussion followed. The conservative government in the 1960s was in favour of nuclear energy as well as the Social Democratic party in the 1970s. However, in the 1960s the conservative government was forced by the industry to complete the development plans in order to effectively start designing and building NPPs.

When the anti-nuclear movement became stronger in the mid-1970s the conservative party started questioning the security of the Zwentendorf NPP. At that time the social democratic party also changed their public policy and initiated a public information campaign. In 1978 it was impossible to find a consensus between the conservative party and the social democratic party concerning the start-up of the Zwentendorf NPP. This led Chancellor Bruno Kreisky to initiate a referendum resulting in a slight majority against the start-up. Several attempts were made to revoke the result of the referendum. Finally, after a last attempt by the Social Democrat and Chancellor, Fred Sinowatz, failed in 1985, all further plans for implementing nuclear power in Austria were definitely abandoned.

The Public

In the 1950s the Austrian government successfully established a positive view of nuclear energy in the public supported by the United States and their manifold information services. This positive view held up until the construction of the Zwentendorf NPP. At the beginning of the construction there were only local protests and opposition by conservative and right-wing groups of the early ecology movement which was strongly influenced by German eugenics (*Rassenhygiene*). This changed after Maoist groups of students entered the field in 1975, and the anti-nuclear movement began to broaden. Finally, it extended across all social classes and social groups which became divided around this question.

2. Showcase: The Austrian Anti-Nuclear Movement

While the anti-nuclear movement in Germany has already been well studied, the Austrian movement has not attracted the same attention.

In the early years, there was only sporadic and local criticism of nuclear power, which was ignored on the whole. For this form of criticism, a memorandum of the Lower Austrian Chamber of Physicians from 1969 serves as illustration. This is the first sign of protest against the construction of the nuclear power station at Zwentendorf. After Zwentendorf had been set as the site for the nuclear power station, Rudolf Drobil, representing the Lower Austrian Medical Association, together with the biologist Gertrud Pleskot, from the University of Vienna, attended Andreas Maurer's surgery and tried to dissuade the Lower-Austrian state governor from constructing the nuclear power station because of potential health hazards. As they failed in their face-to-face negotiation, they made the memorandum public (Straubinger 2009, 211f).

In this memorandum, they demanded not only the participation of nuclear physicists and nuclear engineers in the design of the power plant but also the involvement of those qualified to judge the health and environmental impacts of radiation such as doctors and biologists. The authors of the memorandum stressed that any kind of high-energy radiation is detrimental to the human body and its cells regardless of the size of the dose. In particular, they pointed out the risk of damage to the genome through ionizing radiation. As examples of the victims of such radiation, they listed the first scientists who worked with X-rays or radioactive materials; they also cited the victims of radioactive radiation due the atomic bombs dropped on Nagasaki and Hiroshima. The authors of the memorandum cautioned that even after the most accurate surveys about the potential dangers, and the little consideration they had been given, potential risks will always exist. For instance, even if the probability of an earthquake occurring was *thought* to be extremely low, it could not be ruled out entirely. Moreover, the authors argued that radioactivity discharged into the environment would accumulate over time in organisms. As evidence, they quoted figures from measurements at the Hanford site in the USA (see US's short country report). In addition, the authors questioned the viability of a nuclear power station and highlighted the opportunities for expanding hydropower in Austria. After considering all of these factors, the authors concluded that it was not worth taking the risk of building a nuclear power station.[40]

This memorandum attracted as little attention as the first early protests of the *Bund für Volksgesundheit* (Union for Public Health), in which Richard and Walther Soyka were the main protagonists. After the death of Richard Soyka, his son Walther took over the management of the *Bund für Volksgesundheit*, which derived from the eugenic/racial-hygiene movement. It was founded in 1926, dissolved after the Occupation and Annexation of Austria by Nazi Germany and was founded again in 1946. The main topics preoccupying the *Bund* in the post-war period were diet, alcohol and nicotine abuse. With plans for an Atomic Institute in Austrian higher education, health effects from radioactivity became one of the *Bund*'s concerns. In the early phase of protest against Zwentendorf, the *Bund* demanded a referendum against contamination from nuclear reactors (1969) and organised two marches in 1970 as protest actions, in which protestors starting from different places converged on Zwentendorf. Headed by Walther Soyka, a society for biological safety (Gesellschaft für biologische Sicherheit) was also founded in 1970, whose goal was to oppose to nuclear energy.[41] In March 1972, Walther Soyka, equipped with hundreds of powers of attorney from residents who lived close to the site of the planned nuclear power station, attempted to participate in the hearing for the licensing procedure at the parish hall in Zwentendorf. Since local residents did not have a stakeholder status according to the Radiation Protection Act, Soyka was finally ousted by the police from the parish hall after the protest. In 1972, Soyka became a co-worker at the University of Bremen and moved in circles on the edge of the right-wing spectrum (Geden 1996, 116) until his candidacy as an independent for the Nazi party *Deutsche Volksunion* in the German federal elections for the *Bundestag* (German parliament) in 1998 (Hertel 1998, 26).

The *Bund für Volksgesundheit* collaborated intensively with the *Weltbund zum Schutz des Lebens* (World Union for Protection of Life), which was also conservative tending to "ethonationalistic". German and Austrian sections of the latter were established in 1960 by Günther Schwab, and the environmental historian John Straubinger concludes in his analysis of

[41] Hermann Soyka, The „Bund für Volksgesundheit", 2007, http://www.academia.edu/6641682/Der_Bund_fuer_Volksgesundheit, consulted on 14/03/2007

Schwab's work that he indeed had a considerable propinquity to National-Socialist ideology but was the first to warn about the dangers of nuclear power in Germany and Austria in his work (Geden 1996, 105–7; Straubinger 2009, 65–75). His book *Morgen holt dich der Teufel. Neues, Verschwiegenes und Verbotenes von der friedlichen" Atomkernspaltung*, which appeared in 1968 in Germany and Austria, played an important role in this respect (Schwab 1968). In his book, Schwab provided in the form of a dialogue some facts and arguments for the opponents of nuclear power. Thus, for example, Peter Weish, a former employee at the Research Centre Seibersdorf and later head of the anti-nuclear movement in Vienna, recalled in an interview the important role the book played in his own opposition to nuclear energy.[42] However, the initial protests did not manage to achieve a widespread attraction within the population.

In the federal state Upper Austria and in its capital Linz, resistance against a planned second nuclear power station in Stein/St. Pantaleon stirred early. This protest led finally to the broadening of the anti-nuclear movement across the whole country. The resistance there was instigated by the *Naturschutzbund* (Environmental Protection Group) and the *Weltbund zum Schutz des Lebens*, later joined by the Maoist-oriented *Kommunistische Bund Linz* (Communist Confederation Linz). The latter was the driving force in the working group Nuclear Energy Linz and was popular especially among students. The Upper Austrian anti-nuclear movement spanned the entire political spectrum from the left to the right. Due to its heterogeneity disagreements often occurred concerning the most affective forms of action to achieve the shared goals. A decisive step towards the unification of the movement was taken in the side-lines of a lecture given by Karl Richard Bechert, a nuclear power station opponent and nuclear physicist from Germany. Functionaries of the Austrian *Naturschutzbund*, Upper Austrian activists and the Viennese group surrounding Peter Weish and Bernhard Lötzsch formed a network. Furthermore, the Upper Austrian nuclear power station opponents united in the *Bürgerinitiative gegen Atomgefahren* (Civil Initiative against Nuclear Hazards) (Straubinger 2009, 211f).

The Austrian anti-nuclear campaign gained additional impetus from events in Germany. As the construction of the Württemberg nuclear power plant in Wyhl began in February 1975, demonstrators successfully occupied the building site for nine months. A panel discussion in

[42] Interview with Peter Weish, conducted by the author on 16th February 2016.

Linz in April 1975, with more than 3,500 participants, represented the first high point in the development of the Austrian anti-nuclear campaign. Both the Minister of Trade Staribacher and Chancellor Kreisky took part in the event. Discussion was turbulent, and it was broadcast on TV to all of the federal states of Austria. Nuclear energy was no longer a local issue; it was now a concern of the entire federal territory. In almost all cities and universities, working groups and action groups were formed that made it their business to inform people about the dangers of nuclear energy (Bayer 2014, 173).

Federal Government came under increasing pressure by this development, and in October 1975 federal elections for the parliament were imminent. On 1st April 1975, the Minister of Trade Staribacher announced a provisional construction freeze on the proposed nuclear plant (AKW) at Stein/St. Pantaleon for economic reasons. In April 1976, the Federal Government initiated an information campaign in 10 Austrian cities, in which experts discussed various aspects of nuclear energy and faced questions from the general public. Both supporters and opponents of nuclear energy were represented among the experts. Through this campaign, a strong course of confrontation like in the Federal Republic of Germany was to be avoided. However, the nationwide unification of the different anti-nuclear groups was one of the consequences of the Chancellor's nationwide initiative. In May 1976, the representatives of the various groups met and formed an umbrella organization the Initiative Österreichischer Atomkraftwerksgegner (Initiative of Austrian Nuclear Power Opponents). Their goal was to prevent the Zwentendorf nuclear power station from being commissioned (Straubinger 2009, 211f).

The result of the September 1976 elections in Sweden probably also influenced the turnaround in the politics of the Austrian Federal Government. The Swedish Social Democrats under the leadership of Olof Palme lost the election partly because of its nuclear policy.(See Sweden's Short Country Report) The events in Sweden were reported in detail in the *Arbeiterzeitung*, the daily newspaper of the SPÖ.[43] Kreisky declared, two days after the elections in Sweden, that the construction of nuclear power station Stein/ St. Pantaleon be frozen until the question of disposal of nuclear waste had been cleared.[44]

[43] See, for example, *Arbeiterzeitung* from 21st September 1976.
[44] *Arbeiterzeitung* from 22nd September 1976.

The information campaign of the Federal Government was launched in October 1976 and ended ultimately in a fiasco for the Government. The events in autumn of 1976 and spring of 1977 were clearly dominated by the anti-nuclear activists. Thus the IAEA recorded in its files:[45]

> "*9 December 1976, Salzburg: 'Judging the Risks at Nuclear Power Stations.' This turned into a festival for professional demonstrators, using speaking choruses. The main scientific opponents, Dr. Bernhard Lötsch and Dr. Peter Weihs [sic] from Vienna's Boltzmann Institut für Umweltwissenschaften received ovations.*
>
> *...*
>
> *27 January 1977, Vienna: 'Effects on Society and Control of Operation of Nuclear Plants.' This was the biggest demonstration of anti-nuclear groups in Austria, about 1000 persons attended, 90% of them anti-nuclear. No discussion was possible, only opposition groups made their demands known and elected their chairman. After this, official organizers asked themselves if the campaign should be continued in this climate*."

Some of the events proceeded more quietly; however, overall, it can clearly be said that the Federal Government's campaign was a failure. During 1977, there were several nationwide actions and demonstrations, and the situation for the government worsened progressively (Bayer 2014, 173).

As it had become obvious in the spring of 1978 that a common parliamentary resolution between ÖVP and SPÖ for commissioning the Zwentendorf nuclear power station was not going to be achieved, the SPÖ leadership decided to seek a decision in a referendum. During the preparation for this referendum, the working group *NEIN zu Zwentendorf* (No to Zwentendorf), with the geologist Alexander Tollmann at its head, was founded from the conservative parts of the anti-nuclear movement. Eventually, they just managed to assert themselves in the referendum thanks in part to the lack of mobilization in the supporters of the SPÖ (Forstner 2016b).

[45] Nuclear controversy in Austria, 1976-77, IAEA Archives, Vienna, Box 15521.

3. Events

Critical view to the selection process of the five events

Reasons for choosing the events:

- *Eisenhower's Atoms for Peace speech* was chosen because it was the initial spark for post-war Austria's nuclear energy program. The speech and the Atoms for Peace program had a great effect on several countries of the western hemisphere and might therefore be suitable for a transnational comparison.
- *Conference in Geneva 1955* was also a transnational event. The effects of the conference on Austria and its nuclear program may also be part of a transnational comparison.
- *The Austrian plebiscite in November 1978* marks the failure of the Austrian nuclear energy program. The date is crucial for Austria and cannot be neglected. The analysis shows that the Socialist Party failed to mobilize its supporters for the referendum.
- *A ship's christening* shows how local traditions of protest and civil resistance later developed as anti-nuclear protests. These protests started against the Swiss NPP in Rüthi next to the Austrian border, and later focused on the Austrian NPP.
- *The IAEA and the Austrian events* shows how local/national events influenced the policy of a transnational organization. In this case the Austrian referendum led to a public acceptance program of the IAEA.

3.1. Event 1: Eisenhower's 'Atoms for Peace' Speech

It seems that the American *Atoms for Peace Program* was Austria's only chance after the war to acquire nuclear energy. However, there were also offers from the Soviet Union for the construction of research reactors. In this early period scientists took the leading role and it seems that that followed the political needs of Austria's integration with the West. Political neutrality played no role in Austria's first steps into nuclear energy production. US President Eisenhower's famous "Atoms for Peace" speech before the UN General Assembly in December 1953 gave the ignition spark for Autsria's nuclear energy program after WWII. (Forstner 2016b).

Eisenhower's envisioned program had to face the practical difficulties raised during the discussions with engineers. Already before Eisenhower's speech, the Austrian Electro-Technical Society (Elektrotechnischer Verein Österreichs, EVÖ) had initiated a series of lectures on nuclear physics in 1953 and 1954. From those, it seemed that the set-up of a study group had already been planned at that time but practical aspects, like the transfer from the society to another building, and probably the absence of a concrete perspective for such a group, delayed the constitution of the group. Nevertheless, in December 1954, a formal study group was finally founded with members of the Technical University (TU), among them Heinrich Sequenz the former president of the TU until 1945, and members of the University, like Georg Stetter, the former head of the Four-Year-Plan Institute for neutron physics, the physicists from Vienna University Hans Thirring, Erich Schmid, Karl Lintner, and of course Berta Karlik, the head of the Radium Institute, who had been a co-organizer of the first meeting, and Ministerialrat Alexander Koci as the government representative.[46]

Only five days after the constitution of the study group at the EVÖ the first government meeting on international cooperation for the peaceful use of atomic energy took place with participants of several ministries except military or defence, but with only one representative of academia, namely Berta Karlik the head of the Institute for Radium Research. In this meeting it was decided to establish an advisory expert commission for the peaceful use of atomic energy, which was assigned to evaluate the possibilities and expenses of a research reactor in cooperation with the USA. Also electricity production by nuclear energy was discussed, but at that time it seemed to be only a future possibility to complement other forms of electricity production.[47] After a meeting of the Council of Ministers in January 1955 and several other inter-ministerial discussions, the Minister of Education sent out a circular letter to all Austrian

[46] Sitzungsbericht über die Gründung einer „Studiengruppe Atomenergie im EVÖ" am 16.12.1954 vom 10.01.1955, Archiv der Österreichischen Akademie der Wissenschaft, Ignaz-Seipl-Platz 2, A-1010 Wien, Bestand Institut für Radiumforschung, Karton 51, Fiche 750.

[47] Archiv der Republik, Österreichisches Staatsarchiv, Nottendorfer Gasse 2, A-1030 Wien, Bestand BMU Atom, Zahl 157.959-INT/54.

Universities in February 1955, in which he asked expert reports on a research reactor and on the possibility for energy production from nuclear fission.[48]

Another month later the universities had named the delegates for the commission and it was founded with subcommittees for experimental and theoretical nuclear physics, the application for nuclear energy in physics, chemistry, medicine, biology and one for the technical aspects of a nuclear energy reactor. This time all the delegates came from the university except the one for the technical application and therefore one may imagine strong debates and opinion between the different institutions over the progress and vision of the project. Berta Karlik was assigned to conceptualize all the necessary memoranda, what underlined her central role again.[49]

In her report concerning the expediency of a construction of a nuclear reactor in Austria Karlik expounded ed the different types of nuclear reactors, their purposes, and the costs involved. Furthermore, she gave a short analysis of the situation in other European states like France, Norway, the Netherlands, Sweden, Switzerland, Italy, West Germany, and Belgium. However, Great Britain and the United States were explicitly excluded from this analysis because of the engagement of the military in their nuclear research programs. Karlik pointed out that all these European states installed or aspired to only research reactors and the financial situation in Austria would only allow the construction of a research reactor. However, she considered the financial requirements too high for the Ministry of Education even in the case of a research reactor. Therefore, she recommended an alliance of all concerned ministries, academia and industry. Besides she pointed out to another problem concerning the lack of qualified personnel for operating a reactor. For this reason, she recommended again the construction of a research

[48] Rundschreiben des Bundesministeriums für Unterricht an die Rektorate der österreichischen Universitäten und Hochschulen vom 11. Februar 1955, Archiv der Österreichischen Akademie der Wissenschaft, Ignaz-Seipl-Platz 2, A-1010 Wien, Bestand Institut für Radiumforschung, Karton 56, Fiche 829.

[49] Correspondence between the Ministry for Education and the University of Vienna, February and March 1955, Archiv der Österreichischen Akademie der Wissenschaft, Ignaz-Seipl-Platz 2, A-1010 Wien, Bestand Institut für Radiumforschung, Karton 56, Fiche 829.

reactor, where specialists could be trained in light of a possible future assignment in a nuclear power plant.[50]

The lack of qualified personnel was one of the main problems for the implementation of the project. Therefore, the Ministry of Education initiated a search for Austrian nuclear physicists abroad. Among them one of the central figures of Austrian nuclear research was eager to come back. Gustav Ortner, the former director of the Radium Institute from 1939-1945, was suggested by Karlik as coordinator of the project.[51] Ortner held since 1950 a position as professor for experimental physics in Cairo and was in regular correspondence with Karlik up to the point of exchange of material samples, which Karlik had sent to Ortner in Cairo.[52] Concerned about the possibility of missing this opportunity Ortner wrote a very gentle letter to the Ministry abstaining from any salary claims and Karlik on the other hand refused a request of the Ministry to name a second candidate.[53] Ortner, who finally got selected for the position of project coordinator, was sent to the US for training courses on the technique of nuclear reactors and was belated nominated as Austrian expert for the atomic energy conference in Geneva in August 1955.[54]

The Austrian Council of Ministers, the highest decision-making body of the second republic, accepted the suggestions of the expert committee based on Karlik's recommendations shortly after Austria regained its full sovereignty in March 1955 and made the decision to build a research reactor, most probably with American support. One has to remember that these developments happened during the Cold War and Austria, that was occupied by the Allied until

[50] Gutachten über die Zweckmäßigkeit der Errichtung eines Reaktors in Österreich, verfasst von Berta Karlik im April 1955, Archiv der Österreichischen Akademie der Wissenschaft, Ignaz-Seipl-Platz 2, A-1010 Wien, Bestand Institut für Radiumforschung, Karton 49, Fiche 706.

[51] Letter from Berta Karlik to the Bundesministerium für Unterricht, April 28, 1955. Archiv der Österreichischen Akademie der Wissenschaft, Ignaz-Seipl-Platz 2, A-1010 Wien, Bestand Institut für Radiumforschung, Karton 56, Fiche 829.

[52] Correspondence between Berta Karlik and Gustav Ortner, Archiv der Österreichischen Akademie der Wissenschaft, Ignaz-Seipl-Platz 2, A-1010 Wien, Bestand Institut für Radiumforschung, Karton 46, Fiche 665.

[53] Letter to the Bundesministerium für Unterricht, April 28, 1955. Letter from Berta Karlik to the Bundesministerium für Unterricht, May 4, 1955 and Letter from Gustav Ortner to Berta Karlik, May 17, 1955. Archiv der Österreichischen Akademie der Wissenschaft, Ignaz-Seipl-Platz 2, A-1010 Wien, Bestand Institut für Radiumforschung, Karton 56, Fiche 829.

[54] Letter from Berta Karlik to the Bundesministerium für Unterricht, Juli 16, 1955. Archiv der Österreichischen Akademie der Wissenschaft, Ignaz-Seipl-Platz 2, A-1010 Wien, Bestand Institut für Radiumforschung, Karton 56, Fiche 830.

then, regained its sovereignty only for political neutrality. As a matter of fact, Austria also received offers for building a nuclear reactor from the Soviet Union. However, although these offers were notified and forwarded to the scientists, they remained without responses, probably as a result of the conditions for the aspired integration of Austria into the Western bloc.[55] Karlik recommended the American technology for the comprehensive offer of training, supply of fuel elements and disposal of nuclear waste.[56] However already in December 1954 in an inter-ministerial meeting only the American option was discussed even before the scientific advisory group was formed and the scientists were auditioned.[57]

3.2. Event 2: The Effects of the Conference in Geneva 1955 on Austria

While in the first months of Austria's planning to establish a nuclear energy program academia took a leading role in the discussions, this changed with the conference in Geneva. During the preparations for the conference an alliance between industry, the Austrian utilities, and parts of the Austrian government was set up. This led to the loss of the hegemonic position of academia within the discourse and the new alliance took over the leading role.

In the course of the preparation of the *First International Conference on the Peaceful Uses of Atomic Energy* in Geneva in August 1955, the Ministry of Foreign Affairs asked for a memorandum "that shows the world, that Austria is using for many years atomic energy for peaceful purposes and is one of the leading nations in that area."[58] It was again Berta Karlik,

[55] Letters from the Bundeministerium für Unterricht to Berta Karlik, June 21 and July 5, 1955. Archiv der Österreichischen Akademie der Wissenschaft, Ignaz-Seipl-Platz 2, A-1010 Wien, Bestand Institut für Radiumforschung, Karton 56, Fiche 830.

[56] Letter from Berta Karlik to H. Küpper, November 10, 1955. Archiv der Österreichischen Akademie der Wissenschaft, Ignaz-Seipl-Platz 2, A-1010 Wien, Bestand Institut für Radiumforschung, Karton 56, Fiche 830.

[57] Letter from Bundeskanzleramt – Auswärtige Angelegenheiten to Bundesministerium für Unterricht, December 6, 1954. Archiv der Republik, Österreichisches Staatsarchiv, Nottendorfer Gasse 2, A-1030 Wien, Bestand BMU Atom, Zl. 157.605-INT/54.

[58] „Der Welt soll gezeigt werden, dass Österreich seit Jahren Atomenergie für friedliche Zwecke verwendet und auf diesem Gebiet zu den führenden europäischen Nationen gehört." (English translation from the author), Bundeskanzleramt für Auswärtige Angelegenheiten to Institut für Radiumforschung, January 27, 1955. Archiv der Österreichischen Akademie der Wissenschaft, Ignaz-Seipl-Platz 2, A-1010 Wien, Bestand Institut für Radiumforschung, Karton 50, Fiche 727.

who was asked to compose such a report. Most of the report discusses the use of radioactive isotopes in all kind of fields: from medical over scientific to industrial applications. The last section focuses on the plans concerning a reactor, where she states:

> Austria is considering the building of a research reactor as a joint project of science and industry and is engaged in preparations. It is expected that within a period of one year it will be possible to clear the major problems as there are the juridical form of cooperation of partners in the project, the financial problem, the coordination of the research programs as well as the reactor type, a time schedule, etc. – The construction of a power reactor is not considered advisable at the moment.

The conference took was a catalyst for development in Austrtia, but not in the way as it was hoped for by the scientists. Parallel to the academic study groups an alliance between energy economy, industry and politics had constituted. This alliance led to the founding of the *Österreichische Studiengesellschaft für Atomenergie GmbH* (Austrian Society for Atomic-Energy Studies Ltd.) on May 15, 1956. The society held a capital stock of 6 Mio öS with 51% by the state and 49% by industry, all in all more than 80 companies, but in the board of management of the society only one scientists (Gustav Ortner) was present. However, scientists were invited to participate in the newly founded research groups, e.g. on biology, medicine, safety issues, research and power reactors, metallurgy, physics, chemistry, legal questions etc.[59] In June 1956 a contract concerning the cooperation for the civil uses of atomic energy was signed between the United States and Austria and it was decided to construct a rector centre with an ASTRA swimming-pool reactor in Seibersdorf near Vienna. 40% of the necessary investments of 102 Mio öS were covered by the *European Recovery Program* fund, 9 Mio öS subsidized the *American Atomic Energy Commission* directly.[60]

In the course of planning the academic scientists were heard but they had the weakest position in the struggle for financial and personnel resources and in the question of who defined areas of

[59] Bundesministerium für Unterricht to Berta Karlik, August 23, 1956. Archiv der Österreichischen Akademie der Wissenschaft, Ignaz-Seipl-Platz 2, A-1010 Wien, Bestand Institut für Radiumforschung, Karton 56, Fiche 832.

[60] Peter Müller, *Atome, Zellen, Isotope: Die Seibersdorf-Story* (Wien 1977), p. 83-87; Helmut Lackner, „Von Seibersdorf bis Zwentendorf. Die "friedliche Nutzung der Atomenergie" als Leitbild der Energiepolitik in Österreich," *Blätter für Technikgeschichte* 62 (2000): 209-212.

future research. Finally the close cooperation between academia and industry failed as in May 1957 the decision was made that the new reactor centre should no longer be organized as a university institute.[61] On the other hand the universities enforced their claims on the construction of their own research reactor project, which was approved at the end of August 1957[62] and led to the foundation of the *Atomic Institute of the Austrian Universities* in 1959, which received a TRIGA MARK II reactor called "Austria 30" supplied by General Dynamics for $258.625 US.[63] The location of the Atomic Institute and the research reactor of the Austrian universities was heavily debated in the public, because the scientists first choice was a flak tower, an above-ground bunker built during the NS era in the Augarten, a central pleasure ground in Vienna. Due to massive public protest it was relocated to the Prater, which is a green area in the periphery.[64] The new institute was formally attached to the Technical University for administration but the rules of procedure determined that the new Atomic Institute should be open for research to members of all Austrian universities.[65] Nevertheless, the two directors, that were nominated in March 1961 – the construction was still in progress – came from the Technical University, namely Gustav Ortner and Fritz Regler.[66] The discussions about the rules of procedures, especially about the access to the new research and teaching resources, led to heavy debates between the TU and the other universities up to the point where the University Vienna asked the

[61] Bundesministerium für Unterricht an die Rektorate aller wissenschaftlichen Hochschulen. May 24, 1957. Archiv der Österreichischen Akademie der Wissenschaft, Ignaz-Seipl-Platz 2, A-1010 Wien, Bestand Institut für Radiumforschung, Karton 56, Fiche 832.

[62] Bundesministerium für Unterricht an die Rektorate aller wissenschaftlichen Hochschulen und das Dekanat der Katholisch-theologischen Fakultät in Salzburg, August 30, 1957. Archiv der Österreichischen Akademie der Wissenschaft, Ignaz-Seipl-Platz 2, A-1010 Wien, Bestand Institut für Radiumforschung, Karton 56, Fiche 833

[63] Vertrag zwischen dem Bundesministerium für Unterricht und der General Dynamics Cooperation. Archiv der Österreichischen Akademie der Wissenschaft, Ignaz-Seipl-Platz 2, A-1010 Wien, Bestand Institut für Radiumforschung, Karton 56, Fiche 834/835.

[64] Gedächtnisprotokoll über die Sitzung des Aktionskommitees für Atomenergie, Dienstag 1. April 1958 im kleinen Sitzungssaal des Bundesministeriums für Unterricht, verfasst von Fritz Regler, April 2, 1958. Archiv der Technischen Universität Wien, Karlsplatz 13, A-1040 Wien, R.Z. 1250/58, p. 70.

[65] Entwurf eines Erlassen des Bundesministeriums für Unterricht betreffend der Zuordnung des Atominstituts, February 2, 1959, Erlass des Ministeriums vom February 20, 1959. Archiv der Österreichischen Akademie der Wissenschaft, Ignaz-Seipl-Platz 2, A-1010 Wien, Bestand Institut für Radiumforschung, Karton 56, Fiche 834.

[66] Protokoll der 5. Sitzung der Atomkommission der österreichischen Hochschulen am 11. März 1961 um 10:00 Uhr im großen Sitzungssaal der Technischen Hochschule Wien. Archiv der Österreichischen Akademie der Wissenschaft, Ignaz-Seipl-Platz 2, A-1010 Wien, Bestand Institut für Radiumforschung, Karton 56, Fiche 836.

Faculty of Law for legal support. However, in the long run the universities lost and the Atomic Institute was incorporated into the TU at the beginning of the 21st century.[67]

Finally three research reactors went into operation: The ASTRA reactor of the industrial dominated *Studiengesellschaft* at Seibersdorf in 1960, the TRIGA MARK II of the Austrian universities at the Prater in Vienna in 1962, and a small sub-critical reactor of the Technical universities in Graz in 1963. The latter was financed by the federal state Styria and local industry and developed silently apart from the main negotiations in Vienna (Forstner 2016b).

3.3. Event 3: The Austrian Plebiscite in November 1978

In 1977 nuclear power and the start-up of the NPP Zwentendorf had become a political issue due to the increasing public protests during the years 1976/77. The government passed the decision on nuclear power on to parliament. The Socialists were sure they would come to a mutual agreement with the major opposition party the People’s Party because the latter's most influential groups were clearly in favour of nuclear power. A report on nuclear energy was submitted to parliament by the government.

In the course of the parliament hearings the People's Party reconsidered its position, and declared themselves pro nuclear power, but against the start-up of Zwentendorf for security reasons. Therefore, Chancellor Kreisky decided not to ask the parliament for the final decision and instead announced a referendum in June about the start-up.

The plebiscite took place on November 5, 1978. Only 64.1% of the eligible voters took part in the plebiscite, of which 50.47% were against the introduction. The results in each one of the federal states show that those in the in the western federal states were least in favour of the plant being switched on.

[67] Akademie der Wissenschaft, Ignaz-Seipl-Platz 2, A-1010 Wien, Bestand Institut für Radiumforschung, Karton 56, Fiche 836/837/838, darin insbesondere: Gutachten des Dekans der Rechts- und staatswissenschaftlichen Fakultät der Universität Wien vom 27. März 1962, Fiche 838.

Federal State	Yes in %	No in%
Burgenland	59,8	40,2
Carinthia	54,1	45,9
Lower Austria	50,9	49,1
Upper Austria	47,2	52,8
Salzburg	43,3	56,7
Styria	52,8	47,2
Tyrol	34,2	65,8
Vorarlberg	15,6	84,4
Vienna	55,4	44,4
Whole	49,5	50,5

The SPÖ had not succeeded in mobilizing its followers. This argument is supported by the low participation of voters. Whilst turnout in the referendum was 64.1%, turnout in the 1971, 1975 and 1979 national parliament electionswas solidly between 91% and 92%.[68] The anti-nuclear tradition in the most western state Vorarlberg will be discussed in event #4 “A ship’s christening.”

Kreisky reacted quickly and a month after the referendum the parliament passed without any dissenting vote the *Atomsperrgesetz*, a law that forbade the use of nuclear fission in Austria for energy production which could only be altered by a two-thirds majority in parliament and another referendum. Nevertheless, research was excluded from this ban.[69]

The enriched uranium and the fuel elements were sold to the US. Much of the planning cooperation was liquidated from 1979 onwards. Finally, the planning cooperation for Zwentendorf the *Gemeinschaftskraftwerk Tullnerfeld GmbH* was liquidated in 1985 after the Socialist Chancellor Fred Sinowatz failed to revoke the *Atomsperrgesetz* in parliament. Austria’s final No to nuclear energy was therefore clearly before the Chernobyl accident.[70]

[68]Bundesministerium für Inneres, Nationalratswahlen, historischer Rückblick, http://www.bmi.gv.at/cms/BMI_wahlen/nationalrat/NRW_History.aspx, 25. Mai 2016.
[69] Bundesgesetzblatt für die Republik Österreich, Jahrgang 1978, ausgegeben am 29. De- zember 1978, 232. Stück.
[70] Österreich Journal, Alle Parteien gegen Atomkraft, Nr. 94, 1. April 2011, S. 1-11.

Event 4: A Ship's Christening, November 1964 (basis for anti-nuclear protests in Western Austria against the Swiss NPP Rüthi)

In the table above is shown that Austria's most Western state Vorarlberg voted at 84.4% against the start-up of the Zwentendorf NPP. This is by far the highest rejection rate of all Austrian federal states. In comparison to other Austrian states Vorarlberg had the longest tradition of civil protests, including against nuclear power in Switzerland.

Since 1971, massive protests by the *Naturschutzsbund* (Environmental Protection Group) with the support of the *Weltbund zum Schutz des Lebens* began here against Rüthi, the Swiss nuclear power station close to the border. However, the inhabitants of Vorarlberg could look back on a tradition of protest before the demonstrations against the Swiss nuclear power station. The so-called Fußach Ship Christening in 1964 was written in the consciousness of the population of Vorarlberg as an act of civil resistance. On 21st November 1964, an angry group of approximately 20,000 local inhabitants prevented the christening of a ship of the Lake Constance fleet with the name "Karl Renner", the first SPÖ Federal President in Austria since 1945. The Lake Constance fleet was subordinate to the Austrian federal railway, which was in turn assigned to the Department of Transportation under Minister Otto Probst. As the Ministry of Transport made the planned name known, anger stirred in the Vorarlberg population against "Viennese centralism". The anger was additionally fuelled by the Vorarlberger Nachrichten, the local leading media. After the abolition of the monarchy, christening ships after personalities was waived for less controversial names. The state government of Vorarlberg decided not to send any representative to the ship's christening in protest; instead, the 20,000-strong group of Vorarlberg inhabitants gathered in the harbour of the community Fußach and conducted an emergency christening of the ship in which they gave it the name "Vorarlberg". In the collective consciousness of Vorarlberg, the Fußach Ship Christening is still considered today as an example of successful protest against Viennese centralism.[71]

Between 1972 and 1975, up to 20,000 Vorarlberg inhabitants marched in the so-called Anti-Rüthi Marches across the border to Switzerland. These actions were supported in turn by the *Vorarlberger Nachrichten*, which also played a major role in the later resistance against the

[71] Interview with Hildegard Breiner, conducted by the author on 29th June 2012 in Bregenz.

Zwentendorf nuclear power station. Protest went so far in Vorarlberg that even the state representatives of the Vorarlberg SPÖ called for a “no” to Zwentendorf contrary to the guidelines of the federal party. The high “no” vote, 84%, of voters in Vorarlberg in the referendum on Zwentendorf cannot be understood as a simple “no” to the Chancellor Kreisky; its roots have to be seen instead in a long-standing tradition of civil resistance and protest against nuclear power in Austria's western-most federal state.[72]

Event 5: The IAEA and the Austrian Events

The International Atomic Energy Agency in Vienna began to pay a close attention to the Austrian debates from 1977. It did not limit its interest to the activities of the opponents to nuclear power, but also recorded the activities of advocates in their files. These files include a detailed description of the various groups, their main representatives and the central arguments on which they based their views. After the announcement of the referendum, the depth of detail in the observations increased again. In addition, observations were extended, probably from March 1978, to all democratic countries of the Western world, and all activities associated with "nuclear controversy" were recorded in the files.

The IAEA did not actively intervene in the Austrian nuclear debate. The Swedish IAEA Director General Sigvard Eklund thus made almost no public statement on Zwentendorf. Public statements such as those in a television interview for the Austrian news programme *Zeit im Bild* on 21st September 1978 remained the exception. However, the Agency did make information available to those who advocated for nuclear power plans. It supplied the Austrian utilities with information three months before the referendum and also gave daily newspapers and the ORF information about the disposal of radioactive waste.[73]

In addition, the IAEA initiated a traveling exhibition on its 20th anniversary, which showed a map of nuclear power stations in the countries bordering Austria and discussed disposal and safety issues. After the exhibition in the Kärntnerstraße was destroyed in its first night, 24th October 1977, it was moved for the months of November and December 1977 to Vienna's city hall. In

[72] Interview with Hildegard Breiner, conducted by the author on 29th June 2012 in Bregenz.

[73] Information output in connection with Austrian referendum as known to OPI [Office for Public Information], IAEA Archives, Box 15521

May 1978, it was exhibited at three other locations in Lower Austria. The IAEA also showed information films on nuclear energy. These films aimed to stimulate a positive attitude toward nuclear energy and were in accordance with the mission of IAEA to promote the peaceful use of nuclear energy.[74]

On 23rd November 1978, the IAEA hosted an information event for the Austrian referendum. Altogether 21 people participated: four from Switzerland, two from the Federal Republic of Germany, three from Sweden and one representative each from France, the Netherlands, Spain and Italy. First, a representative of the Austrian Federal Chancellery spoke on the background of the referendum and to the measures pending to cast the results of the referendum into legislation.[75]

Subsequently, a first error analysis combined with behavioural advice for similar situations was given. These included the following points: It was recommended that in principle no more than 50 people be in the audience for an information session. For discussions sufficient time should be allowed; the presentations should therefore be kept short. It seemed of even greater importance to allow sufficient time for informal discussions. The audience should be taken seriously; questions should be answered with a detailed response and not be avoided. The risks of nuclear energy should be mentioned from the beginning in order to avoid having to admit in the course of the discussion that there are "minor problems" yet to be solved. Grossly simplified presentations should not be given neither should simplistic comparisons between the risks of nuclear energy and the dangers involved, for example, in an hour's skiing or drinking half a bottle of wine. Exclusively people with a broad foundation of knowledge on the subject of energy should be sent to such discussions. In this way, it was hoped that speakers would not be so specialised that they could not answer general questions, which shook an audience’s confidence in the expert’s knowledge. In addition, efforts should be made in personal

[74] Information output in connection with Austrian referendum as known to OPI [Office for Public Information], IAEA Archives, Box 15521.
[75] Information Meeting on Austrian Referendum held on 23rd November 1978, Files from D.G.’s [Director General’s] Office - 1978, IAEA Archives, P-156 Box 4.

discussions to find common topics of interest not remotely connected to nuclear energy in order to show that nuclear scientists are also ordinary people with ordinary interests.[76]

The participants to the meetings were grateful for the information as well as the opportunity to exchange experiences over lunch. The importance of the forthcoming Swiss referendum on 18th February 1979 over nuclear power was emphasized. For the French-speaking part of Switzerland, the public relations officer of the French *Commissariat à l'Energie Atomique* (Atomic Energy Commissariat) offered support, which was well received by the Swiss participants. Likewise, the IAEA's offer of a brochure on radioactive waste disposal was welcomed since this topic touched the core of the Swiss debate. Basically, there was a desire to examine the implications of the Austrian referendum for other countries as well as the question whether the results of the referendum could be used by opponents to nuclear energy for their own purposes. Furthermore, a request was made to the IAEA to either promote the benefits of nuclear energy more actively or set out its advantages compared to alternative sources of energy.[77]

In the short term, the IAEA would not only be present at pro-nuclear events but also in those which deal with energy issues in general. Members of parliament and, if possible, journalists should also be provided with information. For this purpose, other United Nations bodies should be incorporated. Thus, in the long run, UNESCO should be incorporated in order to anchor technical progress in the 20th century (including nuclear energy) in the curricula of secondary schools.[78]

Based on these considerations, a list of twelve points for a public acceptance program was created:[79]

1. Fairy tales and facts on Nuclear Energy including description of accidents
2. Publication of positive assessments on Nuclear Energy from outsiders
3. Increased rebuttals in technical literature (New Scientist etc...)

[76] (Ibid).
[77] (Ibid).
[78] (Ibid).
[79] (Ibid).

4. Increased reviews of reports (Club of Rome...) and Dissemination
5. Full use of UN media system (radio, press releases, UNCSTD, papers suplement)
6. Efforts to launch secondary school teacher's training on energy matters:
    a. approach to UNESCO
    b. to governments: Austria, FRG, Sweden
    c. summer schools training by IAEA
7. Better presentation of Agency's Annual Report
8. Prepare short factual rebuttal to Austrian "NO" arguments and disseminate
9. Increase information on comparative health costs and Env. aspects of Energy sources
    a. IAEA/UNEP Panel
    b. 1980 Agency Symposium
    c. Include WHO
10. Increased participation by Agency staff in the preparation of information on the results of Agency's technical meetings (140 a year)
11. Increased Agency participation in meetings dealing with energy matters in general — and increased participation of environmentalism Agency meetings
12. Planning for future Agency actions on specific subjects (decommissioning)"

From these twelve points, a concrete plan of action was then developed, which was provided with a special budget of USD 87,155.[80] The Austrian nuclear programme ended thereby with a similar transnational knowledge transfer to the one it began with, and the Austrian experience was evaluated by the IAEA and was made available to its member states.

[80] (Ibid).

4. Facts & Figures

The purpose of this section is to give an overview of nuclear power in Austria. This section contains such data as number of reactors, reactors' locations, technical and chronological details of reactors' construction as well as statistics on electricity production, periodization and social connections to nuclear constructions. This data can be used as a supportive material to the following sections of the country report and in order to understand the overall country's situation. Key dates and abbreviations used in this report are presented in the beginning of this section.

4.1. Data summary

- Austria projected three commercial nuclear power plants but had only one never operated nuclear power plant at Zwentendorf. The construction of new plants and start-up of the completed Zwentendorf NPP was abandoned in 1978 after a majority voted against nuclear power in a referendum.
- Austria has three small research reactors, two of them being decommissioned, and the other still being operated.

4.2. Key dates and abbreviations

Key dates:

1910	Opening of the Institute for Radium Research as the first Institute of this kind worldwide
1938	Annexation of Austria to Germany
1940s	Austrian physicists became members of the German Uranverein
1943	Merge of the Institute for Physics and parts of Institute for Radium Research into Four-Year-Plan Institute for Neutron Research under the Third Reich
from 1945	Liqudation of Four-Year-Plan Institute for Neutron Research and bring back university research institutions
1953	US-President Eisenhower's Atoms for Peace speech
1955	Austrian national sovereignty and decision to build a research reactor with American support

1955	Foundation of Österreichische Studiengesellschaft für Atomenergie
1958	Austria gets CERN membership
1958	Federal agreement for building and construction of the first research reactor
1959-1965s	Three research reactors starts operation (ASTRA, TRIGA and ARGONAUT)
1962	The second research reactor went critical (TRIGA)
1965	The third reactor went critical (ARGONAUT)
1971	Decision to build a nuclear power plant in Zwentendorf
1974	A new company established to build a second nuclear power plant
1977	International Conference for a Non-Nuclear Future in Salzburg. In the same year – public protests Zwentendorf site and across Austria. Peaceful protests revealed secret fuel imports to the nuclear site and prevented it.
1978	Fuel was transported with the help of police and military helicopters to the Zwentendorf nuclear site.
1978	Majority of votes on public referendum against nuclear power (little difference). Zwentendorf reactor never started. Socialists' party issued a law that prohibited use of nuclear power for generation of electricity.
1979	Three Mile Islands accident. Austrian society realized wisdom of abandoning the nuclear power
1994	Study on decommissioning of the first research reactor (ASTRA)
1999	Constitutional law abandoning the use of nuclear power in Austria (BGBL 149)
1999	Shut down of the first research reactor (ASTRA)
2004	Shut down of the third research reactor (ARGONAUT) and decommissioning of the ASTRA reactor

Abbreviations:

ASTRA	Adaptierter Schwimmbecken-Typ-Reaktor Austria (Adapted swimming pool-type reactor Austria)
AMF	American Machine and Foundry, Inc.
BGBL	Das Bundesgesetzblatt, Federal Law Gazette

BWR	Boiling water reactor
CERN	**C**onseil **e**uropéen pour la **r**echerche **n**ucléaire
NPP	Nuclear power plant
TRIGA	Training, Research, Isotopes, General Atomics – nuclear research reactors
GKT	Gemeinschaftskraftwerk Tullnerfeld GmbH

4.3. Map of nuclear power plants

Figure 1 presents the map of nuclear reactors in Austria.

Figure 1 – Nuclear power plant and research reactors' locations

Zwentendorf nuclear power plant is located on the Danube River only 60 km North-West from Vienna. TRIGA reactor, the only operating of the three research reactors is located in Vienna, Viennise Prater near the Viennese amusement park. The two other research reactors were located in Seibersdorf, about 40 km from Vienna and in the city of Graz in South-East Austria.

4.4. List of reactors and technical and chronological details

The tables below show a summary of the nuclear research reactors and the only commercial reactor in Austria.

Table 1 - List of reactors in Austria

Name	Use	Operator	Supplier	Type	MWe net
Zwentendorf	commercial	GKT	AEG&Siemen s	BWR	700
ASTRA, Seibersdorf	research for planning NPP	Austrian Reactor Centre	AMF	MTR	10
TRIGA	university trainings, education	Atominstitut	General Atomics	Mark II	0.25
Argonaut	university trainings, education	The Reactor Institute Graz	Siemens	Argonaut	0.001

Previously Austrian Reactor Centre is now named Austrian Institute of Technology and the Atominstitut is the Atomic Institute in Vienna. The Reactor Institute Graz was located at the University of Technology, Graz.

Table 2 – Key dates of reactors

Name	First talks	Construction began	Operations started	Shutdown	Decommission
Zwentendorf	earlier 1970	1972	never	1978	
ASTRA, Seibersdorf	1955	1958	1960	1999	2004
TRIGA	1955	1960s	1962		
Argonaut	1955	1960s	1965	2004	2004-2005

4.5. Periodization of nuclear development

The nuclear power development has three periods:

1) 1910 – 1950: radioactivity research, several researchers are female. After the Annexation by Germany 1938, the number of woman in research decreased by half and one fourth of all

researchers lost their jobs. During the war Austrian nuclear physicists worked with German Uranium Club on nuclear fission.

2) 1953 – 1970: After Atoms for Peace speech three research reactors were brought to operation with the aim of developing a nuclear energy program in Austria. The main Austrian political parties – the Socialist Party and People's Party – were both pro-nuclear. The Liberal Party was a small opposition party that had critical views against nuclear power.

3) 1970s – present: Building of the first nuclear power plant and referendum upon using the NPP. Rejection of nuclear energy in Austria.

5. References

There are several papers and books that treat radioactivity research and nuclear physics in Austria before WWII, but only very few publications that address the Austrian nuclear energy program.

1. Literature on Austria before 1950

The most comprehensive work is the book of Silke Fengler (Fengler 2014). She analysed the Austrian research until the end of the 1940s including “denazification” and the reorganization of Austrian research. She edited also proceedings together with Carola Sachse, that give a broader view until the 1970s (Fengler and Sachse 2012). There are several papers by Wolfgang L. Reiter on Stefan Meyer (Reiter 2001c), the Nazi-era (Reiter 2004a; Reiter 2001a; Reiter 2004b), and the reorganization after 1945 (Reiter and Schurawitzki 2005). Maria Rentetzi published on the early period of radioactivity research in Vienna (Rentetzi 2005; Rentetzi 2009; Rentetzi 2004b; Rentetzi 2004a) until 1938.

2. Literature on Austria after 1950

Helmut Lackner (Lackner 2000) was the first, who treated the history from Atoms for Peace to the NPP in Zwentendorf. The most comprehensive work on this topic is my Habilitation (Forstner 2016b), which is currently reviewed and will be published in 2017. Several papers by myself already appeared: (Fengler and Forstner 2008; Forstner 2012b; Forstner 2011b; Forstner 2012a; Forstner 2011a; Forstner 2012c; Forstner 2016a).

There were several master theses at the University of Vienna focusing on one or another aspect of the Austrian nuclear program. Most of them are available through the e-library of Vienna University (Premstaller 1997; Zehetgruber 1994; Schmidt 2007; Martinovsky 2012; Bayer 2013; Bayer 2014).

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Belarus

Short Country Report

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Deutsches Museum

DIALOGIK

EHU Europos humanitarinis universitetas

TU/e Technische Universiteit Eindhoven University of Technology

Friedrich-Schiller-Universität Jena

Swedish Defence University

GRE

KTH

LUT Lappeenranta University of Technology

upna

UPMC Sorbonne Universités

The University Of Sheffield.

Science Museum

spi Sociedade Portuguesa de Inovação

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Executive summary

This report belongs to a collection of 20 short country reports on the History of Nuclear Energy and Society (HoNESt, project Ref.662268). The reports tackle the complex sociotechnical system around nuclear energy. Nuclear developments, notably nuclear energy, are closely intertwined with social, economic, environmental, political and cultural spheres. Nuclear energy is also a globalized system involving transnational transfers of knowledge, materials, technologies, people and products including electrical power, medical elements, toxic wastes and other environmental hazards, materials, capacities and knowledge that must be carefully safeguarded. Nuclear energy is a complex social and technological phenomenon that influences societies but is also shaped by societies.

The short country reports are designed to assemble information and research results on the history of the relations between nuclear energy and society in an accessible manner, and to document the findings with references.

The purpose of the country reports is threefold, addressing three different audiences:

1. to provide basic elements of narrative and analysis for further historical research by HoNESt researchers
2. to provide information, context and background for further analysis for HoNESt's social science researchers
3. to provide accessible information on nuclear-societal relations in the various countries for the purposes of outreach and communication with stakeholders (civil society, industry, associations, policy makers, journalists).

This report focuses on the history of the relations between nuclear energy and society in the Belorussian Soviet Republic and in Belarus. In spite of a series of regimes which limited the extent to which civil society could independently protest or promote nuclear power, the construction of nuclear power plants (NPPs) prompted public concern, and political response. In particular, the construction of NPPs that had been developed before the Chernobyl disaster caused public and political concern. After independence in 1990 the national nuclear program became part of discussions and debates followed by a 10-year moratorium on any NPP construction. Nevertheless nuclear programs in Belarus remained in place due to the way in which nuclear risks and post-Chernobyl uncertainties were articulated, translated for and perceived by the population. This at times confused discourse of nuclear risk, has meant that nuclear protest has been limited since 2001. I In 2008, the Belarusian government decided to build an NPP in Belarus, and construction began in 2012.

1. Historical Context (narrative)

1.1. Introduction to the historical context

The history of the nuclear program in Belarus can be presented retrospectively as a part of the general Soviet planning of nuclear power development and implementation in the Soviet Republics; from the perspective of long-term post-Chernobyl strategy; and of the ambitious energy outlook of the political regime established in Belarus after the collapse of the USSR. The first part concerns the history of the Belorussian nuclear program, the second – the Belarusian nuclear program after independence. Both nuclear programs reflect different political, technological and social contexts, before and after the collapse of the USSR, and before and after Chernobyl whichreveal different forms of civic engagement and participation by differing political actors and social agents.

1.2. Contextual narrative

The Belorussian nuclear program

The first projects for nuclear power in the Belorussian Soviet Socialist Republic (BSSR) were discussed from 1960 to the mid-1980s, starting from the creation of the first governmental commission on nuclear development in 1967 and ending with the construction of the first Nuclear Thermal Power Plant (NTPP) which began in 1983.

During this planning stage the core issues of nuclear development in the BSSR were linked to the research projects of the Joint Institute for Power and Nuclear Research, established near Minsk in 1965 as successor of the Nuclear Power Engineering Institute of the BSSR Academy of Sciences. The core group of nuclear scientists, led by Academician Krasin, one of the founders of the first Russian NPP in Obninsk, developed reactors based on a new technological cycle named *BRIG 300*, a breeder reactor. The administration of the Institute representing the scientific elite of the BSSR was a key promoter of nuclear power in the BSSR and supported the construction of this experimental type of the reactor.

The Joint Institute for Power and Nuclear Research was one of the leading institutions in nuclear research in the Soviet Union and attracted the best nuclear physicists and engineers from around the USSR. In 1962 the Institute acquired a standard IRT research reactor that permitted expansion of experimental nuclear research activities. In addition, the Belorussian State University opened a new study program on the “Physics of the nuclear installations” to prepare qualified personnel for research and work at NPP. This was followed by similar programmes of study and training at two other universities, the Belorussian Polytechnic Institute and the Institute of Radiophysics. By the mid-1970s a group of scientists with the capability of developing a new nucear project had been formed from graduates of the Joint Institute for Power and Nuclear Research. Research was initially focused on two innovative nuclear projects, a portable nuclear reactor – PAMIR, and he BRIG 300.

Qualities	PAMIR	BRIG 300
Technical Qualities	Thermal capacity achieved during tests – 4950 kW, electrical – 630 kW. The height and diameter of the reactor core – 0.5 meters; mass of the core zone – 5.7 tones. Operational time – 10 years. Connected to grid – 24 November 1985. Reactor commissioning from 6 July to 5 August 1985.	Thermal capacity – 1,110 MW, electrical – 353.3 MW. The height of the reactor core – 0.74 meters; the volume of the core zone – 1.41 m^3. The fuel core – uranium dioxide and plutonium. Fuel blanket - natural or depleted uranium.
Techno-political qualities	- The reactor was small and light enough to be transported by truck; - Unlike fossil fuels, the reactor could operate in a wide range of climatic conditions; - Autonomous air cooling without water; - Maximum automation, meant a minimum number of operating personnel were required; - Deploying the portable reactor took less than 6 hours; - Project ceased after Chernobyl	- single-loop circuit which significantly reduced build-cost; - Fuel doubling time (9-10 years); - Concept of the nuclear cycle developed by Academician Aleksandrov: meaning that fuel for proposed plants would first be ‘bred’ in the fast breeder reactors; - To reduce the refuelling time and to use of space above the core for refuelling without removing the cover; - Relatively high condensing temperature of the heater allowed either evaporative or dry cooling towers depending on the availability of cooling water;

In a 1980 report, on the “Actual state and perspectives of the development of nuclear energy in the USSR”[1] the director of the Joint Institute for Power and Nuclear Research, Vasilii Nesterenko, argued that the Belorussian energy system needed nuclear power because of a lack of alternative local energy resources. Without the development of nuclear power, Belarus would have to rely on

[1] Belarusian National Archives (БНА), f.7, o.5, d.8577, pp.14-29, *31.3.1980*

costly imports of fossil fuels. In the same document he announced that the first unit of the Nuclear Thermal Power Plant (NTPP - cogeneration power plant) would be launched in 1988 and the second one in 1990. He noted that the Soviet authorities supported the suggestion of the Joint Institute for Power and Nuclear Research to construct a Belorussian NPP in three possible areas - Minsk, Vitebsk or Mogilev. In 1980 two main trends for nuclear developments in the BSSR were framed: the first concerned the construction of the NTPP and the second one concerned the Belorussian NPP in the northern part of the country. If construction on the first project commenced, then the second was constrained by geological site selection and further discussions with central authorities in Moscow. According to the decision of the Central Committee of the CPSU and the USSR Council of Ministers the building of the Minsk NTPP started in 1982 with two VVER-1000 PWRs at 1 million kilowatts of nuclear capacity each and 1,990 Giga calories of thermal capacity per hour. Development of both nuclear projects was affected by the Chernobyl disaster and especially by its impact on nuclear decision-making in the USSR at the end of the 1980s (Schmid S. 2015). However, whilst the Minsk NTPP project was less affected by the Chernobyl disaster and more affected by the economic and industrial decline of the 1980s; the Belorussian NPP was linked more explicitly to the disasterous aftermath Chernobyl and demonstrated how the local authorities, as well as concerned social groups, reacted to plans for NPP construction in the BSSR after Chernobyl.

Periods	Nuclear Thermal Power Station	Nuclear Power Plant
1970-1983	Discussions of the project, participation of the Belorussian Academy of Sciences, planning, energy and economic forecast. **Actors involed:** Minenergo, Minsredmash, BSSR Council of Ministers, Soviet Council of Ministers	Planning and elaboration of suggestions. Promotion of local nuclear tehcnology, BRIG 300. **Actors involved:** Minsredmash, BSSR commission on national nuclear program, Joint Institute for Nuclear Research
1983-1985	Two level institutional tensions between central institutions (in Belarus and Russia) and between central and local insitutions (in Belarus). **Actors involed:** Minenergo, Minsredmash, BSSR Council of Ministers, Soviet Council of Ministers	Promotion of local nuclear tehcnology, BRIG 300. Nuclear energy is framed as an inevitable part of the energy mix. **Actors involved:** Minsredmash, BSSR comission on national nuclear program, Joint Institute for Nuclear Research
1986-1987	The construction is suspended, manpower and construction machinery moved to the Chernobyl NPP liquidation works. **Actors involed:** Minatom, Minenergo, BSSR Council of Ministers, Soviet Council of Ministers.	The debates about the location of the NPP are renewed. Central instutions pressure local institutionsto implement the nuclear program. **Actors involed:** Belorussian Academy of Sciences, BSSR Council of Ministers, Soviet Council of Ministers.
1987-1989	The official decision to stop construction. **Actors involved:** Soviet Council of Ministers	Social mobilization. Opposition to the NPP project from local institutions **Actors involved:** Local Administration and Communist Party organs in Vitebsk region, Belorussian Academy of Sciences, BSSR Council of Ministers, Soviet Council of Ministers, Minenergo.

From the start of construction in 1982, the Minsk NTPP was declared as a construction site of national importance. This led to the mobilization of many subordinate organizations to ensure the intensive construction; it attracted special brigades of the youth organisation Komsomol to assist in some aspects of construction. The nuclear site had special status not only because it was a nuclear technology, but also due to its importance for national economic, industrial and social developments. “Nuclear” appears here not only as a source of energy, but also as a source of exceptional national status. Both projects were abandoned after the Chernobyl disaster, and generated discussions about the future necessity of nuclear power in Belarus, following the declaration of the independence in 1990.

The Belarusian nuclear program

Belarusian politics has been deeply affected by Chernobyl (see Ukraine SCR) from perestroika under Gorbachev to the consolidation of the authoritarian regime under Aleksandr Lukashenko and construction of the country's first new NPP beginning in 2012. Most scholarship on Chernobyl and its after-effects argues that the country that suffered the most was Ukraine (Marples 1996), and its impact on Belarus is not widely known. While Belarus was kind of a "missing page" in Chernobyl history, the ecological, medical and social impacts continue to play a significant role in political, national and social processes and discourses in the country. The Chernobyl disaster is closely related to significant political transformation in the country beginning with independence, political and social mobilization in the early 1990s, the further development of the political system, and the emergence of new political parties and electoral processes.

Today Chernobyl policy is a significant part of the governments' activities including the liquidation of the disastrous aftermath. This has not only been a matter for the governments as various NGOs, scientific institutions and scientists working on the consequences of the disaster, public organizations dealing with the affected territories and groups, independent and state media covering Chernobyl related issues and political parties involved in the Chernobyl March have participated in defining problems and developing the concept of safe inhabitation of the Chernobyl affected territories.

The first period of Chernobyl policy reflected the post-emergency situation (1986-1989). Its major feature was the almost total lack of official information which shaped Chernobyl's disasterous aftermath in controversial discourse as a system of contradictions, false senses and meanings, and misinformation spread by the state bodies. This lack of information concerning both the process of liquidation and the disaster's after-effects led to the "double mobilization" of society, antinuclear and anticommunist as well.

From 1989 to 1991 a shift within Chernobyl policy became possible. This was promoted by political transformation: the election of the People's Deputies of the USSR in the spring of 1989 under a new election law expanding possibilities of promotion and election of candidates, and the election to the Supreme Soviet of the BSSR in 1990. This reform and elaboration of the Chernobyl policy became possible due to political and institutional transformations and was finalized during the assemblies of the Supreme Soviet of the 11th and 12th convocations. It was in these meetings in 1990 that deputies formalised their opposition to the scientific concept of “35 rem” and their acceptance of the Concept of Residing in the Territories Contaminated by Radionuclides as a Consequence of the Disater at the Chernobyl Nuclear Power Plant. This led to the creation of new zones of radioactive pollution, and further evacuation of the populations within them.

From 1991 to 1997 various legislation was developed, establishing the first government programs, a series of public scientific discussions and promoting the involvement of public organizations. During that time several important laws were adopted, among them a law on the Social Protection of the Citizens Who Suffered from the Disater at Chernobyl Nuclear Plant and the Legal Regime of the Territories with Radioactive Pollution as Consequence of the Disaster at Chernobyl Nuclear Power Plant. These laws have introduced the categories of “suffered people” affected by the Chernobyl Disaster as well as a regulatory regime for the contaminated areas. The public debates that took place in scientific structures and in the media touched upon both the adoption of the Concept of Protective Measures during the Regenerative Period for the Population Living in the Territory of Belarus Exposed to the Radioactive Pollution due to Chernobyl Disaster in 1995 (see Event 3, section 3.4), the work of the Special Commission on Atomic Engineering Development in Belarus in 1998, and the acceptance of the moratorium on nuclear power plant building in Belarus (see Event 4, section 3.5). These two examples of scientific discussions illustrate how Chernobyl policy has become an issue for nuclear policy developments in Belarus. Currently Chernobyl policy in Belarus is mainly carried out under the Government Program on Overcoming and Minimization of Consequences of the Disaster at Chernobyl Plant whose goals are development and revival of the affected territories, reduction of scientific research, and reduction of benefits for "Chernobyl" social groups. These reductions testify the decreasing role of Chernobyl in decision-making.

Periods	Events

1992	The government of Belarus adopted and approved a Program of Energy Development and Energy Supply by 2010. For the first time since Chernobyl, new NPPs were considered.
1993-1998	In 1993 the concept of a draft Program of Nuclear Power Development in Belarus was developed. Between 1993 and 1998, a search for the possible sites for a NPP as well as for radioactive waste storage began.
1998-1999	Problems with the gas supply and the growth of the energy debt promptedincreasing nuclear debates in mass media. Parliamentary hearings discussed the prospects for the development of nuclear energy. The Commission on the Use of Nuclear Energy was set up, which consisted of 34 scientists and activists from various research institutions. In 1998 Belarus abandoned the development of nuclear program for 10 years.
2002	Possibility of the construction of a NPP is discussed between Russia and Belarus, the special intergovernmental group has been established. Alexander Lukashenko announced that Belarus was ready to invest in the construction of new nuclear units in Russia.
2005	The Concept of energy security of the country, and the Program of modernization of the Belarusian energy system for the period 2006-2010 are adopted. One of the articles of the energy security Concept outlines the necessity to construct a NPP.

During the early 1990s the Belarusian Academy of Sciences became one of the central institutions for discussions on the development of nuclear power in the country. It joined the Belarusian Ministry of Energy and Russian Institute of Energy Research in a “Conception of the nuclear energy development within the structure of the energy complex of the Republic of Belarus”[2]. This concept illustrated the raise of the interests to renew the national nuclear program in the 1990’s.

[2] National Academy of Sciences Archives, f.1,d.3315, pp.105-129

Framework	Outputs
Rationale	- The necessity of nuclear programs is questioned: negative social perceptions of nuclear energy; lack of confidence in the reliability and safety of nuclear power plants. - Take into account energy consumption, cost, supply dynamics, upgrading energy equipment and economic and ecological impact of the power plant. - The NPP has multiple risks and demands, but representsa reasonable solution insuring energy secutiry in Belarus.
Legal framework	- The elaboration and adoption of a law on “The Use of Nuclear Energy and Radioactive Protection” before the start of the construction of any NPP. - The creation of a regulatory regime according to the IAEA including the elaboration of norms regulating the choice of NPP, its siting, safety regime and quality of construction.
Public opinion	-The elaboration of educational and propaganda activities to ameliorate public attitudes towards NPP construction: creation of a National Information Centre; the formation of public opinion in favour of nuclear energy; engagement work with population and with political structures in the regions of the possible nuclear sites; distribution of information about the choice of the site, the choice of reactor, and information about the construction; ensure public control over construction; distribution of information about the NPPs, accidents and ecological impact.
Technological Choice	The choice of the reactor type would be made through an open call and then evaluated according to the following criteria: - safety outputs; - commissioning dates; - commercial offers of the main nuclear companies. After the preliminary surveys in 1992-1993 14 possible sites were indicated. Due to the lack of the national legislation regulating the choice of the placement of the NPP, IAEA and Soviet-era legislation were used to determine the main criteria.

In 1998-1999, Belarus abandoned development of a civil nuclear program. Nuclear discourse reappeared in Belarus at the beginning of the 2000s following the re-establishment of initiatives to construct a new NPP.

The government promoted nuclear power and put it firmly on the agenda through a series of directives. On August 25, 2005, President Alexander Lukashenko approved Decree № 399 "On energy security and strengthening the energy independence of the Republic of Belarus, 2006-2010" designed to develop nuclear energy. At a meeting on energy security on December 1, 2006, the President approved in their entirety the proposals of the National Academy of Sciences of Belarus (hereafter NASB) and the Belarusian government on building a nuclear plant. On June 14, 2007, Lukashenko signed directive № 3 "Economy and savings as major factors in the economic security of the state ", where paragraph 1.3.1. provided for the revitalization of the construction of the plant. On November 12, 2007, Decree № 565 "On several measures for the construction of a nuclear power plant" was signed, whereby management of nuclear energy was established. On January 15, 2008, at a meeting of the Security Council of Belarus chaired by Lukashenko a final political decision on the construction of nuclear power plant was taken. In accordance with this decision the Belarusian government plans to build two nuclear reactors of 1,200 MW each, with the first reactor to be commissioned by 2016, and the second by 2018. In August 2008, the government adopted a law on the Use of Atomic Energy that defined the competencies and the process of public participation in decisions relating to policy in the sphere of nuclear energy including the establishment of the nuclear policy and the land and siting of the NPP.

Since 2006 the planning of a nuclear plant has turned from strictly being energy policy to a political project expressing not only rational calculations but political will and ambition. The construction of a nuclear plant is a long-term project involving different public actors and answering not only the economic and political demands of Belarus but also the political and geopolitical ambitions of President Lukashenko as a source of symbolic significance and political legitimation. On January 15, 2008, the decision to construct a NPP in Belarus was made at a session of Security Council of Belarus headed by Lukashenko. No public discussion on alternative projects within the civil or scientific community occurred. The legitimacy of this decision thus remains the subject of civil disagreement and social mobilization.

At first glance the political decision to construct the nuclear power plant in Belarus appears to be an economic one from an energy point of view given the lack of national energy resources, and from a technological point of view given lack of commitment of the government to develop renewable sources of energy. As Mikhail Mikhadzyuk, Belarus' Deputy Minister of Energy stated on March 23, 2011:

> *We must understand correctly, even in light of the events that occurred in Japan [the tsunami and partial meltdown at Fukushima], Belarus needs a nuclear power plant. This is a new qualitative leap in the development of the country; brand new technologies are*

coming to Belarus ... Belarus does not possess its own energy resources, so we have no other alternative. There is criticism, but no concrete suggestions[about] how to do without nuclear power.

According to Article 10 of the Independence Declaration (June 23, 1990, № 193-XII) and Article 18 of the Constitution of the Republic of Belarus (November 24, 1996; 17.10.2004) the Republic of Belarus was declared a neutral and nuclear free territory. However, the way in which these articles is formulated makes clear that the phrase “nuclear free territory” refers to nuclear weapons, and not civil uses of nuclear power.

According to Gamson and Modigliani (1989), nuclear discourse is expressed in various semantic frameworks, for example progress and energy independence. The idea of progress (the development of society and technologies), and of independence from other energy sources (in particular oil and gas), were the basic arguments of nuclear discourse in the BSSR and in independent Belarus. In the BSSR until 1986 the idea of progress in nuclear discourse dominated with an accent both on safety and on the victory of humankind over the atom. After the accident at Chernobyl until the 2000s an anti-nuclear discourse or elements of risk discourse in the use of nuclear energy dominated to a larger degree. During that period such decisions as abolition of the construction of a nuclear plant near Minsk and Vitebsk and the adoption of the ten year' moratorium on construction of any NPP were taken. Since 2006 the building of the NPP has marked a new stage in development of the nuclear discourse in Belarus. At this stage it is necessary to note the domination of the semantic frameworks based on the idea of energy independence with the accent on economic and social necessity and also on the safety of nuclear energy.

1.3. Presentation of main actors

Name/Title	Institutional/Formal/Informal Role	Actor Category
Aksenov, Aleksandr	Chairman of Council of Ministers of the BSSR, 1978-1983	Receptor
Brezhnev, Leonid	Secretary of the Central Committee of the Communist Party, 1964-1982	Promoter
Brovikov, Vladimir	Chairman of Council of Ministers of the BSSR, 1983-1986	Receptor

Burnazian, Avetik	Vice Minister of Health, State Sanitary Doctor of the USSR, 1956-1981	Promoter
Firisanov, Leonid	Vice Chairman of Council of Ministers of the BSSR (1984)	Receptor
Gorbachev, Michail	Secretary of the Central Committee of the Communist Party, 1985-1991	Promoter
Gvozdev, Viktor	Head of the Gosplan of the BSSR, Chairman of the Commission on the nuclear developments in the BSSR (1978-1982)	Receptor
Hartanovich, Georgy	Head of the Belglavenergo, 1969-1991	Receptor
Kamchatny, Anatoly	Major engineer Kola NPP	Receptor
Kebich, Viacheslav	Head of the Gosplan of the BSSR, 1985-1990	Receptor
Kenigsberg, Yakov	Vice-Director of the Institute of the Radioactive Medicine within the Ministry of Health (1998) Head of the National Commission for Radiation Protection under the Council of Ministers of the Republic of Belarus (2001-2009)	Promoter
Kosygin, Alexey	Chairman of Council of Ministers of USSR, 1964-1980	Promoter
Kovalev, Michail	Vice Chairman of Council of Ministers of the BSSR (1978-1984) Chairman of Council of Ministers of the BSSR (1986-1990)	Receptor
Lepin, Georgii	Professor, HDR in technical sciences	Receptor
Ling, Serguei	Prime Minister of the Republic of Belarus (1996-2000)	Receptor
Lukashenko, Aleksandr	President of the Republic of Belarus	Promoter
Lukonin, Nikolai	Minister of Atomic Energy of the USSR (1986-1989)	Promoter
Majorets, Anatoly	Minister of Energy of the USSR (1985-1989)	Promoter
Martynenko, Oleg	Director of the Institute of Heat- and Mass-Exchange of the Belarusian Academy of Sciences (1988-2003)	Promoter
Masherov, Piotr	1st Secretary of the Central Committee of the Communist Party of the BSSR (1965-1980)	Receptor
Mihakevich, Aliaksandr	Member of the NAS, Director of the Energy Institute	Promoter
Neporojnij, Piotr	Minister of Energy of the USSR, (1962-1985)	Promoter
Nesterenko, Vasily	Member of the NAS, Director of the Institute “BelRad”	Receptor
Reut, Anatoly	Head of the Gosplan of the BSSR, Chairman of the Commission on the nuclear developments in the	Receptor

	BSSR (1983-1985)	
Ryzhkov, Nikolai	Chairman of Council of Ministers (1985-1991)	Promoter
Sadovsky, Stanislav	Vice Minister of Energy of the USSR (1984-1990)	Promoter
Semionov, Nikolaj	Vice Minister of SredMash (1971-1982)	Regulator, promoter
Serov, Valery	Vice director of the Gosplan of the USSR (1988-1991)	Regulator
Shamanovsky V.	Chief of the Construction site of the Minsk NTPP	Regulator
Shcherbina, Boris	Vice Chairman of the Council of Ministers of the USSR (1984-1989)	Promoter
Slavskii, Efim	The Ministry of Medium Machine-Building Industry of the USSR (1957-1986)	Regulator, promoter
Slivyak, Vladimir	Co-chair for Russian NGO "Ecodefense"	Activist
Smolar, Ivan	Member of the International Academy of Ecology, Member of the Commission on nuclear developments (1998)	Activist
Solomentsev, Mikhail	Chairman of the Communist Party Control Committee, (1983-1988)	Regulator
Sukhij, Iryna	Leader of the NGO "Ecohome"	Activist
Tikhonov, Nikolai	Chairman of Council of Ministers of USSR (1980-1985)	Promoter
Vitiyaz, Piotr	Academic of the NAS, Chief of the Commission on nuclear developments (1998)	Promoter

2. Showcase: Nuclear attitudes and governance in post-Chernobyl contexts

People who argue for the construction of nuclear power stations in Belarus stress strategic objectives: first the country's energy security and second the potential to export electricity. The long-term process of building the plant can mark both the end of one policy period, post-Chernobyl, and the beginning of a new one – the period of the civilian nuclear program. The most important goal for an authoritarian regime may be the capacity to translate a resource, whatever its origins, in this case nuclear power, into support for a strong and capable state that is able to realize such a modern project and enter the ranks of countries with nuclear technology.

According to opponents of nuclear power in Belarus, President Lukashenko needs his own nuclear power plant to fulfil his political ambitions. For example, Georgii Lepin says that after the withdrawal of nuclear weapons and announcement of Belarus a nuclear-free territory, “President Lukashenko wants to return nuclear power to the country to have it not much as additional source of energy but as a source of [political] power.”[3] This nostalgia for nuclear power, of course, can be examined within decision-making in an authoritarian regime where nuclear power as an energy source can be considered both a resource of political authority and of political power. However, the personal political ambitions of the authoritarian leader are not sufficient to explain this decision. The decision is also based on a long-term strategy from a country disastrously affected by Chernobyl to a country developing a nuclear program.

Public opinion discourses

As, the project for nuclear power successfully moves ahead and public actors are mobilized to participate in the implementation of the most ambitious state project in Belarus today involving the construction of not only a new NPP, but also a new semantic and symbolic space. Such extensive promotion of nuclear power by this variety of public actors has led to an increase in public support for nuclear power over the past 20 years.

[3] The interview with Lepin Georgii, professor, expert in nuclear programs, 04.07.2016, Minsk.

Surveys	Pro-nuclear	Anti-nuclear
1995, Institute of Sociology, Institute of the Problems in Energetics of the NAS *“What do you think about the idea of the construction of the NPP in Belarus?”* *“What do you think about the construction of an NPP near your house?”*	40.9% Minsk 24.7% Gomel reg. 25.2% Moguilev reg. 24.2% Brest reg. 13.8% Vitebsk reg. 22.8%	39.0% 39.8% 53.3% 45.8% 55.9% 50%
2005, Institute of Sociology *Is it necessary to develop nuclear energy in Belarus?*	28.3%	47.7%
2008, Institute of Sociology *Is it necessary to develop nuclear energy in Belarus?*	54.8%	23%
2010, Institute of Sociology *Is it necessary to develop nuclear energy in Belarus?*	57.8%	19.6%

Sources: Mikhalevich, 2010

Various surveys highlight diverging opinions among Belarusians regarding the necessity of nuclear power. According to a multi-centre study of public opinion held in Belarus by the Institute of Sociology, the attitude to the development of nuclear power has changed: “There have been qualitative changes in the public attitude to the development of the national nuclear program: the number of supporters of the development has doubled from 28.3% in 2005 to 54.8% in 2008; two thirds of respondents expressed confidence that NPP construction will improve the state of the fuel and energy complex of the country, and increase the competitive power of Belarusian commodities and services; 75.5% express readiness to support NPP construction given the safety conditions, competitive selection and international examination of the project are provided and observed" (Institute of Sociology, 2008: 120).

However, this survey doesn't provide data regarding the public attitude toward the proposed NPP, while data from the national survey of the Independent Institute of Social-Economic and Political Studies (IISEPS) demonstrates essentially an equal share of respondents who disapprove of the government's decision to start construction - 42.1% in March 2008 and 40.2% in June 2008 - and those who support the decision - 37.4% in March 2008 and 37.8% in June 2008[4]. These reflections of public opinion illustrate the challenges of determining attitudes toward nuclear power in Belarus, and of the sociological framing and representation of problems related to the construction of new NPPs.

For example, in the study of the Institute of Sociology of the NASB, the favourability of the public to nuclear power is a general question, while IISEPS treats the issue as a purely political decision. It should also be pointed out that the Institute of Sociology study avoided certain words and phrases, concerned that they would be affect the survey's response. In instructions the survey designers recommend not to use any concepts related to Chernobyl: "By the way, the expression '30km Zone' came into common use after the accident on the Chernobyl NPP and evokes negative psychological associations. Although it is being mentioned in some IAEA records, it would be rational for us not to use it during an awareness-raising work with the population" (The Institute of Sociology, 2008: 110).

The Institute of Sociology survey held in August and September 1995 and in February 1996 reflected a balanced public attitude to the nuclear power use (Babosov 1996). In particular, 40.9% respondents replied in positive to the question if the project of the NPP construction should be accepted in Belarus, 39% replied negatively, and 19% were undecided (Babosov 1996:105). It should be pointed out that this result coincided with the period of the 10th anniversary of the disaster and resumption of debate over NPP construction. Public attitudes to the NPP construction in Belarus in 1996 were coupled with public attitudes concerning the disasterous impact of Chernobyl on public health and the environment. In particular, in this survey the state of the environment came third in a list of problems that caused concern amongstthe majority of the respondents. Over fifty-five per cent of the respondents residing in the regions affected by Chernobyl noted problems associated with a deterioration in health first, decline in family earnings second, and lack of clean and safe products last (Babosov 1996: 102). They often worried about the safety of NPPs. For instance, more than 75.8% of respondents believed it necessary to pay much more attention to the safety of operation not only at the Chernobyl NPP, but also at other NPPs

[4] According to the data of national opinion surveys held by IISEPS in March 2008, page 6, and in June 2008, page 9, http://www.iiseps.org/poll08.html (20.04.2016). The question was posed as follows: The government of the country took a final decision to construct a nuclear power plant in Belarus. What is your attitude to such a decision?

located around Belarus. The reasons for this concern included risks to health inflicted by NPPs as compared to other processing facilities (28%), the risk of illnesses and environmental crises (21.6%), and third, the potential of harm to the environment as compared to other industrial facilities (17.1%) (Babosov 1996:104).

In 2005, when asked if a nuclear power program should be developed in Belarus (Zaborovski 2009: 131), 28.3% responded positively, and in 2006 the number remained almost unchanged (28.8%). However, in 2008 the number rose sharply to 54.8%, with a sharp decline in the negative from 46.7% in 2005 to 23% in 2008. In 2010 57% responded positively and 19.6% negatively. The share of those undecided remained approximately the same at all times – only dropping from 25% in 2005 to 22.5% in 2010. This suggests that there is a certain correlation between the group of supporters and opponents of the nuclear power in Belarus, and the percentage ratio is generally divided among them, while the group of 'the undecided' remains stable.

An important variable in the comparison of the structure of public opinion toward nuclear power in 1996 and 2010 is the general sociological context of public opinion framing. This refers to the articulation and classification of questions asked during the survey. In 1996-2005 public attitudes to nuclear power engineering were studied in conjunction with public attitudes to the impact of Chernobyl - 46% of the surveyed in 2005 still associated nuclear power engineering largely with dangers and risks. At the same time, the dangers and risks were related to the disasterous impact of the accident, not the technical characteristics of the actual reactors (Zaborovski 2009: 87).

In the late 2000s any connotations of Chernobyl disappeared from the structure of the national opinion surveys conducted by state institutions, while questions related to potential sources of financing for the NPP, the availability of material and technological expertise in Belarus, and the rise of the competitive power of Belarusian commodities resulting from NPP construction replaced them. This methodological discrepancy is not accidental. It actually highlights the specific ways in which surveys were carried out in Belarus, but also the strategies behind them that manifest themselves in decoupling of new reactor construction from Chernobyl, and in the attempt to legitimize the already-taken decision on the construction of new NPPs. While in 1995-1996 this entailed only the possibility of new NPPs, in the late 2000s it related to the possibility of producing nuclear power with all its benefits (and risks).

Nuclear governance discourse

The basic argument of official discourse legitimating nuclear energy in Belarus is safety discourse, including energy safety. This discourse actively uses arguments about the political independence of the country and also arguments of probable risk based on the notion that nuclear power is safe and will help promote energy and political independence. During the session of the Security Council on 15 January, 2008 when the decision about the NPP construction was taken, the President Lukashenko announced: “Today we put the basis of thefunctioning of the Belarusian state in the conditions when the global problem of depletion of stocks of fossil fuels becomes critical…I think that future generations will assess our decision. (…) Our problem is to find a unique and true variant where Belarus will manage to reduce the risks to the minimum in a way to profit from all the advantages of its own nuclear power plant. (...) This energy enterprise has the great value for us, all questions connected with it are important, because they concern the safety of the population, and not only in our country. There are about five hundred of such stations already constructed on the planet, therefore there is nothing extreme in building a nuclear power plant in Belarus - the experience of construction of such objects already exists in the world” (Lukashenko, 15.01.2008).

During a memorial meeting at Komarin on April 26, 2009, Lukashenko announced Chernobyl policy with the decision to construct a nuclear power plant. He declared that Belarus had entered a new stage of Chernobyl policy - the development of the affected territories. The idea of revival and restoration of the former way of life in these regions was (and is) actively used in Lukashenko's discourse. Nevertheless in the context of the new policy paradigm of revival of the territories the health of the population remains the priority, illustrating that life in the affected terrtories after Chernobyl is possible. At the same time, state officials abandoned past categorizations of affected populations to show there was no place for post-Chernobyl social distinctions and that such groupings as “the resettled” and “liquidators” would disappear. These changes in Chernobyl policy became a major line in political discourse intended to permit the advance of nuclear power in Belarus (see the table below).

Institutional changes in Chernobyl policy and in Lukashenko's discourse are revealed in two patterns. First, the government changed how it distributed post-Chernobyl financial resources and altered the nature of the program to ensure the “restoration of those regions” in keeping with the idea of revival of the territories that were hit by the disaster. Secondly, the government liquidated Goskomchernobyl, the bureaucracy responsible for dealing with the consequences of Chernobyl within the Ministry of Emergencies. The disappearance of this unique political structure testifies to the clear strategy of eliminating many of the official signs of the Chernobyl disaster.

Yet elements of risk discourse remained in the new Chernobyl policy in concerns about the safety of the population during the revival of the territories: “Question number one will be the safety of our citizens. If you see where it is possible to plough, plough. But it is necessary to strengthen the control over the food produced” (Lukashenko, 26.04.2009).

Patterns	Samples	Sources
Life after Chernobyl	“In Braghin (one of the “suffered” regions) more people are born than die already, which testifies that the life in the given region is improving”	Memorial meeting at Komarin on April 26, 2009
Chernobyl policy	“The main goal is transition from rehabilitation to development of the territories affected with obligatory preservation of all the necessary measures of radiation protection of the population”	Memorial meeting at Komarin on April 26, 2009
Social groups	“Without forgetting the tragedy of Chernobyl, we have ceased to divide people into Chernobyl people and not. From this year we start to revive the contaminated territories promptly”	Memorial meeting at Komarin on April 26, 2009
Institutional changes	“Nothing will go on until we liquidate the department within the Ministry of Emergencies and we submit those questions (of Chernobyl disaster recovering) to governors at the local level”	Memorial meeting at Komarin on April 26, 2009
Revival of the Chernobyl territories	“Now it is important not simply to minimize the consequences of Chernobyl but also to create normal industrial conditions and conditions of life so that people can be sure of tomorrow”	Memorial meeting at Komarin on April 26, 2009

The decisions about NPP construction and Chernobyl policy changes began the official campaign to promote nuclear energy in Belarus. If in the ‘90s and the early 2000s public attitude to nuclear power was divided between the opponents and supporters of nuclear energy, the late 2000s witnessed an increasing number of pro-nuclear attitudes. The strategy of managing public relations and propaganda was affirmed on November 1, 2008 by Vladimir Semashko, first deputy prime-minister of Belarus and required the framing of public opinion, with specific attention paid to readjusting opinions from negative to positive. As part of this strategy a number of special promotional documents were elaborated and published.

The Joint Institute for Power and Nuclear Research prepared materials such as, *"*The Current State of the World Nuclear Power Engineering: Facts and Figures*"* that were disseminated among all regional government councils (executive committees). For example, the instructions to the Vitebsk regional executive committee indicated that this information was meant 'for use while organizing common days of awareness-building, meetings of awareness-raising and propaganda groups with personnel and the public on the issues of nuclear power[5].

This document, *"*The Current State of the World Nuclear Power Engineering: Facts and Figures,*"* presented a general picture of the development of nuclear power engineering in Europe, the USA and Japan. In it specialists discussed the reaction of different countries and governments to the Fukushima accident in order to demonstrate that Fukushima did not lead to nuclear phase-out in most countries. It does not contain a single word on Chernobyl or its incredible impact. Regarding Fukushima, the document doesn't mention either the causes or the impact on health and environment. Such practices of public outreach and shaping of public opinion can be observed in other materials of this kind. The nuclear industry has prepared a series of publications that are related either to the issues of the development of nuclear power engineering generally or directly to plant construction in Belarus.

In *FAQ on Belarusian NPP* (Minsk, 2009) or Vasily Gigevich's *The Stipulation of the Construction of the NPP in Belarus* (Minsk, 2009) there is no direct mention of the word Chernobyl or any other nuclear accident, except for the cryptic mention that "after 1986 requirements for NPPs became much more stringent." In *Construction of the NPP in Belarus: Economic Viability, Safety, Environmental Impact* by Nikolai Gapanovich-Kaydalov (Gomel, 2012) presents a special rhetoric tool - 'a myth' - namely, the debunking of conventional myths about atoms for peace: 'nuclear myths'. Here the term 'myth' is used tohighlight the distinction between the 'real facts' of the nuclear energy industry and the fears that nuclear energy produces. In this way the debate about NPP construction in Belarus is rechanneled into the sphere of symbolic cooperation, the fight for the right to nominate or determine what is true and false, rather than political struggle.

[5] http://www.novopolotsk.by/attach/informat/IPG-47-29.pdf

In *Nuclear Power Engineering. Perspectives for Belarus* Academician Alexandr Mikhalevich provides a detailed assessment of the development of nuclear power, dedicating only a small part to the Fukushima accident and ignoring Chernobyl and its consequences. In fact, Fukushima is considered to be a result of passive safety systems alone. 'Safety systems' are a significant part of nuclear discourse in Belarus, directed primarily at maintaining the image not so much of the safety of the NPP operation, as of 'credible hazards' which can be easily prevented.

It is possible to claim that Fukushima is a substitute for “Chernobyl” in the discourse of the supporters of the NPP construction in Belarus: 'lessons from Chernobyl' became 'lessons from Fukushima'[6] and there are several reasons for this. First is the tendency to switch attention of the public opinion to issues of safety of NPP operation generally and away from the issues of NPP engineering and construction. That helps to promote the idea of construction of the NPP among populations as a safe process. Also, the proximity of the nuclear facilities plays an important role in this rhetorical substitution. While the Chernobyl NPP was situated 20 km from the Ukraine-Belarus border, the Fukushima NPP is much farther away in distance, danger and time. Also, in spite of Fukushima Japan, did not phase out of nuclear power entirely. It is fair to assume that this discursive shift allows the disaster at the Chernobyl NPP to become a bygone event, replaced by another experience that is neither explicitly related to Belarus nor to its population and territory.

To prepare the population for the NPP construction as well as to define its place within decision-making and political structures, state officials established legal frameworks, namely the decree 'On certain measures related to the construction of a nuclear power plant'[7], and the law 'On the uses of nuclear power.'[8] The institutional setting for nuclear governance was changed: the Department for Nuclear and Radiation Safety was founded in 200(?) to become the main supervision agency in the sphere of nuclear power engineering; whilst in 200(?), the Directorate of the Construction of the NPP was formed.

[6] Mikhalevich, A.A. (2011) *Nuclear Power Engineering. Perspectives for Belarus. [Atomnaya energetika. Perspectivy dlya Belarusi]*, Minsk. One of the chapters is called "Lessons From Fukushima".

[7] Decree of the President of the Republic of Belarus №565 "On certain measures related to the construction of the nuclear power plant” dd. November 12, 2007.

[8] The Law of the Republic of Belarus №426-3 "On the uses of the nuclear power” dd. July 30, 2008.

The Law 'On the uses of nuclear power' determines the system of relations among public institutions in the sphere of nuclear governance. This Law sets both functional framework, the range of public institutions that participate in nuclear policy, and a symbolic framework, namely the introduction and definition of notions related to nuclear power. It defines the terms and concepts that frame nuclear policy in Belarus. 'Nuclear material,' 'nuclear facility', 'nuclear reactor', and 'nuclear plant' are for the first time defined in Belarusian legal documents. As well as the conditions which influence decision-making regarding the construction of the nuclear facility, (art. 14). These include economic, social need, civic safety and environmental safety - which are the conditions that are meant to be the base for the political decision on the construction, operation and decommissioning of nuclear facilities. It is to be recalled that the decision on the construction of the nuclear power plant was taken half a year before the law defining given conditions was passed. Before having passed this law, neither the conditions, nor the main terms were in any way legally defined.

Thus, with this Law the use of nuclear power attains not only the new regulatory domain, but also a separate, independent field of legal, political and social relationships that is shaping a new regulatory and institutional regime which is intentionally un-related to Chernobyl.

The nuclear governance narrative actively uses the 'Chernobyl syndrome' narrative to reject citizens' complaints and anti-nuclear claims (Novikau 2017). This discursive element appeared with the first post-Chernobyl studies of public attitude to NPP construction. Evgeny Babosov, one of the sociologists who conducted a survey in the '90s, writes: "The persistent distrust of the majority of the population of Belarus (39%) to nuclear power is conditioned primarily by the 'Chernobyl syndrome'- the fear of a recurring tragedy similar to one that happened 10 years ago at the Chernobyl NPP" (Babosov 1996: 109). The same argument is used in 2008 by Jakov Kenigsberg, head of the National Commission on Radiation Protection, after the government decision to construct the new NPP: "The construction of the NPP is a sensitive issue in every country, and in Belarus the matters are made worse by the Chernobyl syndrome[9]." He also uses separation between the 'construction' and 'utilization' of the nuclear facility: "There is no risk in construction

[9] "Ministry of Information: Belarus Needs Awareness Promotion on Nuclear Power", available at http://news.tut.by/113553.html, 24.07.2016.

until the fuel is delivered, until the preparation to launching and the operation of the plant begins. (...) Provided regular operation of the plant, there shouldn't be any overexposures."[10] At the level of a symbolic meaning, there is hardly any difference between taking a political decision to constructa NPP and its launch. Their semantic frames are identical since the political decision on the construction implies both launching the NPP and its operation and utilization. This separation between the 'construction' and 'utilization' of the nuclear facility represents a rhetorical tool directed primarily at the creation and reinforcement of an image of safety– the hazard comes not from the nuclear facilities or materials themselves, but from their uses and operation – and in Belarus the authorities are confident of safe operation.

[10] Ibid.

3. Events

Critical view to the selection process of the five events:

Event 1: The Resolution of the Central Committee of the CPSS and of the Council of Ministers of the USSR, 26 June 1980, on the construction of the Nuclear Thermal Power Plant (NTPP) near Minsk

The resolution of the Central Committee to construct a NTPP near Minsk marked the official start of the nuclear program in the Belorussian Soviet Republic. According to the general Soviet plan, this nuclear unit and another NPP on Belorussian territory would complete the network of the Soviet reactors in the western USSR along with the Chernobyl NPP, Smolensk NPP, Ignalina NPP and Leningrad NPP. The preparation and construction of the Minsk NTPP illustrated all the tensions and controversies within nuclear decision-making and governance during the last decade of the USSR's existence.

Event 2: The adoption of the Requirements for the placement of the Nuclear Power Plants (22 October 1987)

Before the accident at the Chernobyl NPP there was no legal framework for nuclear programs in the USSR, especially regarding requirements for the selection of sites for reactors. Such a document appeared only in October 1987 – after Chernobyl; the law clearly defined the role of local institutions in nuclear decision-making and enabled the opportunity for scientific mobilization against the pressure of the central scientific and administrative institutions.

Event 3: "Framework for residing on the territories contaminated with radionuclides as a result of the disaster at the Chernobyl NPP" approved by the Presidium of the Belorussian Academy of Sciences in 1990

The adoption of this Framework regulating the radiation limits for residing on contaminated areas after Chernobyl was part of a debate about intervention measures between scientists and politicians who supported a 35-rem limit and those opposed to it. Those who supported it believed that life in a contaminated area with a 35-rem limit is safe and those who opposed it believed that the limit should be considerably lower. This debate reveals that controversies existed among scientists about life after Chernobyl and underlines the cleavages among pro- and anti-nuclear politicians and scientists in a discourse over “radiophobia” and “Chernobyl syndrome”.

Event 4: The Commission on the Assessment of the Advisability of Nuclear Power Development in the Republic of Belarus (July 1st – December 30 1998)

The work of this Commission in the 1990s, after the collapse of the USSR, and during debates about revival of the nuclear program in Belarus after Chernobyl, reproduces the more or less strict cleavages between promoters and opponents to nuclear energy among citizens, scientists and politicians, and activists. The establishment of the Commission is the last example of the relatively collaborative form of nuclear decision-making which existed shortly after independence. Ten years later, following the recommendation of the Commission, the nuclear program in Belarus restarted in 2008, this time without any open participatory forms of engagement.

Event 5: Public hearings of the "Review of Study of Environmental Impacts of the Belarusian nuclear power station" (October 9, 2009)

This event shows how difficult and controversial it has been for society to participate in dialogue with the state about nuclear energy in a non-democratic regime. The launching of the nuclear program in 2008 was exclusively a political decision. The necessary technology assessment, discussions and debates, public consultations and deliberations came later after the political decision had been taken. The public hearings were used to legitimate the NPP construction and did not contribute to better nuclear governance and had no ability to influence decisions which had already been taken. This event led to the emergence of local, grassroots anti-nuclear mobilization as well as national and transnational actors in an anti-nuclear campaign.

3.1. Event 1: The Resolution of the Central Committee of the CPSS and of the Council of Ministers of the USSR, 26 June 1980, on the construction of the Nuclear Thermal Power Plant (NTPP) near Minsk

The preparation and planning for the NTPP at the beginning of the 1980s was slowed by institutional disagreement and tensions in the Soviet decision-making process. Soviet nuclear policy was implemented through a vertical and centralized system of decision-making (see Russia SCR, Lithuania SCR). The central state body responsible for nuclear innovations, investigation, construction and control was the Ministry of Medium Machine Building (Sredmash). The Ministry of Energy was responsible for the construction of reactors after they had been approved and standardized by Minsredmash. Rivalry developed between these two ministries over the control of nuclear production. On top of this rivalry, the republican governments were kept out of nuclear decision-making; republican voices seldom were taken into account. This kind of exclusion created tension between the republics and Moscow.

Construction of the Minsk NTPP started in 1982, according to the decision of the Central Committee of the CPSU and the USSR Council of Ministers, with two VVER-1000 PWRs at 1 million kilowatts of nuclear capacity each and 1,990 Giga calories of thermal capacity per hour. If we look at the communication of the central and local governmental bodies during this period[11] we will see that the tensions between decision makers occurred on on two levels: between the Ministry of Energy and the Ministry of Medium Machine building; and between the organizations subordinated to the Ministry of Energy and republican organizations subordinated to governmental body of the BSSR.

This two-level institutional rivalry over supervision of the nuclear projects created several problems for the ongoing construction work. According to a resolution “On measures to accelerate the construction of the nuclear thermal power station (NTPS)”[12] construction had deviated significantly from the initial terms. In 1984, after consultation with the Council of Ministers of the Belorussian SSR, the Ministry of Energy decided that qualified personnel from the Kola nuclear power plant should be relocated to the Minsk construction site. Yet this decision, once taken, did not speed up construction or mitigate problems. According to the minutes of the meeting with the Deputy Chairman of the Council of Ministers of the BSSR[13] the organization of construction had serious flaws, leading to omissions and significant delays. The site did not have complete design and technical documentation, nor requisite supplies and construction materials. In addition, there were

[11] Belarusian National Archives (БНА), f.7, o.5, d.8577, pp.48-52

[12] Belarusian National Archives (БНА), f.7, o.5, d.8577 , p.80, 15.04.83 №134

[13] Belarusian National Archives (БНА), f.7, o.5, d.9171, pp… 25.05.1984

continuing funding problems, [14] a result of the institutional tensions between the Ministry of Energy and the republican organizations. An appeal by the Vice Director of the construction site to the Council of Minsters shows that the Ministry of Energy prioritised the construction carried out by its own subordinate organizations ahead of those by the republican organizations[15].

In spite of these problems, central Soviet institutions planned another NPP in the BSSR. The first attempt took place in 1983 when the Central planning committee, GOSPLAN, asked the BSSR authorities to consider the expansion of the capacity of the NTPS under construction from 2,000 MW to 6,000 MW. The BSSR Commission for nuclear developments of the BSSR Council of Ministers instead proposed building a second NPP in an alternative location. In this case the Belarusian government proposed the construction of an experimental nuclear power station with a fast breeder reactor, the BRIG 300, which was developed in the Joint Institute of Nuclear Research.[16].

In 1984 the tensions between the central and republican bodies were symptomatic of existing energy and economic uncertainties. The BSSR government was concerned by decreasing energy supply and increasing energy demands from industrial sites. In this context the Minsk NTPP became imperative for the industrial development of the country. As construction problems mounted, deviations from plans and timeframes intensified this uncertainty and tensions with the Ministry of Energy. For example, GOSPLAN, under pressure from the Ministry of Energy decided to change the turbines to a newer more efficient design., which led to a three year delay in the expected completion of the first reactor from 1989 to 1992. Perceiving that the NTPP was vital for industrial development, the BSSR Council of Ministers made all efforts to reverse this decision[17]. The same logic was behind the initiative of the BSSR Council of Ministers[18] to renew debates about the expansion of the capacity of the Minsk NTPP in July 1985 because of the need to improve the productivity of the agriculture and to ensure the successful implementation of the Food Program.

[14] The correspondence between Belenergo and Stroybank during June and July 1984, Belarusian National Archives (БНА), f.7, o.5, d.9171, pp. 69-79

[15] Belarusian National Archives (БНА), f.7, o.5, d.9171, pp.113, 10.08.1984

[16] Belarusian National Archives (БНА), f.7, o.5, d.8577, pp.107, 186

[17] Belarusian National Archives (БНА), f.7, o.5, d.9171, pp. 171-172

[18] Belarusian National Archives (БНА), f.7, o.5, d.9711, pp.46,51

By the end of 1985 construction lags were still endemic. On the 25th of November 1985 the Ministry of Energy and GOSPLAN decided to take additional measures to speed up the construction of the Minsk NTPP by allocating additional funds.[19] At the same time the Belorussian authorities raised serious concerns about delays in construction due to the issues with design and funding, pointing out that existing deadlines were strictly linked to the energy indicators of Minsk and its industrial sites.

The Belorussian authorities continued to exert pressure on the central government, particularly on the Ministry of Energy, to accelerate the decision-making process and the construction process, referring to the implementation of the tasks arising from the decisions of the CPSU Central Committee from June 28, 1984, and of the CPSU and the USSR Council of Ministers dated 21 September 1984, to ensure the accelerated development of nuclear energy. However, according to the Ministry of Energy of the USSR the choice of the construction site would be considered only after the approval of the feasibility study of the Belarusian nuclear power plant[20].

In sum, before disaster of the Chernobyl, the Belorussian government saw nuclear power as a solution to the republic’s forecast energy problems. Even after the accident, the government did not hesitate to continue the development of nuclear power. On the contrary, several decisions indicated the further promotion of nuclear power in Belarus. In particular, the decision of the Central Committee of the BSSR Communist Party, the Council of Ministers of the BSSR and the USSR Ministry of Energy signed on May, 26 1986, emphasized the special importance of the Minsk NTPP for the BSSR and for the successful implementation of the Soviet nuclear program[21]. In this context not only a series of measures to accelerate the construction of the NTPP were taken, including the introduction of personal responsibility for delays in construction, but the NTPP gained all the important ideological attributes of the Soviet industrial project: the Committee of the Communist Party pushed “socialist competitions” between teams working on the NTPP site, accelerated political education and instruction, and listed the site as a republican Komsomol construction site to attract more young people, while state media regularly reported about the progress of construction on the radio, TV and newspapers.

[19] Belarusian National Archives (БНА), f.7, o.5, d.9711, pp. 87-88

[20] Belarusian National Archives (БНА), f.7, o.10, d.352, pp. 2,6

[21] Belarusian National Archives (БНА), f.7, o.10, d.352, pp.130-134

Officially, the decision to suspend the construction of the Minsk NTPP was adopted by the Order of the Ministry of Atomic Energy of the USSR only at the end of 1986, and in 1987 the Soviet government authorized funds for the mothballing of the station[22]. During the first half of the 1986 the working brigades from the Minsk NTPP were sent to work on mitigation of the aftermath of Chernobyl, that is, to build the decontamination points in the affected Gomel areas, housing facilities for relocated people and new facilities in Slavutych.

[22] Belarusian National Archives (БНА), f.7, o.10, d.352, pp.236

Event 1	The Resolution of the Central Committee of the CPSU and of the Council of Ministers on the construction of the Nuclear power thermal station near Minsk
Who was involved?	Political leaders, central and local political and administrative institutions
When and where did it take place?	22 June 1980
What type of process was it? How did this change over time?	Consultation. The construction of the Minsk NPP was a part of general Soviet planning and the expansion of the Soviet nuclear program. As in other Soviet republics, the participation of the local institutions in nuclear decision- making was limited by fragmented consultation. During the 1980's and before Chernobyl the preparation and construction illustrated the state of the economic and industrial system in decline as well as some institutional discrepancies between local and central political and scientific authorities.
What rationale was given by the party that implemented the engagement?	A nuclear rationale to improve the energy mix and its stability and secure future industrial development

3.2. Event 2: The adoption of the *Requirements for the placement of the Nuclear Power Plants* (22 October 1987)

The decision to suspend construction of the Minsk NTPP renewed the process of preparation for the location and construction of the Belorussian NPP. Documents for the design and construction of the station had been agreed to with GOSPLAN[23] and approved by the Soviet Ministry of Energy[24]. The launch of the first unit with a 1,000 MW capacity was planned for 1994. However, geological surveys planned for 1987 on site selection were never carried out. Republican authorities did not contribute to the organization of the surveys which made it difficult to move ahead (letter from Minatomenergo from 17.04.1987)[25].

[23] Letter № 22-2057 from 23 December, 1985. Belarusian National Archives (БНА), f.7, o.10, d.859, p.99

[24] On 17 January, 1986. Belarusian National Archives (БНА), f.7, o.10, d.859, p.99

[25] Letter from Minatomenergo on 17 April ,1987. Belarusian National Archives (БНА), f.7, o.10, d.859, p.99

Debates regarding the location of the new NPP became possible in this post-Chernobyl period due to wide discussions over a draft law on nuclear energy in the USSR and due to the adoption of the *Requirements for the placement of Nuclear Power Plants* (22 October 1987)[26]. In June of 1987 the USSR State Committee on Science and Technology launched discussion of the draft law. The Belorussian authorities, in particular the Ministry of Justice, the State Planning Commission, Ministry of Health, the Academy of Sciences, Ministry of Internal Affairs and others examined the draft and commented on the document. The main focus of these comments was the competence of republican governmental bodies. They believed that siting the nuclear power plant, as well as the selection of territory and water resources, should fall under the jurisdiction of the USSR (Article 7, 21, part 2), not a national body acting with impunity. Based on the approved requirements for the placement of the NPP Belorussian authorities began to reconsider their initial choice of site.

On November 16, 1987, Boris Shcherbina, the Vice Chairman of the USSR Council of Ministers, decided to alter the program for nuclear power development in the USSR through to the year 2000. Following this decision and in order to promote NPPconstruction the central authorities began to pressure Soviet republics to implement nuclear programs. From September 1987 until the end of May 1988 we can observe tense relations between central governmental bodies and Belorussian experts. The core issue of the controversy was a question about the choice of location of the future NPP. The Belorussian authorities used a range of instruments available at the time to resist various sites. The Ministry of Atomic Energy insisted on a location near Seliava Lake, halfway between Minsk and Vitebsk, while the Belorussian government mobilized the academic and scientific community to elaborate a strong argument against the proposal. Over several months the Belorussian Republican Administration on Hydrometeorology and Environmental Control, the BSSR Geology Department, the Scientific Council on Biosphere Problems, Institute of Geochemistry and Geophysics sent recommendations to Moscow. According to these studies the NPP could not be sited near the lake for ecological, geological, medical and infrastructural reasons, including: high natural groundwater level; insufficient water resources in the area of the site to fulfil the cooling needs (transfer from other basins would cause additional economic and environmental costs); the risk of contaminatingthe Seliava; the lake's location on the watershed of the Baltic and the Black

[26] Belarusian National Archives (БНА), f.7, o.10, d.859, pp.23-71//pp.109-123

Seas with an open communication along the rivers, which could contaminate both basins; being located only about 100 km away from Minsk, a city with population of more than 1 million people and only 40 km away from the Berezinsky nature Reserve[27].

On May 26, 1988 under pressure from experts and political institutions the Ministry of Atomic Energy decided to relocate the NPP to *Yezeritche* in Vitebsk region, on the northern border with the Russian Federation; with construction scheduled to begin in 1990.

Nevertheless from October 1988, mainly in Vitebsk region, public mobilization against the construction of the nuclear power plant began andthe first anti-nuclear publications appeared in the local press. Local enterprise workers used Communist Party organs to voice their anti-nuclear concenrs. For example, at a Party meeting at the Vitebsk TV Manufacturing Plant on October 14 and 15, 1988: “The entire staff of the enterprise expresses its protest against the construction of the nuclear power plant in the Vitebsk region.”[28] At a meeting of the Vitebsk Technological Institute of Light Industry the concerns addressed by the Vitebsk TV plant were widely supported.[29]

In part due increasing perestroika these particular acts escalated a mobilization campaign across the USSR. In Belarus press publications increased, as did a direct appeal of Vitebsk residents to Gorbachev signed by 252 people.[30] This anti-nuclear appeal was supported by local government bodies and transmitted to Moscow to stop geological works in the Vitebsk region for the following reasons: the consequences of the Chernobyl accident; the large number of existing nuclear power plants around the BSSR (Ignalina NPP, Smolensk NPP, Chernobyl NPP); the fear of further radioactive contamination of the territory; and difficult environmental conditions caused by large-scale chemical enterprises.[31]

Taking into account public opinion, the Communist Party of the Belorussian SSR and the Council of Ministers of the BSSR determined that the Vitebsk site was also geologically unsound. In October

[27] Belarusian National Archives (БНА), f.7, o.10, d.1317, pp.10-88

[28] Belarusian National Archives (БНА), f.7, o.10, d.1317, p.97

[29] Belarusian National Archives (БНА), f.7, o.10, d.1317, p.98

[30] Belarusian National Archives (БНА), f.7, o.10, d.1317, p.103-108

[31] Belarusian National Archives (БНА), f.7, o.10, d.1317, p.113

1989 the Belorussian Council of Ministers took the final decision to reject nuclear power for the republic because of the Chernobyl accident and its consequences for the territory of Belarus.[32]

Event 2	The adoption of the Requirements for the placement of the Nuclear Power Plants
Who was involved?	Political leaders, central and local political, administrative and scientific institutions
When and where did it take place?	22 October 1987
What type of process was it? How did this change over time?	Communication. The adoption of the “Requirements” falls into the period just after the accident occurred at the Chernobyl NPP when official information about its consequences was not fully revealed by Soviet authorities. To the adoption of this Act preceded the wide communication of the central administrative institutions with the local actors, including scientific institutions. The introduction of this Act allowed to the Belorussian scientists to mobilize and to address their expert conclusions against the NPP to central nuclear authorities.
What rationale was given by the party that implemented the engagement?	Evidence-based scientific rationale

3.3. Event 3: “Framework for residing on the territories contaminated with radionuclides as a result of the disaster at the Chernobyl NPP” approved by the Presidium of the Belorussian Academy of Sciences in 1990

At the end of the 1990s debates about Chernobyl’s impact on the environment and human health had broken out within the scientific community in discussions between the Soviet Academy of Sciences and the Belorussian Academy of Sciences (Kuchinskaya 2013). These discussions concerned the concept of the acceptable risk of radiation, political decisions about the additional measures for the resettlement of the irradiated population, and the introduction of new categories of contaminated areas – zones.

This dispute is illustrated in two scientific concepts: that of a 35-rem maximum dose[33] promoted by Soviet scientists and, that of the difficulty of residing on territories contaminated with radionuclides

[32] Belarusian National Archives (БНА), f.7, o.10, d.1317, p.146-147

supported by Belorussian scientists. These two opposite scientific discourses indicated not only the potential for contention within the academic community at the end of 1980s but also established the fundamental contradiction of views between promoters and opponents of nuclear power in Belarus.

From April 1986 scientists from the Academy of Sciences of the BSSR tried to alert the republican authorities of the need to take the accident more seriously and to adopt urgent special measures for the protection of the populatio. After hearing about the explosion, Vassiliy Nesterenko, director of the Institute of Nuclear Energy of the Academy of Sciences of Belarus, contacted the First Fecretary of the Belarusian Communist Party, Nikolai Sliounkov, with unsuccessful demands for the immediate evacuation of the population living in the vicinity of the NPP and of the distribution of iodine. Nesterenko communicated information about the accident at Chernobyl to the Belorussian writer, Ales Adamovich, who told Mikhail Gorbachev, who created a Special Commission to study the situation in the BSSR. This action cost Nesterenko his position as Director of the Joint Institute of Nuclear Research and convinced other Belarusian scientists not to express their disagreements openly but instead to share information about the nuclear accident with writers, journalists, and members of informal organizations, a number of whom became members of the Belarusian Popular Front, a growing political movement.

By 1989, more open debates about the effectiveness of post-accident management by the Soviet authorities became possible after the relaxation of censorship. Some Belarusian scientists provided expert opinions to challenge the radiation protection standards introduced by Moscow in the aftermath of the accident that they considered arbitrary and dangerous (Kasperski 2011)**.** These researchers participated in seminars, conferences and rallies organized by the Belarusian Popular Front. The elements of the scientific argument became part of the protest rhetoric against the Soviet authorities generally and its post-accident policy particularly.

Moscow experts argued that it was safe to have a 35-rem dose limit for 70 years of life for all post-accident response measures. They concluded that below this threshold the population could live on contaminated territories without restrictions. The scientists from the Academy of Sciences of the BSSR seriously criticized this limit since residents could not live safely in areas where clean food

[33] The maximum dose of 35 rem is composed from the assumption that the individual can live on the contaminated territory if the annual radiation exposure do not exceed 0.5 rem per year during 70 years.

could not be obtained, i.e., not contaminated by radionuclides, and suggested that the maximum dose should be limited to 7 rem over a 70 year life, i.e. 0.1 rem per year.

	The 35-rem Discourse (Moscow)	Alternative Discourse (Belarus)
Statement	"It is important to remember that there exist elementary bases and positions according to which a measure of dangerous radiation impact is not the concentration of radionuclides. I would underline that it is the total dose of irradiation".[34]	"Any, even the smallest additional radiation dose, is not safe for a life organism and it requires the using of measures aimed at its reduction (this is an internationally recognized principle of ALARA). So we cannot speak about an absolute safety. We should speak about an acceptable risk."[35]
Evidence	"The base of the 35-rem concept is the analysis of a huge volume of material. (…) I declare with full responsibility that obvious changes arise only when the dose is from 35 rem per year or 75-120 rem per life. There were no deviations found at lower doses. We cannot reject this experience. It is an objective reality".[36] "I have been examining the children as a paediatrician since the very first days of the disaster. Neither me, nor my colleagues managed to find any direct impact of small radiation doses on a child's organism which could lead to serious consequences. Data about a sharp increase in the number of illnesses is a manipulation of facts".[37]	"…the limit of irradiation which cannot exceed 0.1 rem (1 mSv) per year. The identified limit of irradiation should be reached step-by-step: in 1991 0.5 rem (5 mSv) per year; in 1993 0.3 rem (3 mSv) per year; in 1995 0.2 rem (2 mSv) per year; in 1998 0.1 rem (1 mSv) per year." The conception of residing on the territories contaminated with radionuclides as a result of the disaster at the Chernobyl NPP approved by the Presidium of the Academy of Sciences of the BSSR in 1990

The discourse for the concept of a "35 rem" limit is thatof risk and nuclear safety expressed in the following way: the effect of radiation on a human body and the environment finds its expression not in the concentration of radionuclides but in the received irradiation dose. This principle assumes

[34] Interview of A.L. Ilyin "Radiatsija: chto bylo, chto budet" (Gomelskaja Pravda. 13.04.1989. S.3).

[35] The concept of safe living, 1990.

[36] Interview of A.L. Ilyin "Chernobyl i budushchee" (Chyrvonaja zmena. 12.08.1989. s.7).

[37] Interview of A. Guskova, a corresponding member of the Academy of Medical Sciences of the USSR (Chyrvonaja Zmena.12.07.1989).

that the main danger of residing on the contaminated territories lies in the total irradiation dose of a person rather than the concentration of radionuclides in a body, food, and territory. If one is to follow this principle then it is possible to live in contaminated areas if the total irradiation dose does not exceed the established norm. This conception was in part created to legitimate political decisions which had already been taken about the safety of living in contaminated areas without a dramatic change in the population's way of life. In addition, this conception supported the notion that the consequences of Chernobyl can be mitigated within a certain period of time and thus made Chernobyl an ordinary accident which did not lead to significant change. According to Yaroshinskaya, "They have probably run out of scientific methods in the struggle for the preservation of their conception. That is why the main argument used was the government administrative pressure" (Yaroshinskaya, 2006, p.160).

A governmental decree (no. 587) of the National Commission on Liquidation of Consequences of the Disaster at the Chernobyl NPP promoted the limit of "35 rem" as established by the Academy of Sciences of the USSR and promoted using it as the basis for the development of the State Program for the liquidation/mitigation of Chernobyl consequences. This produced another obvious benefit for the existing political system: it did not require any noticeable changes in the established normative political and ideological order. Its implication was actually the rejection of certain intervention measures, the discontinuance of re-settlement, and continuance of agricultural activities in the contaminated territories.

However, the Supreme Council of the BSSR rejected the 35-rem standard owing largely to the resistance of scientists from Belarus, Ukraine and Russia, in particular, after the First All-Union Radiobiological Congress in 1990 where this issue was widely discussed. Only during the second half of 1990 the government of the USSR formed an inter-departmental commission consisting of 60 people headed by Belyaev, the academician of the Academy of Sciences of the USSR. The main aim of the commission was to work out "principles and criteria in support of practical measures aimed at the elimination of potential negative consequences of the Chernobyl accident for the health of the population and compensation for the damage caused" (Barjahtar, 1995.). In 1991 the government of the USSR approved a new "Concept of residing of the population in the regions affected by the Disater at the Chernobyl NPP". In accordance with this concept the minimum intervention level equal to 1 mSv of the annual average effective equivalent irradiation dose was set for all territories that were radioactively contaminated. Protection measures were taken if the interval of doses was from 1 mSv to 5 mSv per year and dwellers had the right to a voluntary relocation from this territory (see table below).

Zones	Categorization
zone of evacuation	The zone of resettlement in 1986 surrounding the territory of the CNPP
zone of mandatory resettlement	The territory with the density of soil contamination with caesium-137, strontium-90 and plutonium of 40.3 and 0.1 Ci/sq km accordingly
zone of resettlement	The territory with the density of soil contamination with caesium-137, strontium-90 and plutonium from 15 to 40 and from 2 to 3 and from 0.05 to 0.1 Ci/sq km where the irradiation dose of a human can exceed 0.5 rem (5 mSv) per year
zone with the right of resettlement	The territory with the density of soil contamination with caesium-137, strontium-90 and plutonium from 5 to 15, from 0.5 to 2 and from 0.01 to 0.05 Ci/sq km where the permissible level of population irradiation exceeds 0.1 rem (1 mSv) per year
zone of living under periodical control	The territory with the density of soil contamination with caesium-137 from 1 to 5 Ci/sq km while the permissible irradiation level cannot exceed 0.1 rem (.1 mSv) per year

The Belarusian concept turned into a political challenge for the Soviet system. The Belarusian standard was based on the belief that any, even the smallest radiation dose, affects the health of a person and second that a step-by-step re-settlement of the population from the contaminated areas was required. To support the first principle the scientists introduced the term “acceptable risk” which challenged the principle of absolute safety of the exploitation of nuclear energy along with the principle a threshold below which there was no risk to health. This discussion can be also viewed in debates over the consequences of the Fukushima incident in Japan, and controversy over resettlement policies, and acceptable dose limits, revealing almost exacrly the same questions about standards of living and radioactive protection in the contaminated areas.

Event 3	"Framework of residing on the territories contaminated with radionuclides as a result of the disaster at the Chernobyl NPP" approved by the Presidium of the Belorussian Academy of Sciences in 1990
Who was involved?	USSR Academy of Sciences, BSSR Academy of Sciences, central and local Political Authorities
When and where did it take place?	1990
What type of process was it? How did this change over time?	Participation. This kind of participation in post-nuclear decision-making became possible due to the local scientific and political opposition to central political decisions about the radiation limit of the residents of contaminated areas after Chernobyl. This pressure could only be exerted due to the reduction ofcentral political contral and censorship by the USSR.
What rationale was given by the party that implemented the engagement?	Use of scientific evidence for political rationale.

3.4. Event 4: The Commission on the Assessment of the Advisability of Nuclear Power Development in the Republic of Belarus (July 1st – December 30, 1998)

The Commission on the Assessment of the Advisability of Nuclear Power Development in the Republic of Belarus began work on July 1, 1998. The formation of this Commission by the order of the Prime Minister in March demonstrated that existing debates about the future of the energy programs in Belarus within civil society, academic community, politicians and nuclear industry promoters remained in flux and that post-Chernobyl uncertainties and risks continued to cloud the future of nuclear energy. The work of the Commission illustrated a case of surprising transparency over nuclear issues in an authoritarian regime where opposing opinions were presented and articulated and the recommendations and decisions were independantely mediated.

The work of the Commission concerned not only an analysis of the prospects for nuclear programs in Belarus within the global context, but also analysis of alternative energy sources.[38] The

[38] Belarusian National Archives, f.7, o.16, d.1082, pp. 51

composition of the Commission illustrated this wider context of the nuclear energy issues: it was led by the academician Piotr Vitiyaz, Vice-President of the NASB with representatives of the Ministry of Economy, National Assembly, Ministry of Emergency, Ministry of Environment and representatives of the scientific community (mostly the Institutes of the NASB) and of civil society.

After detailed discussion of the primary materials during an October 1998 meeting a working group on nuclear power developments led by Professor Oleg Martynenko, Director of the Institute of Heat- and Mass-Exchange of the Belarusian Academy of Sciences, was created. Most of the members of the group supported the nuclear program, but members such as Ivan Smolar, Vasily Nesterenko, and Georgii Lepin actively opposed it and convinced the others that NPP construction was premature.[39] As a result of theCommission's work a 10-year moratorium on the construction of any nuclear facilities in Belarus was suggested.

The moratorim was supported by nineteen members of the Commission, with only seven against the suggestion. Despite this recommendation the Commission did not recommend the abandonment of civil nuclear energy, but left the door open as a prerogative of the Government and President of the Republic of Belarus. This prerogative was used exactly 10 years after, in 2008 to begin a new programme of NPP construction in Belarus.

Nuclear Rationale used in 1998	Recommendations
- In spite of specific problems connected with nuclear reactors, nuclear fuel handling, the consequences of accidents, the replacement of one NPP with another, the development of infrastructure, and the training of specialists, the actual contribution of nuclear power into energy production was significant and in 1997 was 16.4% of world energy production.	- To use to the maximumexisting resources for the implementation of energy-saving technologies, use of alternative energy sources, modernization and construction of steam-and-gas plants. - To block the construction of a NPP for the next 10 years but to continue preparation for the development of nuclear power in the Republic of Belarus in the future.
- Some countries had either banned nuclear power or announced a moratorium for construction of new nuclear power plants (Austria, Denmark, Ireland, Spain, Italy, and Sweden). Canada, the UK, and Germany had no plans for new nuclear power plants.	- To continue to study the world experience in nuclear power issues (including radioactive waste disposal and decommissioning of NPPs), carry out further techno-economic analyses of structural changes in the energy system, taking into account techno-economic aspects of the

[39] The interview with Lepin Georgii, professor, expert in nuclear programs, 04.07.2016, Minsk.

	possible development of nuclear power, and encourage the development of regulations.
- In 1998, 437 nuclear reactors with total capacity of 3,517 MWt were in operation; while 90 units with total capacity of 25,140 MWt had been decommissioned, and 36 plants with total capacity of 26,813 MWt were under construction. The following countries were included ina list of states with the highest quota of nuclear power in total electricity generation: Lithuania (81%), France (78%), Belgium (60%), Ukraine (47%), Bulgaria (46%), Sweden (46%), and Slovakia (45%).	- Taking into account technical, environmental, social, economic prerequisites, safety indicators and preparedness of the necessary developmental works, the terms of nuclear power plant construction must be determined by the government of Belarus within the framework of fulfilment of the instructions of the President on review and revision of the main directions of energy policy.
- Programs for new NPPs were in progress in the US, France, Japan, China, Korea, India. Argentina, Brazil, the Czech Republic, Iran, Russia, Slovakia and Ukraine.	- In order to ensure the possible development of nuclear power and the protection of the population, it is recommended to the Council of Ministers of the Republic of Belarus with the aid of the National Academy of Sciences and Ministry of Emergencies develop and introduce for consideration by the chamber of representatives of the National Assembly of Belarus a draft law "On Nuclear Power Use".

Source: *http://www.ecologia.org/nuclearcommunities/countryevals/belarus/commission.htm*

This decision is one of the few if not the only case where scientific debates and expert assessments had such a direct impact on Belarusian policy-making. It can be assumed that such a decision was made possible due to the fact that the authoritarian regime in Belarus had not yet consolidated its power. But when the decision to build a nuclear power plant in Belarus was made by the President in 2008, there were no discussions on alternative projects within the civil or scientific community.

Event 4	The Commission on the Assessment of the Advisability of Nuclear Power Development in the Republic of Belarus
Who was involved?	Experts and political, administrative personnel involved in the established Commission
When and where did it take place?	July 1, 1998 – December 30, 1998
What type of process was it? How did this change over time?	Participation. The Commission dealt with the revival of the debate about the necessity of a nuclear program for independent Belarus and was composed of representatives of the scientific community and civil society. This was the last example of cooperation between official promoters of nuclear energy and their opponents. The Commission recommended the abandonment of the construction of nuclear facilities for 10 years in 1998. In 2008 the nuclear program was launched.
What rationale was given by the party that implemented the engagement?	Nuclear risks and uncertainties after Chernobyl.

3.5. Event 5: Public hearings of the "Review of Study of Environmental Impacts of the Belarusian nuclear power station" (October 9, 2009)

Belarus a signatory to the sections of the Aarhus and Espoo conventions which require public opinion (including that of neighbouring countries) is taken into account when policy decisions of environmental significance take place. However in an un-democratic state, decisions in the field of nuclear energy are a subject of debate and public environmental risk assessment only after they are taken by the government. This makes the opportunities for public intervention very limited.

By the end of 2009 plans for the Belarusian nuclear power plant had still not yet passed through the technology assessment process. On the one hand, this left a window of opportunity for public participation. On the other hand, the public hearings of the NPP as an accepted political decision do not contribute to better nuclear governance and do not improve the conditions for public participation.

In autumn 2008, the Department of Energy announced plans to locate an NPP in Ostrovets, Grodno region, and in December the same year the State Commission indicated this decision was a priority.

Moving quickly to co-opt the public, in spring 2009 the government adopted “Regulations on the order of discussion by the associations, organizations and citizens of the questions in the field of nuclear energy"[40], that authorized public discussion of policy decisions already taken by the government. This created a parallel process of expert technology assessment and public deliberation: from one side official institutions organized a process of public debates and from the other side NGOs attempted to create a platform for an alternative discussion.

In 2006 with publications in media about the possible renewal of the nuclear program in Belarus, the NGO “Ecohome” addressed a letter to the Ministry of Energy with the suggestions to organize public discussions about the proposed program. In response to this letter the Minitry of Energy suggested that “Ecohome” participated in the campaign promoting nuclear energy in a Belarusian society where the “Chernobyl syndrome” was still active.[41]

The same year that “Ecohome” organized a protest against the proposed NPP they also initiated the creation of the “Belarusian anti-nuclear campaign” comprising a number of representatives of civil society and the scientificcommunity in Belarus and abroad. Then the acts of the anti-nuclear campaign were followed by declarations in the media for consolidation, for organization of a referendum and for the collection of signatures of citizens opposed to the program. For example, “Ecohome” and the Belarusian Party of Greens made a joint declaration on November 19, 2009, against the NPP and also the lack of public discussion[42]. Then, as the government announced the state of progress in 2010, anti-nuclear campaigns multiplied and acquired a more grassroots character that complemented expert and NGO mobilization, especially in areas close to the planned NPP. A key strategy was the collection of citizen signatures against the construction of nuclear power. By autumn 2009 a group in the Goretsky region had collected nearly 4,000 signatures, in Ostrovetsky—350, and in Vitebsk—4000 (Novikova 2010).

The main mobilization activities concentrated on establishing the public hearings and discussions, which were a condition of the Aarhus and Espoo Conventions. The conventions stipulated that in any decision related to the development of a nuclear power plant that the public had the right to get

[40] Adopted by the decision № 571 of Council of Ministers 4 May, 2009.

[41] The interview with Iryna Sukhij, leader of the NGO “Ecohome”, 6 July, 2016, Minsk.

[42] See: http://atomby.net/file/position191109after091009engl.pdf, accessed April 4, 2016.

comprehensive information and to participate in decision making procedures. However, Belarus was found to consistently fail to comply with the provisions of these conventions from 2010 onwards[43], as well as falling behind with the requirement of cross-boundary environmental impact assessment procedures with regards to Lithuania, owing to the proximity of the NPP – only 15 kilometres – from the border[44].

In 2009, a preliminary Environmental Impact Statement (EIS) was published. In August and September 2009 the international group "EcoDefense", the NGO “Ecohome “, the Belarusian Green Party and agroup of experts prepared their Critical Remarks on the “Statement on possible environmental impact of Belarusian NPP (preview report on EIS of Belarusian NPP)” and initiated a broad discussion on this paper. On October 9, 2009, in Ostrovets public hearings were organized to discuss these documents and other relevant materials. However, limited participation by the public and environmental activists led the the European ECO Forum, the network of Environmental Citizen’s Organizations throughout Europe, to submit a statement to the Compliance Committee of the Aarhus Convention concerning their opinion that Belarusians had no opportunity to participate or to express their opinions about the political decision to develop nuclear programs and about the siting NPPs. Later in 2010 “Ecohome“ with the international expert commission launched a process of public ecological assessment. The Table below

[43] During the fifth meeting of the parties to the Aarhus Convention concerning a submission to the compliance committee the convention members recommended that Belarus should ensure the compatibility and consistency of the general legal framework for public participation in decision-making (general legislation on EIA) and the framework of its participation in the decision-making on nuclear projects. As a result of the fifth session Belarus developed an action plan to implement the provisions of the Convention on Access to Information, Public Participation in Decision-making and Access to Justice in matters relating to the environment for 2014-2017. Nevertheless from 2014 to 2016 several appeals were addressed to the Compliance Committee of the Aarhus Convention. For example in March 2015 the Republic of Lithuania has submitted the claim in respect of compliance with the Republic of Belarus of article 3, paragraph 9 of the Aarhus Convention concerning the access to the information and participation in the decision-making in the field of the environmental protection.

[44] See: http://www.unece.org/fileadmin/DAM/env/pp/compliance/MoP4decisions/Belarus/frLithuania_19.03.2014.pdf, accessed April 5, 2016.

presents the core of the anti-nuclear rhetoric through the main documents elaborated and published by the “Belarusian anti-nuclear campaign”.

Documents	Remarks
Critical remarks on “Statement on possible environmental impact of Belarusian NPP (preview report on EIA of Belarusian NPP)” 21.09.2009 **Actors:** Belarusian Party “Greens” Group “EcoDefense” Movement “Scientists for anti-nuclear Belarus” “Ecohome”	- Radioactive emissions in case of an accident, the zones of its impact, and radiation exposure are underestimated. - Lack of information about the impact of an accident on Lithuania and Belarus. - Reasons for the choice of an AES 2006 reactor are not articulated. - Impact of decommissioning is not evaluated. - Lack of information about safety issues of nuclear waste repository. - Public opinion is not taken into account. - Lack of information about impact on natural, cultural and heritage landscapes.
Conclusions of the Public Ecological Assessment Commission about the project of the NPP construction in Belarus 21.05.2010 **Actors:** “Ecohome” Expert Commission	- NPP construction in Belarus is not totally justified: the current trends in the world of energy are overestimated; no tendency to increase in energy demand; the costs for adapting the energy system of Belarus to a new large-scale power-generating unit are not taken into account. - Construction of the NPP is economically unreasonable. The estimated cost of nuclear energy does not include expenses for dealing with spent nuclear fuel, including those for radioactive waste as a by-product of so-called “nuclear recycling”. - Legal framework for nuclear program implementation is not set up: questions of legitimacy are not solved; the regulatory regime is not established including the management of radioactive waste. - Lack of information about the technological choice for VVER type reactors: the reactor type – a so-called “water-pressurized" reactor - that is being proposed for implementation, is not considered to be sufficiently safe, regardless of "generation". - Possible impact on environment and human health of the given project is not acceptable. - Selection of the site is unfortunate. The site proposed for the NPP is not acceptable, since it is situated in the in a place with unique natural, historical and cultural heritage. This region is a recreational area for residents of Belarus. - The NPP will not help Belarus in meeting the requirements of the Kyoto Protocol.
Position of the public concerning the course of public discussion on plans to build NPP in Belarus 16.11.2009 **Actors:** Belarusian Party “Greens” Group “EcoDefense” NGO “EcoHome”	- Public hearings could not be qualified as public hearings but as a meeting of the supporters and promoters of the NPP construction: very limited access of participants; limited registration procedure; non-compliance with agenda; no announcements in central media. - The replacement of the documents about the environmental impact (Art. 21 of the Instructions about evaluation of the environmental impact). - The beginning of the construction of the nuclear infrastructure before the ecological assessment starts.

Sources: Official site of the Belarusian Anti-nuclear Campaign http://atomby.net/

The double process of assessment and public deliberation was not a successful one: instead of cooperation this situation generated additional tensions between government bodies and civic institutions. Failure of public participation happens even in democratic conditions (see the France SCR). With the authoritarian regime in power, quite simply, civil nuclear decision-making in Belarus had become more and more closed with the goal of limiting and constraining public participation.

Event 5	**Public hearings of the "Review of Study of Environmental Impacts of the Belarusian nuclear power station"**
Who was involved?	Belarusian Party “Greens”, “EcoDefense”, Movement “Scientists for anti-nuclear Belarus”, NGO “EcoHome”
When and where did it take place?	Ostrovets, October 9, 2009
What type of process was it? How did this change over time?	Consultation. Public hearings of the "Review of Study of Environmental Impacts of the Belarusian nuclear power station" held October 9, 2009 after the decision on its construction has been taken year before. This form of consultation was far from the participatory process and was limited by political qualities of the Belarusian regime. Nevertheless the public hearings and the way that it has been organized allowed to start the public awareness campaign about NPP among population and neighbouring country as well as to organize the ecological assessment procedure of the Belarusian NPP.
What rationale was given by the party that implemented the engagement?	Impact of the civilian nuclear use on the environment and population.

4. Facts & Figures

The purpose of this section is to give an overview of nuclear power in Belarus. This section contains such data as number of reactors, reactors' locations, technical and chronological details of reactors' construction as well as statistics on electricity production, periodization and social connections to nuclear constructions. This data can be used as a supportive material to the following sections of the country report and in order to understand the overall country's situation. Key dates and abbreviations used in this report are presented in the beginning of this section.

4.1. Data summary

In November 2007 a Presidential decree defined the organizations responsible for preparing for the construction of the country's first nuclear power plant and budgeted money for engineering and site selection.

The candidate sites were Krasnopolyansk and Kukshinovsk (both in the Mogilev region) and Ostrovets in the Grodno region. Ostrovets/Astravets, 23 km from the Lithuanian border and 55 km from Vilnius, was chosen in December 2008, despite protests from Lithuania.

Three nuclear power stations are planned to be constructed in this region covering three countries and an enclosed Russian region: the Baltic NPP (near Kaliningrad), the NPP in Ostrovetsk (Belarus) and the NPP in Visaginas (Lithuania).

The distance between the Baltic NPP and two others is almost equal – about 300 km. If we look closely at the nuclear map of the region, placing Belarus in the centre, we will see that the region is circled by the range of the RMBK (high power channel-type) reactors still working or turned off: in the northern part – in Russia the old fashioned reactors at the Leningrad NPP and two new designed reactors are under construction, in Lithuania the decommissioned Ignalina NPP; in the Eastern part – in Russia the Smolensk NPP; in the southern part – in Ukraine the disastrous Chernobyl reactors.

This territory is marked by the second attempt to re-map the nuclear geographies. The first one dated back to the 1980 when the soviet government announced the ambitious plans to construct the Western European line of the RMBK reactors. The Ignalina NPP in Lithuania was the last one before the plan was interrupted by the Chernobyl.

The current projects of NPP construction almost reproduce the Soviet plans with the NPPs in Belarus and transform nuclear landscapes by creating the new nuclear networks and trajectories in post-Soviet contexts.

The state-run Belnipienergoprom enterprise was responsible for negotiating and signing contracts, carrying out feasibility studies and preparing tender documents. In June 2009 the government announced that Russian Atomstroyexport would be the general contractor.

Despite the process of public hearings and consultations with neighbouring countries officially started in 2009, the choice of the site and the process of the construction itself is challenged by anti-nuclear campaign in Belarus and by Lithuanian authorities.

4.2. Key dates and abbreviations

Key dates:

1967	The creation of the first Governmental commission on nuclear development
1980	The Resolution of the Central Committee about the construction of the NTPP near Minsk
1982	The start of the building of the Minsk NTPP
1986	The Chernobyl accident
1987	The adoption of the *Requirements for the placement of the Nuclear Power Plants*
1989	The Soviet Council of Ministers decided to stop construction of the Minsk NTPP. The Byelorussian Council of Ministers took a final decision about nuclear power in the BSSR
1990	“Conception of residing on the territories contaminated with radionuclides as a result of the disaster at the Chernobyl NPP” adopted
1992	The government of Belarus adopted and approved the Program of Energy Development and Energy Supply by 2010.
1993	The draft Program of Nuclear Power Development in Belarus was developed

1998 The Commission on the Assessment of the Advisability of Nuclear Power Development in the Republic of Belarusadvises a 10 year moratorium

2005 Decree № 399 "On energy security and strengthening the energy independence of the Republic of Belarus 2006-2010"

2006 President of Belarus approved in its entirety the proposals of the National Academy of Sciences and the Belarusian government on building a nuclear power plant

2007 Directive № 3 "Economy and savings as major factors in the economic security of the state "

Decree № 565 "On some measures for the construction of nuclear power plant"

2008 At the meeting of the Security Council of Belarus chaired by Lukashenko a final political decision on the construction of nuclear power plant was taken.

The Law on the Use of Atomic Energy had adopted

2009 "Regulations on the order of discussion by the associations, organizations and citizens of the questions in the field of nuclear energy" has adopted

In Ostrovets public hearings were organized to discuss the statements on the possible environmental impact of the NPP and the impact assessment materials.

2010 The public environmental expertise for the proposed construction of the Belarusian nuclear power plant was held.

2011 The Nuclear Power Engineering Department of the Energy Ministry submitted an application for a construction license

2012 The Power Plant Construction Directorate, and a general construction contract was signed

2013 Construction of the first unit started

2014 Construction of unit 2 started, the full construction license was issued

Abbreviations:

BSSR Belorussian Soviet Socialist Republic

EBRD European Bank for Reconstruction and Development

EIA Environmental Impact Assessment

IAEA International Atomic Energy Agency

IRT Research nuclear reactor

mSv	Sievert, micro Sievert
MWe	Megawatt electrical
NGO	Non-Governmental Organization
NPP	Nuclear Power Plant
NTPP	Nuclear Thermal Power Plant
RBMK	High-power channel reactor - Chernobyl type (*reaktor bolshoy moshchnosty kanalny)*
Rem	roentgen equivalent man
SredMash	Ministry of Medium Machine Building
USSR	Union of Soviet Socialist Republics
VVER	Water-Water Energetic Reactor
WNA	World Nuclear Association

4.3. Map of nuclear power plants

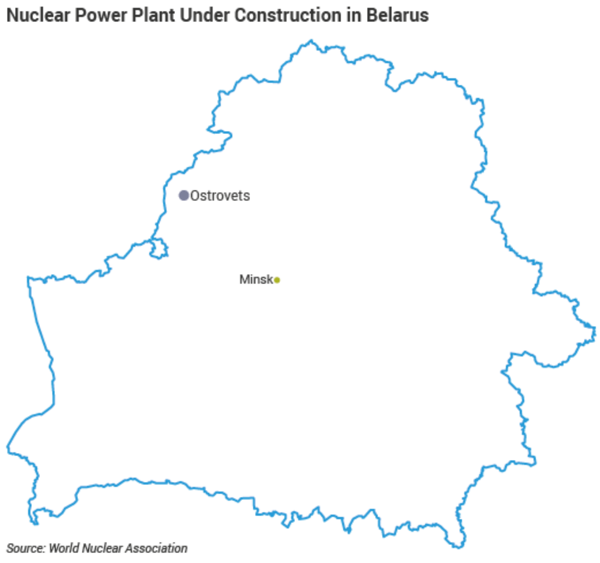

Figure 1 – Planned Nuclear power plant in Belarus

4.4. List of reactors and technical, chronological details

Table below shows the list of reactors, suppliers, operators as well as date details.

Table 1 – projected nuclear power reactors

	Reactor	MWe gross	Start construction	Start operation	Commercial operation
Ostrovets 1	VVER-1200/491	1,194 (1,109 net)	Nov 2013	mid-2019 (planned)	end 2019 (planned)
Ostrovets 2	VVER-1200/491	1,194 (1,109 net)	May 2014	mid-2020 (planned)	late 2020 (planned)
Total		**2,388**			

Operation of the first unit of the Ostrovets plant is scheduled for November 2018 and the second unit in July 2020, to give 2,340 MWe net on line.

Sources:
IAEA. "Belarus". 2016. https://www.iaea.org/PRIS/CountryStatistics/CountryDetails.aspx?current=BY
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WP2

Bulgaria

Short Country Report

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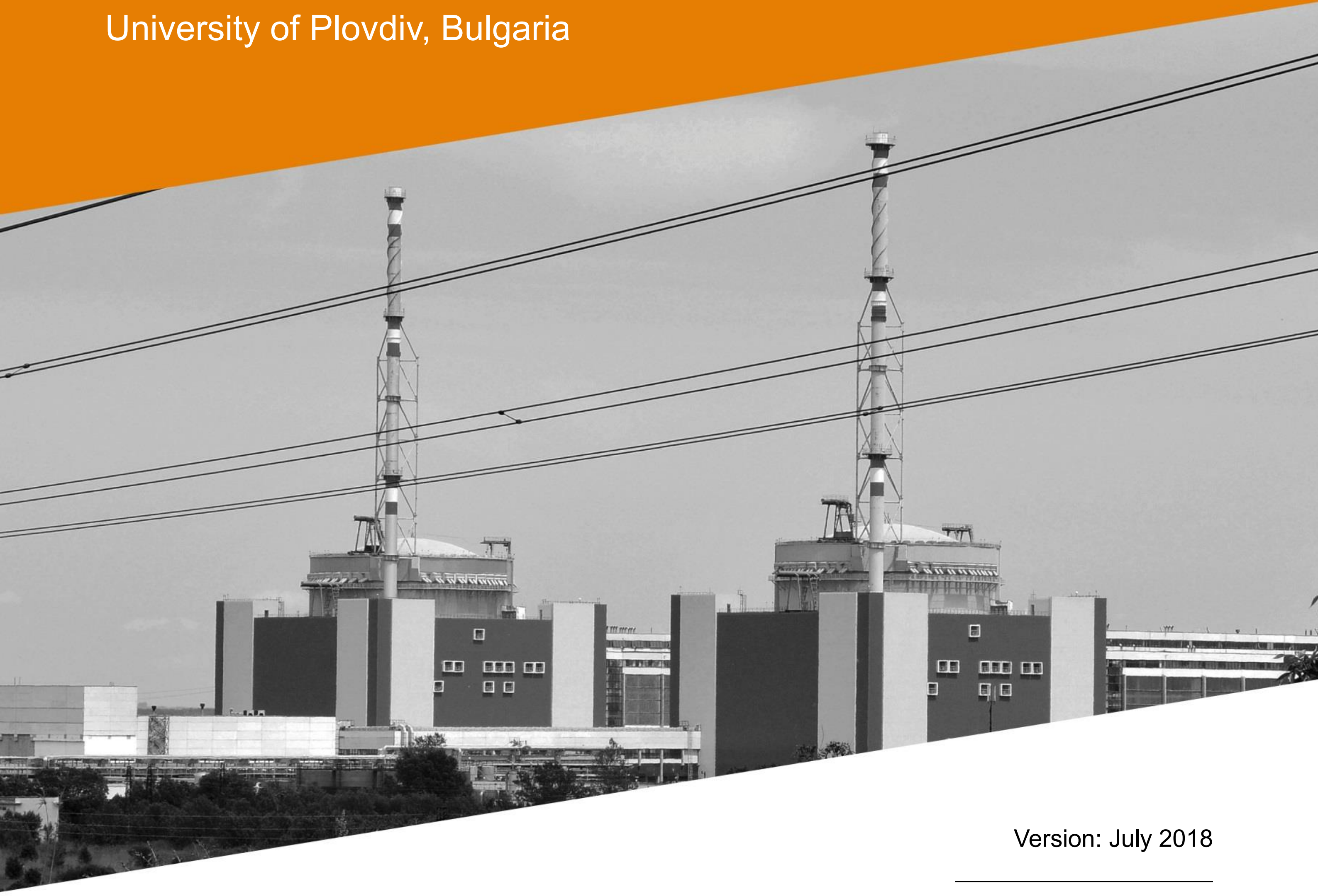

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HoNESt History of Nuclear Energy and Society

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Ciemat

University of Copenhagen Faculty of Humanities

Deutsches Museum

DIALOGIK

EHU Europos humanitarinis universitetas

TU/e Technische Universiteit Eindhoven University of Technology — Where innovation starts

Friedrich-Schiller-Universität Jena

Swedish Defence University

GRE

KTH

LUT Lappeenranta University of Technology

upna

UPMC Sorbonne Universités

The University Of Sheffield.

Science Museum

spi Sociedade Portuguesa de Inovação

CONTENTS

Executive summary

This report belongs to a collection of 20 short country reports on the History of Nuclear Energy and Society (HoNESt, project Ref.662268). The reports tackle the complex sociotechnical system around nuclear energy. Nuclear developments, notably nuclear energy, are closely intertwined with social, economic, environmental, political and cultural spheres. Nuclear energy is also a globalized system involving transnational transfers of knowledge, materials, technologies, people and products including electrical power, medical elements, toxic wastes and other environmental hazards, materials, capacities and knowledge that must be carefully safeguarded.

Nuclear energy is a complex social and technological phenomenon that influences societies but is also shaped by societies. The short country reports are designed to assemble information and research results on the history of the relations between nuclear energy and society in an accessible manner, and to document the findings with references. The purpose of the country reports is threefold, addressing three different audiences:

1. to provide basic elements of narrative and analysis for further historical research by HoNESt researchers;
2. to provide information, context and background for further analysis for HoNESt's social science researchers;
3. to provide accessible information on nuclear-societal relations in the various countries for the purposes of outreach and communication with stakeholders (civil society, industry, associations, policy makers, journalists).

This report focuses on the history of the relations between nuclear energy and society in Bulgaria. The main findings relate to the links in Eastern Europe for technological and scientific transfer. In the period before World War II technological and scientific transfer was conducted on the basis of contacts within Europe. French, British and German/Austrian achievements in the field of nuclear research were introdused to Bulgaria by scientists like Georgy Nadzhakov and Elisaveta Karamihailova.

In the years after the Second World War, Soviet influence on scientific and technological transfer increased. Along with ideological and administrative interference, Bulgaria had the

opportunity to build a nuclear power plant based on Soviet reactors. This relationship led to the construction of six VVER nuclear reactors between1974 and1991 at Kozloduy near the Romanian-Bulgarian border.

In 1986 the policy of perestroika announced by Soviet leader Mikhail Gorbachev and the Chernobyl accident were a major catalyst for change in eastern and central Europe and the emergence of environmental democratic movements. In Bulgaria, major changes occurred after Todor Zhivkov fell from power in 1989. Two years later construction on Bulgaria's second nuclear power plant - Belene NPP was stopped and postponed indefinitely. Long negotiations with the EU began to stop the four older reactors at Kozloduy NPP, which lasted nearly ten years, until 2001. The reactors were seen as bargaining chips for accession to the European Union, and their decommissioning began in 2003. By 2006 the four 440 MW reactors were decommissioned and in 2007 Bulgaria became a member of the EU. In 2003, the Bulgarian Socialist Party initiated a campaign to restart the Belene NPP project. Although contracts have been signed with French, German and Russian partners, and the IAEA has approved the proposals, the project has not yet started. In 2013 the country held a referendum with a question: "Should nuclear energy be developed in Bulgaria through construction of a new nuclear power plant? ". People replied affirmative, but the government led by GERB refused to restart the project due to the non-binding rate of participation of over 50%.

1. Historical Context (narrative)

1.1. Introduction to the historical context

In Bulgaria, research on physics and nuclear physics is associated with two prominent scientists: Karamihailova and Nadjakov. Both scientists trained in Western Europe and were part of the most advanced research teams in the world. They worked with scholars such as **Frédéric Joliot-Curie**, Ernest Rutherford and others. Karamihailova headed the first Department of Nuclear Physics in Bulgaria in 1945. Nadjakov created and later was appointed Director of the new Institute of Physics established in 1946.

Bulgarian nuclear power development began in 1955 when the Bulgarian and Soviet governments signed an agreement for mutual cooperation. In 1956, with Soviet support, Bulgaria took decision for establishement of an IRT 1000 experimental reactor near Sofia for scientific and educational pruposes at the new research base of Institute of Physics. Bulgaria became member of the IAEA in 1957. The country was also member of the CMEA and its Standing Commission for Nuclear Power, which was founded in 1961.

In 1966, Bulgaria and the Soviet Union signed an agreement to build a nuclear power plant with a capacity of 880MW with the possibility of enlargement. The two governments chose a Soviet type of reactor, the VVER- 440 as suitable technology. The Bulgarian Communist Party proposed a site near the town of Kozloduy on the Danube River. Since 1971, the country participated in the Soviet foreign organizations for nuclear equipment and nuclear energy: Interatominstrument and Interatomenero. These international organizations served as centers for cooperation and technology transfer.

In 1969, after heated discussion inside the nomenclature, where the technocratic wing supported a more cautions approach in favour of traditional (thermal and hydro) sources of electricity generation, at the so-named November Plenum of the Bulgarian Communist Party, the party leader Todor Zhivkov nevertheless announced the construction of Bulgaria’s first nuclear power plant. In 1974 the first nuclear reactor was commissioned by a joint team of Soviet and Bulgarian engineers. In 1975 the second reactor followed and the third reactor with a capacity of 440MW was introduced in 1980, after a delay caused by a serious earthquake. In 1982 Bulgarian specialists started the fourth reactor in Kozloduy NPP.

In 1982, Bulgaria and the Soviet Union signed an agreement for a building second nuclear power plant near the town of Belene. This project was never completed.

In 1989, at Kozloduy NPP the fifth nuclear reactor with a capacity of 1000MW became operational, this was followed two years later in 1991 by the sixth and final reactor with the same capacity.

In 1989, the Bulgarian Communist regime collapsed. In 1993 G-7 countries and the European Bank for Reconstruction and Development insisted on decommissioning the first four reactors at Kozloduy NPP against a compensation of 24.5 million ECU. Bulgarian governments postponed this decommissioning for nine years. An agreement for EU membership signed in 1999 by the Prime Minister Ivan Kostov, stipulated discontinuing the operation of reactors 1 and 2 in 2003 and of reactors 3 and 4 in 2006. The clauses of the contract were fulfilled and, in 2007, Bulgaria became a member of the European Union.

Since 1999, the Bulgarian Socialist Party continuously opposed the agreement with the EU and the decommissioning of the reactors. In 2013 Socialists successfully initiated a national referendum asking if Bulgaria should have a new nuclear power plant, which was successful. Nevertheless, a new project for nuclear power plant is still pending.

1.2. Contextual narrative

Nuclear physics in Bulgaria

Elisaveta Karamihailova was one of the most prominent Bulgarian scientists. Before the Second World War, she graduated in Vienna and specialized at Institute for Radium Research, Vienna (1922-1935), and Cavendish laboratory (1935-1939) in Cambridge. In 1939, with her appointment as a lecturer in nuclear physics and radioactivity, Karamihailova finally became a member of the Experimental Physics department at University of Sofia. Initially there was no equipment for practical work and teaching, which forced Karamihailova to improvise and construct her own models. In addition, she had brought her equipment from England and established country's first laboratory in nuclear physics at the university. Karamihailova also introduced practical classes in the department for the first time. In 1945 Elisaveta Karamihailova headed the first Department in nuclear physics. In her work she trained several assistants who became key figures in Bulgaria's nuclear power program, such as Nikolai Karabashev, Hristo Hristov, Maria Moldovanova, Lubomir Pophristov, Parashkeva Simova, Milko Borisov, and Leon Mitrani.[1]

Karamihailova's assistant Leon Mitrani had defended his dissertation on cosmic radiation in 1954. He worked at the nuclear physics department in Sofia and the Physical institute. In his early career he initiated the joint project of the latter institute with the Hungarian Academy of sciences to establish a cosmic research station on the highest peak of the Balkan Peninsula, Musala, at 2,925 meters; in 1959 it was Europe's second station for investigating cosmic radiation.[2] In 1957 Mitrani was promoted as a lecturer at Sofia University but soon after in 1961, he was dismissed from the Bulgarian Communist Party and had to leave the University of Sofia. He now accepted an invitation from the High Nature-Mathematical institute in Plovdiv, where he started a new nuclear physics department.[3]

Georgy Nadjakov had joined the experimental physics department in Sofia in 1921. He too had connections to the West: in 1925 he went for specialization at the Sorbonne in Paris. There he joined Professor Paul Langevin's team and met Frédéric Joliot-Curiewho became his long-time friend, their friendship lasted until Joliot-Curie's death.[4] Importantly, Joliot-Curie and Langevin, like Nadjakov, were sympathetic to Marxism. Back in Bulgaria, Nadjakov published a number of significant papers and was elected head of the Experimental Physics Department at Sofia University in 1937.[5] Thus he had on one hand the expertise for being head of the Department and on the other hand to serve lately as one of the most prominent scientists related to the

[1] Nikola Balabanov, *Over the Nuclear Physics Highways* (Plovdiv: Paisii Hilendarski University Press, 2010). See also: Ani Minkova, "60 Years Nuclear Physics Department," *Annuaire de l'Universite de Sofia "St. Kliment Ohridski" Faculte de Physque* 100 (2007).

[2] Sazdo Ivanov and Penka Lazarova, *Georgi Nadzhakov* (Sofia: "Kliment Ohridski" University Press, 1989): 151-152.

[3] Nikola Balabanov, "The Physics of Leon Mitrani - from the Space to the Human," *People in Physics* (Plovdiv: Plovdiv University Press, 2000).

[4] Ivanov and Lazarova, *Georgi Nadzhakov*, 24.

[5] Ibid., 61.

Communist political elite. After the establishment of Communism in Bulgaria Nadjakov had very important role in several directions. He became part of the International peace movement and president of the UN Society in Bulgaria; "these positions gave him ample cause to travel and maintain his international networks".[6] Back home, good relationships with the new political leaders helped him to further expand the Bulgarian infrastructure for nuclear science. Most important perhaps was his leadership of the Physical Institute of the Bulgarian Academy of Sciences established in 1946. From 1962 the institute would host the Bulgarian experimental nuclear reactor, an IRT-2000. Later this organization was transformed into the Institute for Nuclear Research and Nuclear Energy.

Nuclear power in the communist period

In 1955 Nadjakov signed the Bulgarian – Soviet agreement for cooperation in the development of nuclear power. Such agreements came from proposals made by Igor Kurchatov to support nuclear scientists within the Soviet bloc, in part as aresponse to the American "Atoms for Peace" initiative. Thus the Soviet government signed several bilateral agreements with its satellite countries. As we see also in some of the other reports, the bilateral agreements of 1955 created an opportunity for nuclear scientists and research institutions in Bulgaria, Poland, Czechoslovakia, Romania, Yugoslavia, the GDR, and Hungary to access recent Soviet research results and connect to the larger Soviet research centers like the Joint Institute for Nuclear Research in Dubna.[7] The Soviet Union helped to build nine research nuclear reactors, six cyclotrons, and seven physical and radiochemical laboratories in the satellite countries. In August 1957 a nuclear reactor in Romania, in October and December in the Czechoslovak Socialist Republic and the GDR, in 1958 research reactors became operational in the People's Republic of Poland and in China, in 1959 in the People's Republics of Hungary and Yugoslavia, in 1961 in the People's Republic of Bulgaria, etc.[8]

As consequence of the bilateral agreement, Soviet and Bulgarian authorities decided to build a research reactor with 1MW capacity near the capital – Sofia. To facilitate the construction of

[6] Plamen Damianov, *Bulgarian Academy of Science Contribution for Establishing Nuclear Energy Industry in the State (1954–1974)* (Sofia: Heron Press Ltd., 2008): 77.
[7] Use Hungarian, Lithuanian, Ukrainian, Belarusian short reports for refference.
[8] Morohov, Zadikyan, et al. (eds.) *Nuclear Science and Technology*, 328.

scientific installations in partner countries, partner governments usually received cheap, long-term Soviet credit. The Soviet Union then provided technological equipment in the form of "fraternal assistance". These loans further deepened the interdependency of Eastern European countries on the USSR. Often such technology flows and flows of scientists coincided: technological and scientific assistance agreements often included the deployment of young specialists to the USSR; after their return, they would work in the new research centers. A significant part of Soviet scientific integration policy was the commissioning of Soviet specialists to partner countries. These specialists provided technical plans, drawings, and other documentation and assisted in construction works; work with new equipment, and so on. Such was the Bulgarian case. Construction work began in 1956 with the arrival of Soviet specialists. The reactor was situated at Institute of Physis research site seven kilometers outside the capital Sofia, however today it is inside the city. In 1962 the Bulgarian reactor of the type IRT – 1000 became operational. Lately it was upgraded to 2MW and is now known as an IRT-2000. This reactor served as a scientific and training base for scientists and reactor operators until 1989.In 1957 the Bulgarian Communist government created the Committee for Peaceful Uses of Nuclear Energy, responsible for using isotopes in civil spheres including: medicine, science and electricity. Nuclear power establishments in Bulgaria relied very much on Soviet assistance and CMEA activities. In 1961 the CMEA started a special Permanent Commission on Nuclear Energy, which included a mutual program between Eastern European partners and the Soviet Union aiming to develop the VVER reactor - the Russian version of the Pressurized Water Reactor (PWR).

The SMEA's Permanent Commission on the Peaceful Development of Atomic Energy was established in 1961. Bulgaria, Hungary, GDR, Poland, Romania, USSR and Czechoslovakia actively participated in its work. While all of them sent a representative, it was Soviet officials who had a leading role. The Commission was settled in Moscow. Its first Director was Artiom Gregorianc, who was at the same time a Director of Glavatomenergo, a state-owned organization that was part of the USSR's Ministry of Electrification. The second Director during the 1980s was Feodor Ovchinnikov, Deputy Minister of Soviet electrification.[9] The Commission

[9] Stanka Nojarova, "Bulgarian Participation in Section 5 in Comecon Permanent Commission for Electricity" *Energy* no. 4, (1981): 30–31.

was separated into two sections: Section One was for reactor science and technique. It organized cooperation for production and development of reactors, reactor physics of research reactors, problems of safety in nuclear plants and plans for future development of nuclear power technology in CMEA. Section Two worked on instrumentation and propulsion systems of nuclear technology. It organized cooperation in nuclear instrumentation, electricity, medicine, industry and scientific research.[10]

The Bulgarian government founded the Committee for Peaceful Usage of Atomic Energy (CPUAE) by decree № 603 of June 4, 1957. It was established to work with the IAEA and other international bodies. The Committee was placed under the Bulgarian Council of Ministers, the executive body of the Bulgarian government.[11] In the beginning the control and supervising functions of the new Committee were limited to domestic research applications in medicine, industry, and agriculture.[12] After the opening of the experimental reactor IRT - 2000 near Sofia the duties and responsibilities of the regulatory body expanded. An important domestic problem that the Bulgarian nuclear authority solved was building a repository for radioactive waste in 1963 near the town of Novi Han.

For coordination with the international organizations, the Committee appointed a sub-committee responsible for International Atomic Energy Agency issues as well as to cooperate within the organizational framework of the CMEA.[13] The Committee interacted with both international agencies, and a formal contract was signed for cooperation between the International Atomic Energy Agency and the CMEA.[14]

[10] *The Leadership of the Permanent Commission on the Peaceful uses of Atomic Energy* Fund 1244, Inventory 1, file 1525 (Bulgarian Central state archives, Moscow: 1963), 1 (In Russian).

[11] Bulgarian Central State Archives, Fund 978, *Historical Preview.*

[12] Ibid.

[13] *Order from the Ministry Council for Establishing the Committee for Peaceful Use of Atomic Energy and Regulations for its Activity*, Fund International Relations and Contracts (IRC), Inventory 18, file 236 (Sofia: Bulgarian Ministry of Foreign Affairs Archive, 1972): 1–2 (in Bulgarian).

[14] *Agreement for Cooperation between CMEA and IAEA. Vienna, Austria 26 September 1975*, Bulgarian Central State Archives, Fund 1244, Inventory 1, file 1582.

In 1965, authorities of the Permanent Commission on nuclear power created a new working group on “reactor science and technology, and nuclear energy.”[15] Additionally three years later, a “working group on projects, facilitating, and exploitation of nuclear power plants” that included specialists from all CMEA member countries was established.[16] In this three year period, the Soviet Union made bilateral offers to Bulgaria and Hungary to sign agreements for the construction of nuclear power plants. Signed in 1966, the agreements were neither final nor indisputable, as is shown also in the Hungarian report.[17] On the contrary, the achievement of the goals set in the agreements depended on numerous and various factors. The signing did show the importance of bilateral relationships with the Soviet Union and national choices of the various Eastern European countries outside the CMEA framework. Yet the CMEA performed important auxiliary functions. The signing of the agreements coincided with the intensification in the activities of the Permanent Commission to coordinate mutual efforts of the member countries. It elaborated a common plan for scientific and technical research for the period 1966–1970. The plan included 37 main issues, 10 of them on “reactor science and nuclear energy”.[18] The Commission created a specialized body for implementing the plan during 1967–1970. It organized a range of conferences in Czechoslovakia, the GDR, Hungary, and the USSR on topics such as: “The state of the art work on the creation of NPP with fast breeders and future perspectives; Research in the field of recycling of nuclear fuel; Research on the problems related to protection from radiation; The state of development and the perspectives for WWER nuclear power plants;” and others.[19]

About 100 research institutes were engaged in this cooperative effort. Over 800 specialists attended the events and presented more than 400 reports. Representatives from Vietnam,

[15] --------. “The Activities of the Council for Mutual Economic Assistance Connected with the Use of Atomic Energy for Peaceful Purposes.” In *Peaceful Uses of Atomic Energy. Proceedings of the Fourth International Conference on the Peaceful Uses of Atomic Energy Jointly Sponsored by the United Nations and the International Atomic Energy Agency and held in Geneva, 6–16 September 1971. Volume I* (New York: United Nations, Vienna: International Atomic Energy Agency, 1972), 695–705, 698.

[16] Ibid., 698.

[17] Ibid., 698

[18] Ibid., 698.

[19] Preliminary Meeting among the socialist states in berlin Concerning the Fourth international Conference in Geneva and the XV General Conference of IAEA in Vienna Fund iRC, inventory 18, file 220 (Bulgarian Ministry of Foreign Affairs, Sofia Archive, 1972): 20.

Yugoslavia, and the IAEA also participated at these conferences.[20] The USSR had the leading role along with strong participation by the member countries of the CMEA.

The Bulgarian government considered the agreement from 1966 at a special meeting (plenum) held in November 1969. At this meeting the Central Committee of the Bulgarian Communist Party took the decision to build a nuclear power station. At the November plenum on 25 and 26, they discussed a wide range of issues. Experts presented a general estimation about the future needs for the production of electricity.[21] The gap between electricity production and the projection of future needs made plenum participants decide in favor building a nuclear plant. It happened especially after the party leader speech about the need and the work which had already been implemented.

The Bulgarian design organization responsible for the creation of the nuclear station was Energoproekt, which was founded in 1948 with the initial name Energohydroproekt. In 1959, state authorities changed the name to Energoproekt as its responsibilities expanded to cover new fields. The designers' institute benefitted from their relationship with the Soviet Union. During the first years of its existence, Soviet specialists participated in many projects in the electricity industry in Bulgaria.[22] Many hydro and thermal power plants were established with their aid. They often worked with the Soviet design bureau Toploelektroproekt, as well as with some other institutional bodies from Eastern Europe. In 1968, Energoproekt employed over two thousand personnel. The institute had a design department with R&D groups for prospective studies related to the design of thermal power plants and hydro power plants, and a department for scientific research in the energy industry. Another department specialized in engineering, geological, and hydrogeological studies.

Choosing a construction site for the Bulgarian nuclear plant depended significantly on the characteristics that the technology possessed. In contrast with thermal power stations that rely

[20] "The Activities of the Council for Mutual Economic Assistance Connected with the Use of Atomic Energy for Peaceful Purposes," (Sofia: Bulgarian Ministry of Foreign Affairs Archive, 1972), 699

[21] Zhivko Zhivkov, *Directions for Energy Development and Perfecting Heat-energy Balance of Peoples Republic of Bulgaria. Report in Front of Plenum of the Central Committee of the Bulgarian Communist Party Conducted on 25–26 November 1969. Resolution of the Plenum* (Sofia: Bulgarian Communist Party Press, 1969), 91–93.

[22] Kimon Georgiev, "Bulgaria's Electrification," *Energy* no. 3 (1958): 3–5.

on closely situated sources of coal or other fuel, nuclear plants do not depend on fuel resources in nearby areas. An important condition for a NPP is having sufficient water to cool the reactor. Therefore, the Bulgarian experts chose a site close to the Danube River to have access to the necessary amount of water.[23] The choice of the site was also in a strong correlation with the population density of the region. As a common practice, such nuclear establishments needed locations with low population density to protect people from any accidents that might occur.[24] Specialists from Energoproekt completed the preparatory works. They also prepared the sketches for the subsidiary equipment of the station. The subsidiary equipment included the pump water station that delivered cold water from the river through two artificial canals with very high output. Each of these canals was four kilometers long and served to bring fresh water in and lead the used water back to Danube. The experts also designed and later constructed a diesel generator facility that, at first, fed the construction. The institute also designed the electricity distribution installations used to connect the station to the country's grid.

The Soviet design company Toploelektroproekt designed the machine hall and the reactor facilities. The Soviet body already had rich experience in the creation of VVER-based stations, gained at Novovoronezh NPP. The lack of engineers versed in reactor technology was a serious challenge for the completion of the plant. Few Bulgarians received training in the nuclear field before 1969. Therefore, one of the tasks of the government was to educate specialists in the field of reactor science. For this reason they asked Soviet government to assist and Bulgarian engineers took courses at Novovoronezh NPP and at the Bulgarian experimental reactor IRT – 2000. Also number of students were sent to study nuclear engineering in USSR.

The first nuclear fission reaction in the Kozloduy NPP was constructed by a joint Bulgarian–Soviet team on June 29, 1974.[25] The second reactor of the Kozloduy NPP was commissioned a year after the first one. The output of both reactors was paired according to the original project. In that way, the overall capacity of the Bulgarian NPP reached 880 megawatts. During the official opening of the second reactor on March 27, 1976, two more reactors with equal capacity

[23] Dobri Dobrev, "The Role of 'Energoproekt' in projecting NPP Kozloduy," *Energy* no. 8–9 (1976): 46–49. (In Bulgarian)

[24] The same conditions exist today. Interview with senior expert Stoian Stoianov at the Bulgarian nuclear regulatory agency, December 12, 2008.

[25] Interview with Zahary Boiadjiev in the *Kozloduy* NPP, 2008.

were being constructed. According to the prospective plan, the two additional reactors were scheduled to begin generation in 1978 and 1979, respectively.

On March 4, 1977, an earthquake with an epicenter near the Vrancea Mountain within Romanian territory interrupted the initiated construction of the third and fourth blocks of the Kozloduy NPP. The earthquake had a magnitude of 7.6 on the Richter scale and inflicted serious damage. In the town of Svishtov near Kozloduy, two blocks of flats were destroyed and over two hundred people died. This accident showed the seismic vulnerability of the region and raised the issue to the authorities of the measures that needed to be taken to avoid possible disasters.

The first and second power blocks of the Kozloduy NPP were in operation at the time of the earthquake. The operator on duty stopped one of them, whereas the other continued to operate until morning. The earthquake moved part of the main equipment of the nuclear block but did not affect its functioning. It did create the potential danger of nuclear fallout from water spilling from the first loop but the construction of the plant had prevented this. The construction was built with what Soviet nuclear specialists referred to as thirty percent additional strength. They referred to this as the "internal safety rule", Bulgarian experts trusted this rule.

Bulgarian authorities postponed the start of the two additional reactor blocks. Subsequently with help from Soviet colleagues they defined a set of measures to enhance the seismic resistance of the third block. They planned to apply these measures to the other plants as well. The main changes made to the plants included improving how the reactor was fixed to the construction frame using a bearing ring. Additional metal constructions for the volume compensator and the steam generators were reinforced with four hydro shock absorbers of fifty tons. The main circulation pumps were reinforced with three hydro shock absorbers of twenty-five tons. The main stopping sliding rules were reinforced with two hydro shock absorbers of twenty tons and the main pipelines were reinforced.[26] After consultations with specialists from the USSR, the

[26] Ibid., 32.

government decided to buy hydro shock absorbers from Japan.[27] Thus adapted, the third and fourth reactors started in 1980 and 1982.

In 1981, Bulgaria signed an agreement with the Soviet Union for the construction of two power blocks based on VVER – 1000 type reactors. The agreement was signed on October 1 in the town of Plovdiv and included the construction of the third part of the Kozloduy NPP, which consisted of two power blocks equipped with VVER – 1000 reactors.[28] The two VVER-1000 reactors began operating in 1987 and in 1991, respectively. Unlike other Eastern European nations, such as Belarus, where Chenobyl led to a halt in construction, the construction of reactors at Kozluduy was not affected by the distaster at Chernobyl.

In 1982 Bulgaria and the USSR signed an agreement for a second nuclear plant with two reactorsbased on VVER – 1000, near the town of Belene. The construction work started but the project was abandoned in 1991 and only conservational work was done during the decade that followed.

Democratic period

From its very beginnings the development of nuclear power in Bulgaria has been strongly influenced by policy and the political environment. As we saw during the first thirty years of its development nuclear industry was under national and Soviet Communist Parties governance. After the political change in 1989-1991, public opinion began to shape policy, especially after the formation of the independent Green movement Ecoglasnost.

Intially democratic changes in Bulgaria took place under the political concepts of "glasnost" (openness) and "perestroika" (transformation, rebuilding) adopted by Soviet leader Mikhail Gorbachev. In 1986, Gorbachev decided that the time had come for political change in the ruling elites of the satellite Communist Parties in other socialist countries. Such a policy directly affected the political situation in Bulgaria. Changes in energy policy, however, were catalyzed by the nuclear accident at Chernobyl NPP and other environmental problems created by the peculiarities of Communist governments.

[27] Oved Tadjer, "The Nuclear Power Complex 'Kozloduy' – Scales and Development Perspectives," *Energy* no. 2 (1980): 9–15.

[28] *Bulgarian–Soviet Relationships and Connections*, 541.

The emergence of democratic movements in Bulgaria was related to the specific attitudes of Communist leaders to the industrialization of the country. On the one hand, following the Soviet model of industrialization, Bulgarian leaders began several very large projects such as the metallurgical plant at Kremikovtsi, the machine-building plant in Radomir and others. These large and energy intensive projects of socialist industry became serious environmental polluters. This situation remains unchanged due to the priorities of the political regime to catch up the developed capitalist economies at any cost. For this reason, the environment was of secondary concern compared to the industrial development.

The neglect of environmental issues by the dominant model of large-scale and accelerated industrialization was particularly evident in the late 1980s with the deliberate policy to conceal the consequences of the Chernobyl accident and other big polluters. After the Chernobyl accident the atmospheric currents brought radiation particles to the country on 02 May 1986. During the days and weeks that followed the radiaton often exceed the the permissible limits. However, Bulgarian media under the dictates of communist leaders refused to inform the public about the level of pollution and its health consequences, nor to advise people how to protect themselves.

The extent of the radiological contamination were immediately registered by Bulgaria’s scientific and other institutions, possessing the necessary measuring devices. Within the Communist Government a special meeting of its "Standing Committee on Government to combat natural disasters and major industrial accidents" was convened, where four important decisions were taken: 1. Creation of a working group in the field of radiation protection with the task to register and account for the effects of the accident and to take the necessary measures to prevent negative consequences. 2. To prepare informative programme to acquaint the popultation with the necessary radiation protection and hygiene measures, and for this to be aired on national television. 3. To instruct and raise awareness in regional authorities of the radiation situation and discuss measures to protect the population. 4. To explore the possibilities for iodine prophylactics of the population and availability of iodine in the country. The first and third of these solutions were implemented, while the second was dropped for unknown reasons. The last decision was implemented too, but it was found that Bulgaria did not have adequatee stocks of iodine, which impeded the actions planned.

On May 7 1986 by order of Grigor Stoichkov - Vice Prime Minsiter and member of Politburo a committee of experts was established. The members of this committee were the main witnesses in the court trial against Stoichkov’s case. The trial was also against the former government, claiming a lack of adequate measures against radiation contamination in the country.[29]

One of the consequences of the inadequate reaction of the Communist regime was the emergence of mass “radiophobia” among the Bulgarian population. The concealing of the truth about the consequences of Chernobyl, the lack of information about the reactors at Kozloduy NPP and their difference from those in Chernobyl NPP created lasting distrust of nuclear technology as a whole. Over the next 2-3 years a fear was accumulated among Bulgarians, which accelerated the degradation of the Communist political system:

“The lack of official announcements and explanations about the necessary radiation-prevention measures, with the circumstance, that information was irregularly provided, not sufficient, unclear, often incorrect, and manipulated in relation to the radioecology status and the radiation danger, led to oppressing uncertainty, felling of insecurity, depression, and helplessness.”[30] In this way the Bulgarian state and the communist party as its main representative, created an atmosphere of radio-phobia. In 1993 more than 38% of Bulgarian population considers radiation pollution as the most dangerous threat.[31]

The birth of the environmental movement in Bulgaria is associated with the heavy air pollution caused by the largest chemical plant "Verahim" in Romania built in the city of Giurgiu on the Danube. On the opposite bank of the river was located the large Bulgarian city of Rousse with a population of two hundred thousand people. Regular air pollution from the chemical factory for

[29] Angel Antonov, dr. Maria Minkova, *Chernobyl. Days from the Apocalypses*, Ekoglasnost, Sofia, 2006., p.71-72

[30] Ibid, p. 93; Krassen Stanchev – founder and one of the leading Ecoglasnost activists, later member in the first democratically elected Bulgarian Parliament, pointed that many of Ecoglasnost activists lost trust in government and begun questing the Communist party policy already in summer of 1986. “Digging into details about the Chernobyl accident helped me realizing the inhumanity of the regime and I lost any illusions about it.” (Interview taken in August 2016)

[31] Ibid, p. 93

nearly ten years eventually ignited the citizens of Rousse. In 1988 an initiative committee of the women in Rousse took action to alert public authorities that the situation was intolerable. Until this point representatives of the Communist Party had intentionally turned a blind eye in order not to cause an international conflict. In 1988 the "Public Committee for Environmental Protection of Rousse" was established. The journalist Yurii Zhirov created a documentary film "Breathe" that reached wider intellectual circles and in early 1989 under the influence of many other environmental problems in Bulgaria, including the consequences from Chernobyl, the independent environmental movement *Ecoglastnost* was established in Sofia.

The activists, who founded the environmental movement and later political organization Ecoglasnost, see their activities as a catalyzer of the political change, which happened on 10 of November 1989 when the communist leader Todor Zhivkov resigned. Some of them see it as a purely environmental organization which aimed to change privacy policy and challenge industrial incompetence, whilst others view it as political party. Ecoglasnost was formed in January - February 1989 as informal movement, as the founders tried to relate its program to the Rousse committee. Founders of the movement were intellectuals and activists from Sofia, including actors, intelectuals and university lecturers. In March 1989, Ekoglasnost activists attempted to convene a plenum in a public space, but militia blocked the site. Initially nineteen people founded the organization on 11 of April, in a private apartment. Two days later, organizers submitted documents to the regional court of Sofia for registration. Just five days after this act, Ecoglasnost, sent an official inquiry to all the state institutions to publicise the origin and place of all toxic materials on Bulgarian territory. At the end of June the regional court of Sofia rejected the registration of the organization, however without providing sufficient reasons. The court argument was that there was no state department which could control and administrate the organization. Thus the court proved that the state, respectively the Communist Party, would not allow civil organization even for environmental problems. Six days later, the activists sent an official note to the national media and to the National assembly, about the court of Sofia's arbitrariness.[32]

[32] Aleksandrieva, Liliana and Alexander Karakachanov, edit. *Ekoglasnost*, Siela Press, Sofia 2009

The police oppressed every attempt for a larger public meeting in the summer of 1989. This began with regular checks and even the arrest of some of the activists, which included aggression and verbal attacks. After September, members of the organization worked on nine environmental problems which they had hoped to present at an international forum in November. In October one of the regular meeting was attacked by the police, but people willing to participate continued to arrive. Thus Ecoglasnost already had significant support from the citizens. Organization members also made posters, which were spread across the city. Even though these had all been removed by the police and state security by the next day. Ecoglasnost had its first public meeting at one cinema hall on 20th Ofctober. The cinema was overcrowded, and the activities of Ecoglasnost, unleashed the accumulated social energy. From this moment onward environmental problems became broader social issue.[33] At the end of October repressions against the activists escalated but after one day in police departments they were released. On 3rd of November 1988 the first free protest after the establishment of Communism in 1944 walked on Sofia's streets. Around four hundred people went to the National Assembly and submitted a petition against environmentally dangerous industrial projects. In December the High Court of Bulgaria revised the court of Sofia's decision and officially recognized Ecoglasnost.[34] However, the organization went into political alliances and some of its original founders, still under the influence of the Bulgarian Communist Party (and its security apparatus), did not approve the December 7, 1989 decision to enter into coalition as co-organizer of the new anti-communist political bloc - The Union of Democratic Forces. In this way the organization felt apart and some of its members ahead of Alexander Karakachanov created a new Green Party, which unsurprisingly was less anti-nuclear than *Ecoglastnost*.

In 1991 the construction of the second Bulgarian NPP Belene was frozen. However, this will be discussed in more detail in the show case below.

In the late 1990s EU membership became one of the most critical steps for the new political parties. Democratic leaders easily accepted the EU proposal for decommissioning the old reactors in order to achieve membership for Bulgaria. This deal was broadly commented on in

[33] Aleksandrieva, Liliana and Alexander Karakachanov, edit. *Ekoglasnost*

[34] Ibid,

the media and it soon became a heated political issue. The technical arguments and the possibility to lose one of the strongest industrial enterprises in Bulgaria created the feeling of an unfair deal for the EU membership. The Socialist Party and its media in particular were a focus for opposition to the deal.

In 1993 the first negotiations about the fate of the oldest Russian reactors began. Vice-chair of the Committee for Nuclear Development, Nikita Shevarshidze, began negotiations with the European Bank for Reconstruction and Development for 24 million ECU in order to renovate the first two reactors ay Kozloduy NPP. However the bank decided that renovation was unacceptable, and requested that the reactors be shut down by 1996. Such a demand was against the Bulgarian energy plan which had envisaged extension until 1998 at earliest. Bulgarian representatives argued that the reactors fulfilled the technical and safety requirements of IAEA.[35] In June the same year the Bank stepped back leaving this topic to 1997, when the fate of thereactors would be negotiated again.

In 1997 the Government of the Republic of Bulgaria authorized the Chairman of the Committee for Nuclear Energy Ivan Shilyashki to negotiate the extension of operational life of the four 440 MW nuclear reactors at Kozloduy NPP. The Government claimed that according to the techno-economic analysis carried out these reactors could continue their work – after necessary modernization, until 2005 for reactors I and II, and until 2010 for the reactors III and IV. In 1999 negotiations about the four old reactors began again. The Bulgarian government insisted on the extension to 2004 and 2010 respectively, while European experts required shorter periods. In December 1999 the two sides seemed to find a solution which involved the closure of the first two reactors by 2003, along with compensation of 200 milion ECU. The European Union on its side would drop the initial conditions for membership.

During the negotiations the right-wing Government of Ivan Kostov was not engaged with determining a timescale for decommissioning reactors III and IV. The left opposition headed by Rumen Ovcharov insisted on a full exploitation period as envisaged in the Bulgarian energy plans.[36] Bulgarian society stayed divided on the topic and left the political parties to lead the

[35] Newspaper Trud, 07.06.1993 Eurobank surprised Kozloduj NPP with an ultimátum to decomission its old reactors".

[36] Newspaper Trud 13.11.1999, "We will not negotiate with EU for Kozloduy"

negotiations. Only small green fractions with no political agenda sent a note to the government to indicate that they supported the decommissioning of the old reactors.

In 2001, just before stopping the first reactors Bulgarian intellectuals took another step to postpone the shutdown. They create a *Citizens' committee in defense of Kozloduy* aiming to request a reassessment of the technical conditions at Kozloduy NPP in order to demonstrate the technical fitness of the reactors. Despite their efforts, however, the closure of the reactors was performed according the terms agreed.[37]

On November 18, 2002 Foreign Minister of Bulgaria accepted the closure of reactors III and IV by the end of 2006, and the next year Bulgaria became part of the European Union. Thus ended the debate on the fate of the old reactors of Kozloduy NPP. The next step, which is part of the plans of the nuclear lobby in Bulgaria is to resume construction of Belene NPP. This part of the story is presented below in a case study.

1.3. Presentation of main actors

Physical Institute with Nuclear Research Base – founded by Georgy Nadjakov. The institution served as mediator for scientific transfer, including specialization in JINR – Dubna. Later it was transformed into separed Institute for Nuclear Research and Nuclear Energy (INRNE) at BAS.

IRT – 2000 Bulgarian research reactor built near Sofia. The reactor was built with Soviet assistance and served for research and training for the Kozloduy NPP.

Committee of peaceful usage of nuclear energy 1957 – in 2001 transformed into **Nuclear Regulatory Agency.** The organization was created to communicate with IAEA and the commissions in COMECON. In the beginning it organized the work of the research reactor IRT – 2000, and the nuclear waste depository near the town of Novi Han.

Energoproekt – Bulgarian design bureau responsible for supplementary design of Kozloduy NPP it served as the partner organization during the construction

[37] Newspaper Trud 16.01.2001 “Intellectuals in defense of NPP”

Toploelкtroproekt – Russian construction organization responsible for building the reactor blocs at Kozloduy NPP

Kozloduy NPP – The first nuclear plant built in Bulgaria. It has six VVER reactors four of which have a capacity of 440MW and two of 1000MW. In 2002-2003 the first and second reactors were decommissioned. In 2006 the third and fourth reactors were also decommissioned. The decision was not due to technical reasons but was political; namely the acceptance of Bulgaria as European Union member.

Belene NPP – The second nuclear power plant. The construction of this power plant started in 1985 and until 1991 almost 80% of it was completed. The plant however, is still under construction and under negotiations with international partners. This plant was the arena for various political conflicts.

БКП Българска Комунистическа Партия - Bulgarian Communist Party – main actor of state industrialization. Its leader Todor Zhivkov had final word for building Kozloduy NPP.

БСП Българска социалистическа партия – Bulgarian Socialist Party (former Bulgarian communist party), 1995-1997; entered in coalitions 2001-2009. Supporter of nuclear power in any form. It was the main opposition against decommissioning the reactors and any policy against nuclear power.

ЕКОГЛАСНОСТ - ECOGLASNOST – nonpolitical environmental movement established to demand free information about environmentally dangerous industrial objects. It was the first free organization which demanded better environmental policy and information about consequences from Chernobyl.

Риск Инжинеринг - Risk Engineering Ltd. - A company with experience in the power-engineering sector, established in 1992. The company has active paricipation in the attempts to restart Belene NPP.

Български енергиен холдинг - Bulgarian Energy Holding (BEH) - is the successor of the state-owned company Neft i Gas (Oil and Gas) established in 1973. In 1990, the company was renamed to Bulgargaz. In 2006 Bulgargaz was transformed into Bulgargaz Holding. In

September 2008, Bulgargaz Holding was renamed Bulgarian Energy Holding.

СДС Съюз на демократичните сили- The Union of Democatic Forces (UDF) – 1991-2001 The Union of Democratic Forces, was an early political party. Ecoglasnost, and much (but not all) of the green movement entered into UDF in 1989.

НДСВ Национално движение за стабилност и възход – 2001-2005 The National Movement for Stability and Progress. A political party which represents pro-NATO and pro-EU political line. Accepted all the demands about stopping the first four reactors of Kozloduy NPP.

ГЕРБ Граждани за европейско развитие на България - *Citizens for European Development of Bulgaria* – 2009-2013; 2014 – The last ruling party follows European Union directives and refuses to start a new nuclear project or restart the old one at Belene. For Bulgaria political parties represented voices of the supporters or opponents of the nuclear program.

In 2008, a **Green party "Zeleneite"** (*The Green*) was registered. They had special platform about the referendum in 2013 in which demanded the referendum to include point of "against" any nuclear facilities. The election law of the country did not allow such change from a party or organization.

2. Showcase: The unfinished nuclear power plant Belene and the political conflicts

The agreement for the Belene NPP, signed on March 27, 1984 between the Soviet Union and Bulgaria marked the ambition of the Bulgarian government to extend its nuclear program even further. Before 1989, 80% of the equipment had been supplied and about forty percent of the first reactor had been completed. This reactor had been built in the Škoda factories in Czechoslovakia, from where it was shipped to Belene.

The political changes in November 1989 weakened the position of the Bulgarian government in relation to Belene NPP project. Due to financial difficulties in 1990 the Government of Andrey Lukanov suspended the payment of wages to workers on NPP site, which caused a strike. Simultaneously citizens of the nearby town of Svishtov began protests against the Belene NPP project. Hence the situation changed after 1989, but as we mentioned above, this was prepared by the events immediately after Chernobyl accident and immediately after that. Taken together they form an interesting sequence of events:

Firstly, unlike their neighbour Yugoslavia and other (West) European countries, the Bulgarian authorities banned media coverage of the disaster and practically left the country's population unformed for several months. Hence during the most important first weeks after the accident (April 26, 1986) – when a series of radioactive rainfalls hit the country - the vast majority of Bulgarian people were left unaware and without any protection. As a result of this hundreds of thousands Bulgarians were exposed to increased levels of radiation that have had lasting negative health effects on the several generations. When the censorship was uncovered later that yearthere was mass public indignation, one of the manifestations of which was the establishment in 1988 of Ecoglastnost movement, the first mass political opposition against Communist rule. Similarly to the green movements in Western Europe, its program included measures against nuclear energy. They helped establishm a committee against the Belene NPP in the neighbouring university town of Svishtov that had been heavily hit by the powerful Vrancha earthquake in 1977. The committee gained strong support amongst thelocal population and throughout the country. After the political changes in November 1989, the members of

Ecoglastnost were elected to the Bulgarian Parliament and contributed to the expansion of public resistance against the Belene NPP. This also made possible the "Chernobyl" process in 1990, where the Bulgarian court issued effective sentences against the former Deputy Prime Minister Grigor Stoichkov and Lubomir Shindarov, First Deputy Minister of Public Health and Chief State SanitaryIinspector for the non-acceptance of necessary measures to protect the public following the Chernobyl accident 1986. Hence for the period of several years at least the Chernobyl disaster and construction of Belene NPP became related in the public perception.

Secondly, in 1990 the Soviet Union took unilateral decision to increase the price of nuclear fuel for Kozloduy NPP and simultaneously to stop the import of Bulgarian uranium (in fact for many decades the export of uranium to USSR balanced the purchase of nuclear fuel). Krasen Stanchev, one of the leaders of *Ecoglasnost* movement who in 1990 became MP in the first Bulgarian post-communist Parliament and headed its Environmental Commission, remembered:

> *The decision of Dimitar Popov Government from 18 August 1991 to stop the construction of Belene NPP was carbon copy of the written position the parliamentary Environmental Commission took few months earlier. It summarized a number of arguments for discontinuation of the project - both environmental and economic ones, such as expected dynamics of electricity prices, consumption of electricity, etc. But this decision included also discontinuation of the extraction of uranium in Bulgaria and gradual liquidation of all related mining and uranium processing facilities. Soviet Government decided that they will not import Bulgarian uranium and will use their own resources. The Bulgarian government appointed Vise Prime Minister to negotiate this decision, but in vain… And these events came after the shock from December 30 previous year, when Soviet Union almost tripled the price of nuclear fuel for Kozloduy NPP, which raised from about $ 20 million in 1990 to $ 56 million for the next 1991 year. This took place in the conditions of heavy financial crisis of the country, when the entire financial reserve of the Government was little more than $ 60 million!*

Yet, during the next decade the nuclear lobby in Bulgaria pushed hard for reconsideration of this decision and achieved (if partial) success in it. Since then, measures have been continuously undertaken to preserve the supplied equipment, the construction site and the buildings; various investigations and assessments have been carried out with respect to the site suitability and the equipment status, all of which yielded positive conclusions. New investigations have been performed in relation to site safety and its compliance with international requirements. There has been particularly extensive research on the seismic safety of the chosen site. A number of missions were carried out by the IAEA and other bodies of authority. All these came up with positive conclusions and confirmation that the Belene site is suitable for the construction of a nuclear power plant.

In 2002 the Bulgarian Government decided in principle to restart of the Belene Project. Fulfillment of all legislative requirements allowed the Government to approve the construction of a nuclear power plant on the Belene site with total rated capacity of 2000 megawatts.

In 2003 - Minister of Energy Milko Kovachev sent letters to six leading companies in the field of nuclear energy with a request for current technical, economic and financial information. By order of the Minister of Energy and Energy Resources of May 7, 2003 anexpert working group in connection with the construction of the plant was established.

In late October 2006 the offer of a consortium of Russian Atomstroyexport, French Framatome (Areva), and German Siemens using third-generation VVER-1000/V-446B reactors was approved by the National Electric Company. On 7 December 2007 the European Commission gave its favourable opinion to the NPP, saying that it met all requirements of articles 41 to 44 of the Euratom Treaty.

In 2008 - Belene received a construction permit from the Ministry of Regional Development and Public Works. Prime Minister Sergey Stanishev officially began construction works on the Belene site. It was expected that the first block of the power plant will be commissioned in 2013 and the second - in 2014.However, various issues have meant that the project has not yet been completed.

In 2010 - BNP Paribas suspended its participation in the project due to the expiry of the mandate. Bulgarian Energy Holding launched the procedure to select a new consultant, but none was appointed before 2012.

In 2011 - The National Electricity Company and Atomstroyexport signed Appendix № 13, which extends the duration of the Agreement of 2006 to September 30, 2011. After expiry the NEC brought a claim against Atomstroyexport at Arbitration Court in Geneva under the auspices of the Paris-based International Chamber of Commerce. On June 16, 2016 the court has ruled that Bulgarian state energy firm NEK should pay nearly 550 million euros ($620 million) in compensation to Atomstroyexport for a cancelled nuclear power project. The money have been paid in 2017.

The negotiations stalled again after the GERB government decided to add an American or a European contractor to the project, as well as insisting that Atomstroyexport to lower the price to less than five billion euro. As no major European or American investor appeared, the talks continued to yield no results. This led to the official termination of the Belene project in March 2012.

The first national referendum after 1989 on building a new nuclear power plant was held in Bulgaria on 27 January 2013. Whilst it was not explicitly mentioned in the question, it was widely acknowledged that the referendum was about restarting construction at the Belene NPP. The referendum required a turnout of at least 60% to be binding on the government. Voters were asked the question "Should nuclear energy be developed in Bulgaria through construction of a new nuclear power plant?" Although the proposal was approved in all 31 electoral divisions, turnout did not pass the required 60% threshold, resulting in the referendum becoming non-binding.

Supporters of the plant argued that it would mean the country would not have to buy electricity from Romania and Turkey, whilst opponents have claimed that it would increase the country's energy dependence on Russia as the Russian firm Atomstroyexport had been contracted to build the plant.

The referendum resulted from a petition organized by the opposition Bulgarian Socialist Party after the center-right government of Prime Minister Boyko Borisov and the GERB party terminated the Belene project in March 2012.The Socialists got the referendum through after some 770 000 Bulgarians signed their petition, with 500 000 signatures needed to make a referendum petition binding.

Bulgaria's Central Electoral Commission had registered four initiative committees for the informational campaign for the referendum.

Only the one of political parties - the Socialists, campaigned in favor of a second NPP, and more specifically – the Belene NPP. The campaign was headed by Prof. Stefan Vodenicharov, the newly elected chair of the Bulgarian Academy of Sciences. The ruling party GERB's committee initially also intended to campaign in favor after it was GERB who changed the referendum question omitting the Belene NPP from it. Subsequently, however, Prime Minister Boyko Borisov changed his mind, and urged GERB voters to vote with "no" because the referendum question referred to Belene by implication, and GERB was against the project. Two other committees of smaller parties – Democrats for Strong Bulgaria and the United People's Party – also campaigned against a second NPP. The referendum result would have been binding if more than 4 225 000 Bulgarians had cast their vote. If more than 20% voted in favor, then a decision would have been made with a vote in the Bulgarian Parliament. In spite of the referendum success there is still no step undertaken for restarting the NPP Belene project or for initiating another one. Specialists from nuclear industry speak also about the option of establishing a 7th reactor at Kozloduy NPP.

On February 26, 2018 Bulgarian Prime Minister Boyko Borisov, when participating in the Western Balkans Investment Forum organized by the European Bank for Reconstruction and Development in London, UK, announced a proposal for the construction of Belene NPP as a common Balkan project with European funding. "If we could not think of common financing, a Balkan project for our power transmission system, today I thought it would be a great solution for Belene NPP. We have 2 paid new nuclear reactors for 2200 megawatts, we have paid them and are in boxes," said Borisov, cited by *Novinite.com*.

3. Events

The selection of the five main events in Bulgarian summary report is based on the main points that have influenced the development of nuclear energy in the country, and public relations with, and reactions to, the use of nuclear energy. First is the construction of the experimental reactor, leading to the creation of a community of nuclear scientists and specialists. Second, the start of Kozloduy NPP and the earthquake in Vrancea. Both events are important to understand the dynamics and processes that led to the use of nuclear energy in the country. Third is the fall of the Communist Party and civil protests from environmental organizations, leading to the suspension of the Belene NPP project. Fourth are the negotiations with the EU to close the first four reactors at Kozloduy NPP and the country's accession to the Union. Finally, the referendum on the construction of new nuclear facilities which was accepted, but was non-binding due to low turnout.

3.1. Event 1: Starting the experimental reactor IRT-2000 near Sofia in 1962

The Soviet-Bulgarian nuclear science assistance agreement of 1955 was the starting point of the Bulgarian nuclear program. The agreement was co-signed by the ideologically reliable Bulgarian physicist prof. Georgi Nadjakov.[38] The agreement specified the delivery of an IRT–1000 (1000 kilowatt) experimental reactor with the possibility of an upgrade to 2000 kilowatts (this occurred in DATE, and it has since been known as IRT-2000). In fact, Nadjakov had made earlier requests to the Bulgarian Academy of Sciences for an experimental reactor in his Physical Institute, but the Academy's administrative body had continuously postponed responding to his demands. It was only when the international environment changed, after Eisenhower's Atoms for Peace initiative in 1953 (See the USA Country Report) when the Soviet government decided to step in.

Notably, from a design perspective, the Bulgarian experimental reactor was similar to other IRT reactors built on Soviet territory. This particular type of research reactor had first been inaugurated at the Institute of Atomic Energy in Moscow in 1957; Igor Kurchatov's assistant V. V. Goncharov headed the division of research reactors and reactor technologies, and shared the credits for designing the reactor with Yury. G. Nikolaev and Yury. F. Chernilin. The literature described the reactor as having "structural simplicity, operational safety, low cost, and operational reliability".[39] Now this nuclear technology was transferred to Bulgaria and other satellite countries without substantial technical changes.

[38] Nadjakov begin his carrier as research physisist in late 1920s and specialized in France with Paul Langeven, later becoming close friend with **Frédéric** Joliot-Curie.

[39] E. Ryazancev, "Anniversaries. 50th Anniversary of the iRT Reactor. (History of Creation and Development)," Atomic Energy 104, no. 6 (2008): 359.

In 1956 Russian specialists came to Bulgaria and started constructing the facilities for the Institute of Physics and the reactor. These new facilities were erected in an open field seven kilometres outside the Bulgarian capital. Currently the site is inside the city, and people live a few hundred meters from it. Soviet specialists kept a close watch on the construction process. They also elaborated on the safety and operating procedures to ensure that the device would be installed and handled properly. Given the urgency of the project, the Bulgarian scientists did not wait for all of the facilities to be completely; instead, they took their old equipment and moved into the new buildings before the site's construction was finished.

At the same time, several Bulgarian scientists were required to go to the USSR for specialization. The Bulgarian government assembled two groups of researchers in 1956 and early 1957 from different educational centers in Bulgaria. These groups had to specialize in the most important fields of nuclear physics. The first group specialized in nuclear processes and nuclear physics; it included Georgi Bliznakov, Ivan Mitev, Lenko Kalchev, Milko Borisov, Nikifor Kashukeev, Stanka Vaklinova, and Hristo Hristov. The second group studied IRT–1000 services and functions and included Anton Markov, Vasil Hristov, Dimitar Vatev, Ivan Pandev, Ivan Traikov, Ilia Mishev, Kirkor Sakalian, Nikolai Bachvarov, and Simeon Ruskov. A number of these researchers would later work on Bulgaria's first commercial nuclear power plant.

The Bulgarian IRT–1000 (2000) went critical on September 18, 1961. Dmitrii Blohincev, director of the JINR in Dubna and a corresponding member of the Soviet Academy of Science, set in motion the first nuclear fission in the reactor and entered its time and date in the reactor diary. On his command, the specialists put a polonium-beryllium starter into the active zone of the experimental reactor; after which the active zone emanated neutrons. From that moment until its decommissioning in 1989, the reactor served scientific purposes. As for safety, it is noteworthy that the reactor had the technical characteristics of a light-water reactor; distillated water slowed down the neutrons and acted as a bearer of heat and a protector. For additional protection, the reactor had a two-meter thick concrete shell. It was fed with uranium dioxide enriched with ten percent uranium 235.

Bulgarian reactor research often involved international cooperation projects. Vasil Hristov, who had specialized in the Kurchatov Institute in Moscow and later in the JINR at Dubna, founded a reactor-physics measurements laboratory to investigate the characteristics of the IRT–2000 (and later to study materials used in the Kozloduy nuclear power plant). His team also worked on a mechanical selector for researching neutron behavior in heterogeneous spaces together with the Polish Institute for Nuclear Research. Natalia Ianeva and her team contributed internationally to the field of fast breeder research; concentrating on heavy nuclei-fission in cooperation with the JINR in Dubna and the Institute of Physical Energy in Obninsk. At the same laboratory, Nikifor Kashukeev, who had specialized in Dubna for eight years or so, continued his work on the production of heavy, cold and ultra-cold neutrons in Bulgaria. Others worked on nuclear spectroscopy, neutron activation analyses, physical and biological radiation, biochemical investigations, and isotopes production. The laboratory and other departments in the Institute of Physics established itself in an international network, collaborating with the East German, Polish, Hungarian, Czechoslovakian, and Romanian Academies of Science and the IAEA.

Notably, the IRT–2000 enabled investigations into the characteristics of nuclear reactors for electricity supply. In the beginning, Bulgarian and Soviet teams in close cooperation experimented with neutron diffusion in VVER reactors. The results were compared to those of the experimental ZR-6 system researched in Hungary, a system designed to investigate the properties of a new type of VVER reactor. Bulgarian specialists proposed various programs and mathematical equations on the active zone in VVER that were later used to improve this reactor technology.

The Bulgarian experimental reactor remained active until the political changes of 1989.

Event 1	Establishing the Bulgarian experimental reactor
Who was involved - potential actors	Committee for Peaceful Uses of Nuclear Energy, Bulgarian Academy of Science, Institute of Atomic Energy in Moscow, Soviet government, Bulgarian Government, Igor Kurchatov, Georgy Nadzhakov
When and where did it take place?	1961, near Sofia
What type of process was it (communication, consultation or participation)? How did this change over time? Please state process type, then describe in detail.	**Communication and participation**. First step of establishing the Bulgarian nuclear program. The reactor IRT – 1000 was the first successful cooperation between the Soviet Union and Bulgaria in the field of nuclear technology. This was the beginning of the creation of nuclear society in the state.
What rationale was given by the party that implemented the engagement (if any)?	On the Soviet side it was the expansion of their scientific and technological model. For Bulgaria it was announced as sign of brotherhood and a big scientific step for a modernizing country.

3.2. Event 2: Starting the NPP Kozloduy and the Vrancea earthquake – 1974-1977

The agreement for constructing a Bulgarian nuclear power plant at Kozloduy was signed on July 15, 1966 and stipulated the collaboration in the construction and commissioning of a nuclear power plant with a total capacity of 800 megawatts within the People’s Republic of Bulgaria 1973–1974. The Soviet and Bulgarian parties shared responsibility for the project: the Soviet Union would supply the design, technology, specialists, construction management, training, and uranium fuel, while Bulgaria would choose and prepare the building site and execute construction under Soviet leadership.

In addition, the agreement obliged the Soviet Union to grant credit worth fifty million rubles at two percent interest per annum. These funds covered the delivery of specialized equipment and project design provided by Soviet organizations. The Bulgarian state was expected to repay the loan within a period of ten years, but payments were not expected in cash; payments would be made in Bulgarian commodities based on a previous agreement. If the loan was insufficient to cover the expense, Bulgaria was to pay for additional costs. Notably, the agreement also specified the secrecy of technical information: none of the organizations involved was to reveal the provided documentation to entities or organizations of other countries.

As the implementation of this nuclear power project approached, opposition voices became stronger. This opposition was rooted in the struggle between different factions within Bulgarian society, in particular, in the political, economic, and scientific nomenklatura. Like in other cases with large technological projects, Party leader Todor Zhivkov would have to decide. The Head of State's passion for innovation and technical progress often helped overcome administrative resistance in Communist Bulgaria, but this enthusiasm was not always enough.

Regarding nuclear power, former Vice-Minister of Electrification, Oved Tadzher remembers that his Ministry of Electrification officials were not convinced that Bulgaria was ready to operate a nuclear power plant. According to Tadzher, these officials considered the nuclear plant too expensive and too sophisticated for Bulgaria's existing technological capabilities. Accordingly the Minister of Electrification, Konstantin Popov, and the Vice-Chair of the Council of Ministers, Tano Tzolov, attempted to convince Todor Zhivkov and other Politburo officials to delay a decision on Kozloduy.

Opponents of Bulgarian nuclear power referred to the achievements in conventional electricity supply during the second half of the 1960s. Firstly, vast investments had been made in thermal power plants since 1964. New power plants were projected and established based on local coal resources, such as "Maritza-East III", and imported Ukrainian coal, such as the "Varna" plant. In addition, the 440 kV transmission line from the Soviet Union had been decided. These projects seemed sufficient to meet Bulgaria's electricity need for the time being. By the late 1960s, electricity sector leaders and thermal power engineers competed for the final word from the Communist Party leadership with a younger nuclear educational, scientific, and engineering community. The latter had ascended to high positions in Party structures but was still a relatively young group.

In retrospect, the crucial moment of choice was the Party plenum of November 25 and 26, 1969. The meeting attendees discussed a wide range of issues relating to electricity requirements. Experts presented estimates of future needs, talked about the use of domestic energy sources like lignite and water, and the search for new fossil fuel deposits. They also considered future relationships with the Soviet Union and the import of Soviet petroleum, petroleum products, natural gas, coals, and electricity. However, the gap between electricity production and the projection of future needs made the plenum participants decide in favor of building a nuclear plant. The plenum decision read as follows: “A concrete program shall be elaborated for the construction of the first nuclear power plant near the town of Kozloduy as well as the research, project design and construction of nuclear power plants up to 1980.”[40]

Communist leaders at the plenum decided that: “The first nuclear power plant shall be of the highest technological quality and shall correspond to the new phase in the development of the energy industry of the country”. In addition they declared that the plant should be “a school where highly qualified professionals gain experience in project design, construction, and exploitation of nuclear power plants”. It was also decided that the two reactors would start up in 1974 and 1975. The plenum participants decided that by 1980, nuclear energy would make up 50 percent of Bulgaria’s electricity production. They also planned to start the necessary research for the storage and reuse of nuclear waste.[41]

The plenum’s final decision to build a nuclear power plant, however, had been pre-made. Before the November plenum, two promoters of the nuclear option, Oved Tadzher and Pencho Kubadinski, had taken the key plenum decision in advance. Tadzher represented the economic nomeklatura and was one of the best known construction engineers in Communist Bulgaria; later the Politburo chose him to establish the nuclear plant. Pencho Kubadinski was one of the most influential Politburo members with direct access to Todor Zhivkov; he was part of the political nomenklatura and Minister of Construction Works. According to Tadzher’s memoirs, he and Kubadinski made an attempt to influence the decision-making processa month before the plenum meeting. On October 14, 1969, they staged the first dig for the Kozloduy nuclear plant. This event was only made known in narrow official circles; Tadzher and Kubadinski were top-level participants and their presence signaled high level support. At the plenum a month later,

[40] Zhivko Zhivkov, Directions for Energy Development and Perfecting Heat-energy Balance of Peoples Republic of Bulgaria. Report in Front of Plenum of the Central Committee of the Bulgarian Communist Party Conducted on 25-26 November 1969. Resolution of the Plenum (sofia: bulgarian Communist Party Press, 1969): 91-92.
[41] Ibid, 91-92

they presented the first dig as a *fait accompli*: they suggested firmly that construction had already begun, effectively inviting participants to approve a project which was already underway.

In early 1974, Bulgarian specialists trained in the USSR were on the construction platform and performed the preliminary testing of the reactor body, the so-called *obkatka*. The first nuclear fission reaction in the Kozloduy plant was set in motion by a joint Bulgarian–Soviet team on June 29, 1974. On the Bulgarian side, the engineers on duty were Zahary Boiadjiev, Dianko Dobrev, Milka Lukanova, and Georgy Aleksandrov. The Russians were Viktor Smutnev, Viktor Sveshtnikov, and Walerii Baritkin. As this only required a certain number of people it was decided thatthe team of Bulgarian specialists would actually start the reactor, while the Soviet team would have a controlling and observing role. It is clear that the young Bulgarian specialists had a lot of respect for their Soviet supervisors; they amply praised Soviet professionalism and said they learned very much from it.

The second reactor at the Kozloduy plant went critical a year after the first one, giving a combined capacity of 880 megawatts. During the official opening of the second reactor on March 27, 1976, two more reactor bodies with equal capacity were under construction. According to the plenum's plan, these were due to start in 1978 and 1979.

New assements of safety and risk, which appeared in mid-1970s, also affected the expansion of Bulgarian nuclear plants. This was heightened on March 4 1977 when an earthquake with its epicentre in the Vrancea Mountains, Romania, interrupted the construction of Kozloduy's third and fourth reactors. The earthquake had a magnitude of 7.2 on the Richter scale and inflicted serious damage in the region. In the town of Svishtov near Kozloduy, two apartment blocks collapsed and over a hundred people died.[42] This accident underscored the seismic vulnerability of the region and raised a call for political measures to avoid future disasters.

In the Kozloduy nuclear power plant itself, the operator on duty had stopped one of the operational reactor units, whereas the other continued to operate until morning. The earthquake moved part of the main equipment but did not directly affect its functioning. The shifted equipment did create the theoretical danger of nuclear fallout from water escaping the first loop,

[42] Hristov, Ivaylo, *The communist nuclear era,* 133

but in practice the construction of the plant had prevented this: the Soviet "internal safety rule" of thirty percent over dimensioning of the steel reactor body proved its value, and Bulgarian experts continued to trust this rule.

In response to the 1977 earthquake, the Bulgarian authorities postponed the launch of the two additional reactorsand demanded additional safety measures. They presented the key features a few years later at a special conference in Dubrovnik, Yugoslavia. The topic of the conference was "Problems in the creation of nuclear plants resistant to seismic activity". Over a hundred representatives from Bulgaria, Hungary, Czechoslovakia, East Germany, Poland, Romania, Yugoslavia, the USSR, and Interatomenergo participated. The Bulgarian specialists explained that they had set out to determine the maximum strength of potential earthquakes in the region, which was calculated to be seven degrees on the Medvedev—Sponheuer—Karnik scale with the probability of occurrence of once in 10,000 years.[43]

With the help of Soviet colleagues, they had then defined a set of measures to enhance the seismic resistance of the third Kozloduy block, which they intended to apply to the other blocks as well. These included fixing the body of the reactor to the construction frame, additional metal constructions for the volume compensator, and four fifty-ton hydro shock absorbers for the steam generators. The main circulation pumps were reinforced with another three hydro shock absorbers of twenty-five tons. The main stopping sliding rules were reinforced with two hydro shock absorbers of twenty tons, and the main pipelines were reinforced. After consultation with specialists from the USSR, the Bulgarian government had decided to buy the hydro shock absorbers from Japan. The purchase of hydro shock absorbers from Japan, with Soviet approval, opened the door for additional improvements to the nuclear power plant through trade with non-Communist countries. Thus the Bulgarian government bought Sempel valves from West Germany that were installed on the 440 MW reactor blocks, and it ordered additional ball cleaning systems to cleanse the condensers. Another important improvement after the earthquake was the installation of an automatic shutdown system; no such system had previously existed for the first two reactors.

[43] Ibid., 133

Finally the Bulgarian delegation presented a report on the psychological stress on workers during an earthquake. This report provided suggestions on how to prepare workers, and how authorities should react in the event of an earthquake.

The delay in the construction of the third and fourth reactors reveals the willingness of the Bulgarian nuclear specialists and the Communist government to improve the overall construction of the nuclear power plant. They invested massively in devices to improve its safe exploitation. In addition, the country intensified its participation in international forums on nuclear safety. At these meetings Bulgarian officials shared their experiences and acquired new knowledge about potential safety measures. However, regardless of the many improvements, the Kozloduy reactors continued to work with one flaw in Western eyes: they lacked the additional concrete containment of Western nuclear plants.

Event 2	**Bulgarian nuclear power plant and the earthquake in Vrancea mountain**
Who was involved - potential actors	Bulgarian Academy of Science, Bulgarian design bureau – Energoproekt, Soviet state company – Toploelektroproekt, Bulgarian Government, vice minister Oved Tadjer, Communist Party Leader Todor Zhivkov
When and where did it take place?	1974 and 1977, near Kozloduy
What type of process was it (communication, consultation or participation)? How did this change over time? Please state process type, then describe in detail.	**Communication and participation**. Second step of establishing the Bulgarian nuclear program. The first two reactors were completed- VVER – 440's. This was a process of communication and participation by various factions of Bulgarian government and nomenklatura. After the Vrancea earthquake Bulgarian authorities undertook steps to improve safety of the reactors. Requirements for new shock absorber devices, also opened paths for importing technologies from the Western bloc.
What rationale was given by the party that implemented the engagement (if any)?	The Bulgarian Communist Party announced the project as the most significant achievement in the state. Both the Bulgarian and Russian Communist Parties also described it as Communist brotherhood in action.

3.3. Event 3: Reaction of the green movement to the Chernobyl accident – ECOGLASNOST against Bulgarian nuclear program and the research reactor – 1989-1990

On 26 of April 1986, when the serious accident happened at the Ukrainian nuclear power plant of Chernobyl, the Bulgarian Ccommunist government did not inform the population. The national media remained silent, saying only that therewas no serious danger after the accident. This was the second world government, which misinformed the people. The first one was the Soviet. Bulgarian Communists towed the Soviet party line and were just too loyal to the Russians to tell the Bulgarian public the truth. Only people close to the party nomenklatura knew the seriousness of the situation and ordered special supplies, clean from radiation pollution, for themselves, and their families. Aside from those close to the party, on the armed forces were routinely given special supplies by officials.

Along with these inadequate activities, Communist leaders, continue their plans for extending nuclear power plants and nuclear power production. In Bulgaria Kozloduy's new VVER-1000 reactors began operating in 1987 and 1991 respectively. The technology transfer process was not influenced by Chernobylandthe government continued to prepare a second nuclear plant near the town of Belene.

Three years later, atthe end of 1989 Bulgarian communist regime collapsed. The green organization - Ecoglasnost, had been a catalyst which opened the door for political and social change. Activists in Ecoglasnost demanded information about environmental pollution caused by big technological projects and by Chernobyl. At the time of the accident, Bulgaria had five operational Soviet nuclear reactors, four VVER's with a 440MW capacity and one newer generation VVER with a capacity of 1000MW. The country also was buying nuclear fuel for these reactors and returned spent fuel and waste to the Soviet Union, where it was used by the military.

However, the Bulgarian public awakening happened in late 1987, when a short documentary environmental movie by the journalist Jurii Zhirov was aired by the national television service. However, this movie was not about Chernobyl or other nuclear issues. It was about regular gas and sulphur pollution coming from a Romanian factory across the Danube River. The town of Rousse on the Bulgarian shore received regular doses of sulphur but this problem was initially a matter of debate only at a high level in the party. In March 1988, in Rousse, a civil society committee for environmental protection of the city was founded. From this moment onward, environmental problems became matter of public discussions and forums in otherwise closed totalitarian society.

Founders of the Ecoglasnost movement were intellectuals and activists from Sofia, including actors, philosophers and university lecturers. In March 1989, Ecoglasnost activists tried to meet in a public space, but militia (police) blocked the place. Officially the organization was founded on 11 of April, in a private apartment by just 19 people and two days later, organizers submitted documents to the regional court of Sofia to register the organization. Just five days after this the group sent an official inquiry to all the state institutions about the origin and place of all toxic materials on Bulgarian territory.

During all of this short period, less than one year, Ecoglasnot kept its main themes and demands for environmental protection and information. One of the main questions remained the consequences of Chernobyl. At a meeting o 20th of October 1989 members of Ecoglasnost presented the truth about Chernobyl and its consequences. A report about the criminal behaviour of the Ccommunist ruling elite shed light on the how the state and the media had misled the public.[44] One of the themes was named the Future without Atom; it provoked a discussion about the real state of Bulgarian nuclear power plants at Kozloduy and Belene.

Event 3	**Reaction of the green movement to the Chernobyl accident – ECOGLASNOST against Bulgarian nuclear program, the experimental reactor and the new project of Belene NPP – 1989-1990**
Who was involved - potential actors	Bulgarian green movemet Ecoglasnot, Communist Party and the leader Todor Zhivkov, Socialist party and the GERB Party
When and where did it take place?	1989, 1991 In Sofia

[44] Aleksandrieva, Liliana and Aleksandar Karakachanov, *Independent Society of Ecoglasnost 1989*

What type of process was it (communication, consultation or participation)? How did this change over time? Please state process type, then describe in detail.	**Communication** It was the first free public reaction related to nuclear power program. This began in 1989 as a spontaneous reaction to environmental problems. The next step was the closing down of the experimental reactor near Sofia, and construction of the Belene NPP. It caused also foreign (G7) reaction against the reactors in Kozloduy.
What rationale was given by the party that implemented the engagement (if any)?	Bulgarian green activists protested against the inadequate measures of the Communist party in the days after Chernobyl and the lack of any information provided to the public. This led to protests against nuclear facilities in the state.

3.4. Event 4: Initial negotiations and contract with the European Union for membership, which included decommissioning of reactor bodies 1, 2, 3, 4 at Kozloduy NPP – 1993 – 2004

Disputes about Bulgaria's reactors began in 1993 when the European Bank for Reconstruction and Development (EBRD) proposed that Bulgaria stop, and decommission the four reactors at Kozloduy. The main argument for this was to ensure more safety for Europe. Bulgarian specialists and experts believed that the reactors were safe and defended the technical and safety characteristics of the reactors.

From 2nd to 4th of June 1993 the Vice Chair of the Committee for Peaceful Uses of Nuclear Energy, Nikita Shevarshidze, negotiated for a 24.5 million ECU loan from the EBRD's Nuclear Safety fund. Whilst the EBRD insited that the 24.5 million ECU loan, should be used to stop reactors 1 and 2 at Kozloduy by 1996, Bulgaria's "Energy Charter 93" had envisaged that the reactors would continue to operate until 1998.

After long negotiation the Bulgarian state agreed to link its energy balance to other duplicating power sources between 1993 and 1998. The fate of reactors 3 and 4 remained dependent on the condition of modernizing one of the biggest reactors, 5 or 6. The Director of Kozloduy NPP Kozma Kozmov commented that the plant produced electricity equal to 24 million ECU in only 20 days and that such an agreement would harm the Bulgarian economy. With this agreement

Bulgarian authorities postponed the negotiations on the other reactors for five years – until 1998.

In the beginning of December 1999, Bulgarian Prime Minister Ivan Kostov and the European Commissioner for Enlargement Günter Verheugen had a meeting to decide on Bulgaria's candidature for the European Union. One of the main topics of this meeting was the fate of the Bulgarian nuclear program and particularly its four old reactors. The European Union's argument remained the same; that Bulgaria must accept dates to decommission its remaining reactors in order to join the EU. After pressure from Verheugen, Kostov agreed to stop the first two reactors, which were the oldest, in 2003, just one year before the envisaged date by the Bulgarian energy strategy. Meanwhile, the second pair of reactors would stop in 2006, three to four years before their planned decommissioning. For the Bulgarian Socialist Party, the question was why Bulgarian reactors had to be decommissioned as a condition for acceptance, while Slovakian and Lithuanian politicians used nuclear facilities as strategic objects in the same type of negotiations.

As part of the agreement, the Bulgarian Prime Minister stipulated that the European Commission dropped a requirement for Bulgarian citizens to obtain visas. The visa requirement had been controversial, and he perhaps hoped that dropping the visa requirement would quell anynegative reaction to the closure of Kozloduy. This was purely political decision without announcement to the journalists and media, the memorandum was already signed when it became generally known.

After this agreement had been signed the sociological research agency MBMD conducted research examining the population's responses to potential EU membership. A large percentage of the population were for the joining the Union, 33.8% fully positive and 37.7 predominantly positive, 8.2% were slightly against and only 4.1% strongly against (16.7% had no answer).[45] To the question: "To what extent you agree with the statement: Membership in EU needs sacrifices and privations now, but its worth for the future?" 23.9% fully agreed, 34.7 rather agreed, 15.8 rather disagreed, 11.4% totally disagreed, and 14.2% had no answer. In this period Bulgarian

[45] Newspaper "24 hours", "80% believe: In 10 years we are in the EU", 13 December 1999

society sawmembership of the EU as a greater opportunity than keeping the nuclear industry at its former scale.

In this 10 year period the issue of nuclear fuel delivery and the treatment of spent fuel became more problematic. Until 1999 when the preliminary agreement for joining the EU was signed, spent fuel was exported to Russia. After Bulgaria became a member of the EU the EBRD established a special fund for decommissioning the old reactors and to establish storage for spent fuel. Bulgaria already possessed facilities for temporary storage of the spent nuclear fuel before it was exported to Russia. In 2001 the Chair of the State Committee for Energy, Milko Kovachev, discussed the possibility of purchasing fuel from the British company BNFL. However, it was not proven that the fuel was compatible with Russian technology.

Following the agreement with the EU Bulgaria decommissioned its old reactors and became a full member of the EU in 2007. Three years before that in 2004 Bulgarian authorities established "The State Enterprise Radioactive Waste" (ST RAW) company to be responsible for nuclear waste. Until then spent nuclear fuel had not been defined as radioactive waste according to existing Bulgarian legislation, as it was a matter of agreement between Bulgaria and Russia. ST RAW became responsible for The Permanent Repository for Radioactive Waste (PRRAW), which is situated near the village of Novi Han, and had been established in the late 1950s to store radioactive wast from from the application of radioactive sources in medicine – for diagnostics and treatment, as well as in industry, science and education.

The Specialized Division Radioactive Waste – Kozloduy (SDRAW Kozloduy) operates within Kozloduy NPP., and collects, sorts, transports, processes, and stores radioactive waste generated from the operation and maintenance of the power plant units.

On October 18, 2010, the enterprise was granted also licenses for operation of Kozloduy NPP Units 1 and 2 as facilities for radioactive waste management.

The solid radioactive waste is generated as a result of the maintenance and repairs of the NPP facilities. They are parts of dismantled equipment, reinforcement, filters, tools, special clothing for work in the controlled area, construction waste, etc. The liquid radioactive waste is in the form of water solutions, suspensions, concentrates, and oils. A considerable amount of radioactive waste is expected to be generated during the process of decommissioning the Kozloduy NPP units.

On November 21, 2012, the Council of Ministers declared Units 3 and 4 of Kozloduy NPP as installations for management of radioactive waste and entrusted their management to State Enterprise Radioactive Waste through SDRAW Kozloduy.

Event 4	**Initial negotiations and contract with the European Union for membership, which included decommissioning of reactor bodies 1,2,3,4 at Kozloduy NPP – 1993 – 2004**
Who was involved - potential actors	Bulgarian parties – SDS, NDSV, Socialist Party, Prime Minister Ivan Kostov, Vice-Chair of the Committee for Peaceful Uses of Nuclear Energy, Nikita Shevarshidze, European Commissioner for Enlargement Günter Verheugen, Establishment of State Enterprise – Radioactive Waste.
When and where did it take place?	1993- 1997- 2003 In Sofia
What type of process was it (communication, consultation or participation)? How did this change over time? Please state process type, then describe in detail.	**Communication** Negotiations about the future of the Bulgarian nuclear program in relation to its foreign policy. The European Commission's insistence that older reactors were decommissioned became tied to Bulgaria's potential membership fo the EU. Political parties in Bulgaria periodically raised the question of the reactors.
What rationale was given by the party that implemented the engagement (if any)?	On one hand the Bulgarian Socialist Party wanted to keep all of the reactors operational, arguing that they were safe and profitable. On the other hand Bulgarian democrats and pro-EU parties and officials were willing to compromise arguing that EU membership would be better for the country than keeping the plants open.

3.5. Event 5: Referendum for constructing new atomic power plant in Bulgaria – 2013

Discussions about a national referendum related to nuclear energy started in 2000, when a significant group of professors and intellectuals established a "Civil Committee for the defence of Kozloduy NPP". The chair of this Committee was Doctor Stefan Vodenicharov. This Committee aimed to engage the public with the debate over the safety of the first four reactors and to renegotiate their fate. In fact this Committee served the interests of the Socialist Party, which represented the old political regime. These activists tried to collect over 500 000 ginatures in order to have the referendum.

In addition to these initiatives, on 9th of September 2003 the Bulgarian administrative court reversed the government's decision to the stop reactors 3 and 4. The main argument is that the parliament has not approved this clause of the contract with the European Union and the Government has acted against the constitution. Representatives of the ruling party the NDSV, and the ministers Solomon Pasi and Meglena Kuneva, answered that the Bulgarian administrative court did not have the authority to overturn a decision of foreign policy. Thus in 2006 nuclear reactors 3 and 4 also stopped working permanently.

After 2007, Bulgarian parliament continued discussing the future of nuclear energy as the main supporting group for having new reactors was again the Socialist Party. The first national referendum after 1989 on building a new nuclear power plant was held in Bulgaria on 27 January 2013. Whilst it was not explicitly mentioned in the question, it was widely acknowledged that the referendum was about restarting construction at the Belene NPP.

The referendum resulted from a petition organized by the opposition Bulgarian Socialist Party after in March 2012 the center-right government of Prime Minister Boyko Borisov and the GERB party terminated the project for the construction of a second Bulgarian nuclear power plant – located in the Danue town of Belene – by Russian state company Atomstroyexport, subsidiary of Rosatom, with a capacity of 2000 MW. The Socialists got the referendum through after some 770 000 Bulgarians signed their petition, with 500 000 signatures needed to make a referendum petition binding.

Supporters of the plant argued that it would mean the country would not have to buy electricity from Romania and Turkey, whilst opponents claimed that it would increase the country's energy dependence on Russia as the Russian firm Atomstroyexport had been contracted to build the plant.

Bulgaria's Central Electoral Commission registered four initiative committees for the informational campaign for the referendum. Only the one of the Socialist parties campaigned in favor of a second NPP, and more specifically – the Belene NPP. It was headed by Prof. Stefan

Vodenicharov, the newly elected chair of the Bulgarian Academy of Sciences. The ruling GERB's committee initially also intended to campaign in favor they had altered the referendum question to omit Belene NPP. Subsequently, however, Prime Minister Boyko Borisov changed his mind, and urged GERB voters to vote with "no" because the referendum question referred to Belene, and GERB was against restarting the project. Two other committees of smaller parties – Democrats for Strong Bulgaria and the United People's Party – also campaigned against a second NPP. The referendum required a turnout of at least 60% for the result to be binding. Voters were asked "Should nuclear energy be developed in Bulgaria through the construction of a new nuclear power plant?". Although the proposal was approved in all 31 electoral divisions, turnout did not pass the required 60% threshold, resulting in the referendum becoming non-binding. As such there has been no indication that the government will restartthe NPP project at Belene or initiate another one. Although nuclear industry experts speak about the option of establishing the 7th reactor at Kozloduy NPP, this has not been made formal policy of any major party.

4. Facts & Figures

The purpose of this section is to give an overview of nuclear power in Bulgaria. This section contains such data as number of reactors, reactors' locations, technical and chronological details of reactors' construction as well as statistics on electricity production, periodization and social connections to nuclear constructions. This data can be used as a supportive material to the following sections of the country report and in order to understand the overall country's situation. Key dates and abbreviations used in this report are presented in the beginning of this section.

4.1. Key dates and abbreviations

Key dates:

1945 Opening of the nuclear physics department at the University of Sofia

1949 Joining COMECON (CMEA)

1955 Soviet Union Agreement for mutual assistance in developing nuclear energy

1957	Joining the IAEA
1957	Establishing the Bulgarian Committee for Peaceful Uses of Nuclear Energy as part of the Council of the Ministries
1962	Start of the nuclear experimental reactor IRT-1000 near Sofia
1966	Agreement with the Soviet Union for building nuclear power plant based on two WWER – 440 MW reactors
1969	Construction of Kozloduy NPP begins
1973	Soviet Union Agreement for building two more reactors at Kozloduy NPP
1974	Commissioning of the first VVER – 440
1975	Commissioning of the second VVER – 440
1977	Vrancea earthquake: construction of of reactors III and IV isdelayed. Japanese and West German anti-seismic technology is employed as a result.
1980	Connection of the third VVER – 440 to the grid
1982	Connection of the fourth VVER – 440 to the grid
1980	Agreement with the Soviet Union for assistance in building two more reactors with capacity of 1000 MW each.
1982	Agreement with the Soviet Union for building second nuclear power plant Belene
1987	Commissioning of the first VVER – 1000 at Kozloduy
1991	Commissioning of the second VVER – 1000 at Kozloduy
1991	Civil movement against the beginning of the second NPP at Belene as part of “Green movement” (Ecoglastnost), established since 1988; Bulgarian Government decision to stop construction works.
1999	Pre-Agreement with EU for decommissioning of the small reactors 1–4 at Kozloduy
2001	Bulgarian Government relaunches construction work at NPP Belene
2002	Transformation of the Bulgarian Committee for Peaceful Uses of Nuclear Energy into the Nuclear Regulatory Agency
2002	Final agreement for joining the EU after decommissioning the small units
2003	Nuclear reactors 1–2 stopped
2006	Nuclear reactors 3–4 stopped, December 31
2007	Bulgaria becomes full member of EU, January 1

2011	Government decision to terminate Belene NPP
2013	The first national referendum about the future of nuclear power

Abbreviations:

COMECON (CMEA)	Council for mutual economy assistance
BCP	Bulgarian communist party
BCPUNE	Bulgarian Committee for Peaceful Uses of Nuclear Energy
BSP	Bulgarian Socialist Party (former Bulgarian communist party)
GERB	Citizens for European Development of Bulgaria
IAEA	International Atomic Energy Agency
NEK	National Electricity Company
NPP	Nuclear power plant
NRA	Nuclear regulatory agency
NDSV	The National Movement for Stability and Progress
PWR	Pressurized water reactor
SDS	The Union of Democratic Forces
SE RAW	State Enterprise Radioactive waste
WWER	Water-Water energy reactor (Водо-водний енергетически реактор)

4.2. List of reactors and technical, chronological details

Table below shows the list of reactors, suppliers, operators as well as date details.

Table 1 – Capacity and closure of the small reactors and Kozloduy NPP

Unit	Type of reactor and capacity, MW	Year of connection to the grid	Closure of units	Current fuel campaign	Electricity generated for the period, MWh
Unit 1	VVER-440	1974	31.12.2002	23	66 675 397
Unit 2	VVER-440	1975	31.12.2002	24	68 905 334
Unit 3	VVER-440	1980	31.12.2006	22	68 703 260
Unit 4	VVER-440	1982	31.12.2006	21	66 711 966

Table 2 – Projected and established reactors in Bulgaria up to 2011

Name	Type	Status	Location	Capacity (MWe)		Date connected
				Net	Gross	
BELENE – 1	PWR	Under construction		953	1000	Construction frozen
BELENE – 2	PWR	Under construction		953	1000	Construction frozen
KOZLODUY – 1	PWR	Permanent shutdown	Kozloduy	408	440	1974/07/24
KOZLODUY – 2	PWR	Permanent shutdown	Kozloduy	408	440	1975/08/24
KOZLODUY – 3	PWR	Permanent shutdown	Kozloduy	408	440	1980/12/17
KOZLODUY – 4	PWR	Permanent shutdown	Kozloduy	408	440	1982/05/17
KOZLODUY – 5	PWR	Operational	Kozloduy	953	1000	1987/11/29
KOZLODUY – 6	PWR	Operational	Kozloduy	953	1000	1991/08/02

Source: International Atomic Energy Agency, 2011, PRIS database, http://www.iaea.org/programmes/a2/

Electricity production share of Kozloduy NPP:

– in green: total production of electricity in Bulgaria in Terawatt/hour (millions Megawatt/hour)

– in blue: share of electricity, produced by Kozloduy NPP

4.3. Periodization

First period 1945–1974: Establishment and development of Bulgarian nuclear physics with its institutional structures and experimental facilities - main actors and organizations, experimental reactor IRT-2000. Agreements with COMECON and USSR for assistance in developing nuclear energy. Communist party debates and final decision of the party leader for constructing the nuclear plant.

Second period 1974–1986: Beginning of the construction of the first nuclear power plant. Commissioning reactors 1–4 at Kozloduy with a capacity of 440MW. Vrancea earthquake and redefinition of safety standards and opens paths for importing innovations from Western countries. Bulgarian-Soviet agreements for construction of second NPP - town of Belene at Danube river.

Third period 1986–1994: Chernobyl and the Bulgarian nuclear community. The reaction of the Bulgarian Communist Party and prevention measures. Construction begins on reactors - 5 and 6 with a capacity 1000MW each. November 1989 - political changes in the country, rise of antinuclear movements after revelations of Communist Government misconduct after Chernobyl accident. Closure of the experimental reactor IRT 2000 and stopping the construction of NPP Belene. Safety check on reactor body 1 at Kozloduy NPP, initiated by IAEA.

Fourth period 1994–2007: Political instability in the country and the controversial decision for decommissioning the small reactors at Kozloduy NPP under political pressure from the EU. In 1999 democratic government negotiated extension of the working period for these reactors up to 2003 for reactors 1 and 2 and up to 2008-2009 for reactors3 and 4. The government signs a final agreement with EU for the closure of reactors 1 and 2 in 2003 and of reactors 3 and 4 in December 2006, just on the eve of Bulgaria’s membership of the EU.

4.4. Results of Bulgarian Public Opinion Survey on the use of Nuclear Energy (March 2011, Alpha Research Agency)

"After the events in Fukushima, Japan, do you think Bulgaria should build new nuclear reactors?"

	%
✔ Yes	**50.9%**
✘ No	**45.2%**
No opinion	**3.9%**

"If you are in position to decide, instead of the Bulgarian Government, what would you prefer?"

	%
Building two reactors at Belene NPP	**24%**
Building one more reactor at Kozloduy NPP	**44%**
Not building reactors at all	**32%**

4.5. Results of Bulgarian referendum about the establishment of a new nuclear power plant

Bulgarian nuclear power referendum, 2013

"Should nuclear energy be developed in Bulgaria through the construction of a new nuclear power plant?"

	Votes	%
✓ Yes	**851,757**	**61.49%**
✗ No	**533,526**	**38.51%**
Valid votes	**1,385,283**	**98.56%**
Invalid or blank votes	**20,180**	**1.44%**
Total votes	**1,405,463**	**100.00%**
Registered voters/turnout		**20.22%**

Table 1 Results of Bulgarian referendum about the establishment a new nuclear power plant

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5. References

A brief description of methods for archival research and analysis of literature for the period 1945 – 1986

In the cases of the Eastern European socialist states there was no option for private or public involvements into the nuclear power debates. However, the socialist system had many political actors inside the administrative system who made nuclear power field stage for big debates and fights. At first glimpse the picture for announcing nuclear programs might look like a total Soviet dominance for colonizing the Eastern European technological space, but if we go deeper into the details we could see many tensions and contradictions. The examination of a single nation state case is probably the most appropriate way for revealing these issues. For this reason it is also a good strategy to study the activities of COMECON and other international organizations. An appropriate source we decided to focus on 1) the Bulgarian Central state archive and 2) the Archive of the Bulgarian Ministry of foreign affairs. The work will be carry out in the coming months by Ivaylo Hristov with possible assistance by junior researcher.

These two archives are the first step for searching the Bulgarian activities in the field of nuclear development and their relation to COMECON and the Soviet Union. The aim is to reveal how the Bulgarian case emerges as creation of a kind of 'socialist nuclear network'. The funds in the Central state archive are especially useful for this process. There are three main catalogues that contain useful information. The first one is the fund on COMECON possessing more than five thousand archival files related to all of the organizational activities. Significant part of the COMECON activities is preserved both in Russian or Bulgarian. There are two other funds available there: the first one contains files from the Bulgarian nuclear regulatory body, i.e. 'The Committee for Peaceful Usage of Atomic Energy' (CPUAE) that was internationally recognized and connected to the other agencies. The activities of this organization show how particularly the nuclear network in Eastern Europe worked; the second fund is the Ministry of electrification. In this source is the information of Bulgarian nuclear program Development during the socialist governance. This archival fund, simultaneously with the specialized Bulgarian journal Energy, serves as a main tool for establishing good picture on the national level.

The second research step is to analyze how Bulgaria communicated with the transnational organizations in the field of nuclear power. Thus we need to involve the activities of the International Atomic Energy Agency (IAEA). This organization had rich interactions with CPUAE and the Bulgarian Ministry of foreign Affairs. For this reason will examine the archive of the ministry and especially its fund "International relations and contracts". Simultaneously with this fund the plan is to use as secondary source the bulletin of IAEA, which was published regularly since the establishment of the organization.

The third research step is to analyze the covering the development of nuclear power in Bulgaria and (Eastern) Europe is the published literature. Primarily such was represented by publications in Russian that include propaganda literature and technical description of the nuclear power plants produced in USSR. Through these sources we will examine the Soviet perspective on what had been achieved in the Socialist bloc. Such literature however has its limitations as it is too positivist. During the Cold war period every successful achievement was largely propagandized in the media and literature. The ideological, political and technological failures were concealed. The Bulgarian publications in the field are in the same positivist style. Still they contain many valuable details on technical and organizational work in the nuclear sphere.

A brief description the media research for the period 1986-2007

Aiming at better identification of the key actors and their role in development of nuclear power in Bulgaria, public attitudes towards nuclear power and key issues in this area that attracted public attention, the Bulgarian team of HoNESt project decided to carry out media analysis during the period between Chernobyl accident (1986) and closing the four 440 MW nuclear reactors at Kozloduy NPP in 2007 in accordance with the 2004 treaty for the Bulgaria's acceptance in EU. The analysis is based on the methodology, already applied by the team members in studying transformation of Bulgarian power industry after 1989 (overview of the study available at http://ivantchalakov.weebly.com/uploads/6/8/7/1/6871680/summary_black_holes_of_bulgarian_power_industry_2011.pdf)

This analysis includes two weeklies - *Capital* newspaper and *168 hours* newspaper, and two political daily newspapers – Communist (later Socialist) Party official *Workers' Daily* (Rabotnichesko delo), renamed after 1989 to *Duma* (Word) and *Democracy,* that after 1989 became an official newspaper of Bulgarian Democratic opposition. Additionally we decided to analyze publications in *Trud* newspaper. The idea is to "catch" two serious independent analytical weekly with relatively opposite positions and policies as well as two dailies with strong policy orientation. The latter were examined in the periods in which their parties were in opposition - respectively *Workers' Dcaily/Word* newspaper (1987-2005) and *Democracy* newspaper (1990-2003). Newspaper *Trud* was elected as a relatively neutral daily, until 1989 organ of the mainstream syndicate unions, and then in 1990 evolving as a newspaper for a mass audience, controlled indirectly by the Bulgarian communist political nomenclature.

Based on key (landmark) events, there are three periods, covered by the survey of the media:

1. The period from the Chernobyl accident in the spring of 1986 to political transition in late

1989 and early 1990;

2. The period of the fall of the first communist government of Andrey Lukanov in 1990 to the end of 1999, when democratic government of Ivan Kostov signed preliminary agreement with the EU;
3. The period between initial negotiations with the EU 1999 to the Bulgarian official entry into the EU at January 1, 2007.

The selection of articles is based on the following procedure: every second year is selected, and then we monitor every second number of the newspapers during that year in order to comprehensively track events in each of the above mentioned periods. We look for main points of conflict where important decisions were taken, but also the propaganda associated with the maintenance and development of nuclear power after the fall of the communist regime. However, we analyzed every number of the selected newspapers for the limited periods related with important events – such as Chernobyl accident, closure of Bulgarian second NPP in Belene, closure of 440 MW reactors in Kozloduy NPP, etc.

The key nuclear power issues targeted by the media analysis

The aim is to identify and follow the main streams (information, financial, legal, technological) and related and trails of strength, through which the transformation of atomic complex in the country have been carried out. Thus we formulate key topics, characterizing the development of nuclear energy in the period 1945-2007 and related with the HoNESt project objectives:

- Basic local actors (political parties and organizations, state and local institutions, companies, research institutions, supervisory bodies, NGOs and civil movements...);
- Public opinion about nuclear energy measured by: positive / negative tone of the articles; type до the described events (successes, achievements or critical situations and problems); "Expert" or "lightweight" papers and comments, lower level of popular writing about nuclear energy, or whether trying to educate the audience back or deliberately kept in the dark; medical and environmental effects of nuclear energy;
- Nuclear technology - science, innovation, economy, import of technology, personnel
- Uranium – extraction, processing, use, spent uranium and level of technological development;

- Security of nuclear energy compared with other energy technologies;
- The link between nuclear energy and nuclear weapons;
- Local communities in the atomic towns of – Kozloduy, Belene, Svishtov, Novi Han.

Archival materials

Bulgarian central state archive

Фонд 136: Министерски съвет (Fund 136: Ministry council).

Опис 49: 1969. (Inventory 49: 1969).

A.e. 143: *Сключване на спогодба с Чехия за използване на атомната енергия*, 15. 05. 1969. (File 143: *Agreement with Czechoslovakia for using nuclear energy*, 15. 05.1969).

A.e. 260, *Започване строителството на АЕЦ Козлодуй*, 14.08. 1969. (File 260, *Starting the establishment of Kozloduy NPP*, 14.08. 1969).

Опис 51: 1970. (Inventory 51: 1970).

A.e 263: *Одобряване спогодба за електропровод с Румъния*, 29.04. 1970. (File 263, *Approving the agreement for transmission line with Romania*, 29.04. 1970).

A.e 272: *Изграждането на АЕЦ Козлодуй*, 03.07.1970. (File 272:*Building Kozloduy NPP* 03.07. 1970).

A.e . 395: *Спогодба за свързване на електроенергийните системи на НРБ и Турция*, 04.09 1970. (File 395: *Agreement for connecting power grids of Bulgaria and Turkey*, 04.09 1970).

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Опис 1. (Inventory1).

A.e. 1522: *Второ заседание на Постоянната комисия за мирно използване на атомната енергия. Протокол № 2* (Москва, 1961) (File 1522: *Second Meeting of the Permanent Commission on the Peaceful Uses of Atomic Energy, Protocol 2* Moscow, 1961).

A.e. 1523: *Трето заседание на Постоянната комисия за мирно използване на атомната енергия. Протокол № 3* (Москва, 1961). (File 1523: *Third Meeting of the Permanent Commission on the Peaceful Uses of Atomic Energy, Protocol 3* Moscow, 1961).

А.е. 1524: *Доклад с изводи за работата на Постоянната комисия за мирно използване на атомната енергия през 1962 г. и задачи произтичащи от решенията на XVI сесия на СИВ* (Дубна, 1962). (File 1524: *Report about the Work of the Permanent Commission on the Peaceful Uses of Atomic Energy in 1962 and the Tasks from the XVI Session of CMEA.* Dubna,1962).

А.е. 1525: *Ръководството на Постоянната комисия за мирно използване на атомната енергия* (Москва, 1963). (File 1525: *The Leadership of the Permanent Commission on the Peaceful Uses of Atomic Energy* Moscow, 1963).

А.е. 1552: *Протокол от извънредното заседание на ръководителите на делегации за Постоянната комисия за мирно използване на атомната енергия* (Москва, 1969). (File 1552: *Protocol from the Unscheduled Meeting of the Delegation Cheerleaders of the Standing Commission on the Peaceful Uses of Atomic Energy.* Moscow, 1969).

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Dilian Petrov – Director of State Enterprise Radioactive Waste

Dimitar Tonev – Director of the Institute for nuclear research and nuclear energy

Ivaylo Hristoskov – Director of Nuclear technology and nuclear energy department at University of Sofia

Bogomil Manchev – Director of Risk engineering Ltd.

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Denmark

Short Country Report

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Executive summary

This report belongs to a collection of 20 short country reports on the History of Nuclear Energy and Society (HoNESt, project Ref.662268). The reports tackle the complex sociotechnical system around nuclear energy. Nuclear developments, notably nuclear energy, are closely intertwined with social, economic, environmental, political and cultural spheres. Nuclear energy is also a globalized system involving transnational transfers of knowledge, materials, technologies, people and products including electrical power, medical elements, spent fuel and other environmental hazards, materials, capacities and knowledge that must be carefully safeguarded. Nuclear energy is a complex social and technological phenomenon that influences societies but is also shaped by societies.

The short country reports are designed to assemble information and research results on the history of the relations between nuclear energy and society about all the different country cases in an accessible manner, and to document the findings with references. The purpose of the country reports is threefold, addressing three different audiences: (1) to provide basic elements of narrative and analysis for further historical research by HoNESt researchers, (2) to provide information, context and background for further analysis for HoNESt's social science researchers, (3) to provide accessible information on nuclear-societal relations in the various countries for the purposes of outreach and communication with stakeholders (civil society, industry, associations, policy makers, journalists).

This report focuses on the history of the relations between nuclear energy and society in Denmark. Even though Denmark was home to one of the pioneers of nuclear research, Niels Bohr, the country never introduced commercial nuclear power. Until the early 1970s, Denmark's development conformed to the general path among developed countries. The Danes participated in the Atoms for Peace Campaign and attempted to develop their own reactor type. However, when most countries moved ahead with nuclear plans after the oil crisis, Denmark took a different route. The decision not to "go nuclear" was taken in three steps:

First, in 1974, the Danish government proved very open to civil society concerns, advanced notably by the newly founded Organisationen til Oplysning om Atomkraft (Organisation for Nuclear Information, OOA). The OOA demanded that the decision on nuclear power was to be taken by parliament, not simply by the relevant minister. They also called for postponing the decision, in order to allow for a public debate. The government accepted this and made public funds available for a “debate on energy” to civil society via the EnergiOplysningsUdvalget (Energy Information Committee).

Second, in the summer of 1976, the Social-democrat-led government further delayed the decision to licence nuclear power plants, for two reasons: internal divisions within the party, as a consequence of the intense public debates about nuclear power, and adverse public opinion due to the well-organised campaigns of the Danish anti-nuclear movement.

Third, in 1985, the Danish parliament decided to exclude nuclear power from future energy planning. Changing positions within the political parties, adverse public opinion, and concerns about nuclear waste disposal within Danish borders informed this decision. However, Danish civil society continued to engage with nuclear power outside of Denmark. The Swedish nuclear power plant Barsebäck – near Copenhagen – remained the target of annual marches. After Chernobyl, the OOA started a campaign against “radiating neighbours”, protesting against Swedish, West and even East German reactors. Most recently, public engagement with nuclear issues concerned nuclear waste from the research reactors and potential uranium mining in Greenland.

Three main analytical conclusions can be drawn, with a view to civil society and public debate, economy and democracy and the perception of nuclear power, and politics:

1. Civil society and public debate

A well-organised and non-confrontational anti-nuclear movement highlighted the risks and potential problems of nuclear power in a small country, and managed to have a strong presence in an open, publicly supported “debate on energy”, which influenced public opinion.

2. Economy and Democracy: Perceptions of nuclear power

In the public debate of the 1970s, critics represented nuclear energy as contradicting the small-scale economic structures of Denmark. They further argued that the long-lasting impact of nuclear materials affecting future generations tested the limits of democratic decision-making.

3. Politics mattered

Party politics and the divisions within parties and within the fragmented Danish party system mattered greatly for the political decision to reject nuclear power.

1. Narrative of the Historical Context

1.1. Introduction

Denmark was home to one of the great pioneers of nuclear research, Niels Bohr, whose lab played a pivotal role in nuclear fission research in the 1920s and 1930s. Bohr joined the United States Manhattan project during the Second World War (Nielsen et al. 1999, 64) and played an important role in the establishment of nuclear research in postwar Denmark, as influential chairman of the Atomic Energy Commission. Still, the country never moved towards the commercial use of nuclear power. Today nuclear power does not even feature as an option any more, and there is great ignorance about it among younger people (Nielsen 2016). Indeed, it is indicative of Danish society's engagement with nuclear power that in a recent overview of Danish environmental history, the chapter on energy did not even mention nuclear power. Only the anti-nuclear sun is presented in the section on "action" (Fritzbøger 2014, 17-20, 32).

Until the early 1970s, Denmark's development, focusing mostly on nuclear research, conformed to the general path that many developed countries followed. This included the participation in the Atoms for Peace Campaign, and the establishment of a state-funded nuclear research centre to develop its own national reactor type. However, when – as a response to the oil crisis – most countries moved ahead with their nuclear plans in the mid-1970s, Denmark took a different route. This is surprising, considering Denmark's extremely high dependence on imported oil, accounting for some 88 per cent of Denmark's total energy supply in 1970 (Jamison et al. 1990, 90).

The decision *not* to "go nuclear" was effectively taken in three steps:

The first step was taken in 1974, when the Danish government responded to the critique by the emerging anti-nuclear movement led by the Organisationen til Oplysning om Atomkraft (Organisation for Nuclear Information, OOA), founded in early 1974, to put the decision on nuclear power in the hands of parliament, and to delay the decision, in order to allow for a public debate on an issue, that – as OOA claimed – would entail grave societal consequences (Jamison et al. 1990, 99)

The second step was taken in the summer of 1976, the government led by the largely pro-nuclear Social Democrats under prime minister Anker Jørgensen decided to delay the decision to licence nuclear power plants. Two reasons motivated this decision: Against the backdrop of intense public debates about the consequences of building nuclear power plants, the Social Democratic party became increasingly divided over the issue. Moreover, the government was facing an adverse public opinion (Villaume 2012) in part due to the active campaigns of the Danish anti-nuclear movement, led by the well-organised OOA (Mez and Ollrogge 1979/1981, Section 3.5). Concerns about the storage of nuclear waste also played a role.

Almost a decade later, on 29 March 1985, the Danish parliament took the third step. An left-leaning alternative majority led by the Social Democrats formed and decided to exclude nuclear power from future energy planning. In order to make the decision clearly irreversible, on 30 April 1985, the Danish parliament also withdrew the planning rights and claims to the sites foreseen for nuclear power plants (Sidenius 1986, 377).

However, mainly due to Denmark's geographical location, the history of societal engagement with nuclear power did not end, but turned transnational. Located barely 20 km away from Copenhagen, the Swedish nuclear power plant Barsebäck remained the target of annual marches of the OOA together with Swedish protesters from 1976 onwards. Moreover, in April 1986 Denmark was affected by fallout from Chernobyl. In its "Radiating Neighbours" campaign the OOA lobbied the government to take international action on Barsebäck, but also on power plants in West and East Germany. An OOA delegation actually visited East Berlin in the October 1986 to protest against the East German reactors on the coast of the Baltic Sea (Meyer 2016).

1.2. Emerging networks of nuclear research (1950s)

The early history of nuclear energy and society in Denmark conforms very much to the standard trajectory in Western Europe, and developed countries worldwide. From 1945 onwards, in the public sphere, all things nuclear were initially very much associated with the destructive forces of the "bomb" (Melosi 2013, 118ff.). However, from the mid-1950s – supported by the United-States-led Atoms for Peace campaign, also in Denmark, an emerging network of institutions and researchers supported by the state, and by the United States government, sought to put a different spin on the nuclear issue. They highlighted its practically and economically useful aspects of harnessing the forces of the atom. This notably included the possibility of generating electricity (Melosi 2013, 166-171). Event 1, below, will examine this process of engaging with the public in greater detail.

The development of nuclear energy in Denmark in the 1950s and 1960s was characterised by the establishment of relevant institutions and networks; efforts to develop nuclear research in a national setting at the Risø (Risø 1968) research centre, and subsequently in transnational cooperation with a Swedish reactor project. These efforts were mostly focused on basic research. As in many other countries this research was part of a quest to develop a "national" reactor type of its own (e.g. Switzerland Wildi 2003, for Denmark Nielsen et al. 1999). In the Danish case, the goal of a national reactor was not only motivated by industrial policy and export aims, but by ideas of national self-sufficiency in uranium, to be resourced from Danish Greenland (Knudsen and Nielsen 2016, Nielsen and Knudsen 2013). These technologically very ambitious projects failed, both due to a lack of resources and the lack of project management skills and direction among the Risø leadership (Nielsen et al. 1999).

Engagement with the public did not feature very prominently in the 1950s and 1960s, except in the Atoms for Peace campaign. Civilian uses of nuclear power were linked to visions of a modern, positive, science based future, and were not yet controversial.

1.3. Actors

It is worth, however, taking a look at the actors who were part of an emerging network of promoters of utilising nuclear power in Denmark.

The central institution for developing nuclear energy was the **Danish Nuclear Energy Commission (Atomenergikommissionen, AEK)**, modelled on the American Atomic Energy Commission, and established by law in 1955 (Petersen 1996, 40). This institution emerged from the scientific establishment, the Danish Academy of Technical Sciences, with seed funding from a private foundation. The expressed aim was to participate in the Atoms for Peace programme and to obtain fissible material from the US to start nuclear research in Denmark.

While scientists took the initiative on the establishment of nuclear (research) institutions, support from the state, and by political actors proved extremely important, not least due to the high cost of nuclear research. In the 1950s and 1960s, the Danish Social Democrats were very receptive to requests from scientists. Across Scandinavian and European countries, postwar Social Democrats were highly committed to science and education as a path to modernisation, prosperity and welfare. Particularly the social democratic finance minister Viggo Kampmann, under whose auspices AEK was established, provided massive financial support to this new body's activities. In 1960, the expenditures of the AEK-administered Risø research centre accounted for 40 per cent of overall Danish technological research spending across all technology research centre (Nielsen et al. 1999, 65f).

While generously funded by the state, in its structure, the AEK remained dominated by scientists. Among its 24 members, ten were scientists from academic institutions, seven represented industry, only three were from utilities – the future users of the technology – and three from the labour unions. Personal connections mattered: the only high-ranking official who provided a link to government, Hans Henrik Koch, permanent secretary in the Ministry of Social Affairs, also happened to be a personal friend of Niels Bohr's, the chairman of the AEK until his death in 1963 (Nielsen et al. 1999, 66).

The generous funding and corporatist setup of the AEK ensured that it remained the central hub of what can be characterised as the emerging nuclear network in Denmark. Furthermore, the AEK was also in charge of the central research establishment for nuclear research in Denmark. The **Risø Research Centre** was established on a 250 hectar ground along Roskilde Fjord not far from Copenhagen. It officially opened on 6th June 1958 (Nielsen et al. 1999, 66), and subsequently acquired three research reactors.

Given the dominance of the AEK, utilities and industry played a more limited role as actors in the emerging nuclear sector. Despite the ongoing centralisation in the 1950s and 1960s, electricity provision in Denmark was relatively decentralised (Van der Vleuten and Raven 2006). There were only two larger players: **Kraftimport**, a body established in 1954 to import electricity from Sweden and to link between regional power grids and **Elsam**, which was founded in 1956 and integrated the grid for seven power stations in Jutland and Funen in the West of Denmark.

These organisations subsequently became large enough to pursue nuclear plans by the early 1970s. As a federation of utilities, the association of **Danish Electricity Providers (*Danske Elvaerkers Forening, DEF*)**, was the central association and lobbying body of the utilities.

Due to the small-scale structure of Danish industry, very few companies were interested in actively pursuing nuclear power technology. Some industrial companies from the metal industry, like **Burmester and Wain** and **Helsingør skibsværft**, had know-how in outfitting power plants and providing boilers, and were thus interested to get their share of the cake of new power plant projects.

Despite the general interest in nuclear power, utilities' and industry's primary interest in reliable and cost-efficient solutions differed somewhat from that of the scientists at Risø. Hence, in order to have a say and to counterbalance Risø's monopoly on nuclear expertise, industry and utilities, led by the DEF, established **Danatom** to "help Danish industry and utilities with information on design and construction of nuclear reactors for generation of heat and power" (quoted in Nielsen et al. 1999, 69).

The development of nuclear research in Denmark did not lead to a nuclear power plant. The initial Danish reactor project of a Deuterium-moderated, Organic-cooled Reactor (DOR), to be run with uranium from Greenland was abandoned in 1963. The Danish utilities were not interested in buying such a reactor, for a lack of demonstrable "economy and reliability". Subsequent cooperation projects with Swedish reactor development companies and attempts to develop a Nordic reactor equally failed, so that, when Elsam started to become interested in actually building nuclear power plants in 1971, the nuclear power plants to be installed were to be imported. After a Canadian heavy water reactor to be run on natural uranium from Greenland could not provide the necessary safety documentation, the only option remaining were light water reactors relying on imported enriched uranium (Nielsen et al. 1999, 85). This put an end to any dreams of self-sufficiency in uranium resources.

With a view to relations with the public, Risø presented itself in glossy brochures (Risø 1968). This was not a problem, at a time when nuclear power remained mostly a vision, rather than a reality, and was hardly challenged. However, this changed in the 1970s, when the new policy of the new executive director Allan R. Mackintosh, led to Risø researchers advocating nuclear power in the public sphere, and refuting any critique members of the public and the OOA might have (Nielsen et al. 1999, 86). This is discussed in greater detail in case 3 below.

With Risø's role as a provider of self-made nuclear reactors dwindling, in 1967 a new role was ascribed to it. Apart from training nuclear engineers, gathering expertise in safety issues, in 1967 **Risø** was turned into the **regulatory body** for the implementation of nuclear power.

However, in the growing public debate about nuclear power, from 1973 onwards, Risø's problematic dual role of being an advocate of and a control body for nuclear power became increasingly apparent. Thus, in **September 1973, a new regulatory institution** was established, still under the auspices of the AEK, **the Nuclear Inspectorate (Tilsynet med nukleare anlæg**). The ten employees of the new Nuclear Inspection however had their offices at Risø. This induced critics to continue raising objections concerning their independence (Nielsen et al. 1999, 83-84, Henningsen 2017)..

1.4. Not going nuclear (1970s-)

Nuclear power rapidly became a controversial issue in the public when Elsam presented actual plans for the introduction of nuclear power in December 1973. Elsam had started studying various possible reactor sites for their suitability since 1971. Given Denmark's reliance on imported oil, Elsam perceived going nuclear as the best available solution to combat rising fuel prices, and problems of providing fuel for its large number of oil-fired power plants, even more so after the start of the oil crisis.

In the Danish parliament and in the public sphere, the existing rules of Danish legislation concerning nuclear installations dating back to 1962 were increasingly considered inadequate with a view to the introduction of the much larger commercial nuclear power plants. Notably the provision that the Minister of Education could independently authorize power plants without any parliamentary involvement was publicly challenged (Petersen 1996, 169-171).

By 1973/74, Danish society had increasingly become more politicised - in the wake of 1968, the referendum of October 1972 on the controversial issue of joining the European Community, and the December 1973 “landslide” elections, which had reshuffled the Danish party system (Petersen 1996, 169-171, Hein Rasmussen 1997). Economically, the oil crisis hit Denmark hard. It was in this context that the OOA emerged.

The origins of the OOA are somewhat coincidental. The organisation grew out of the activities of young Christians who got together for a three-day meeting in mid-June 1973 at the Danish section of the International Fellowship of Reconciliation (IFOR) in Lyngby in the North of Copenhagen. Those attending the meeting explored issues that they could devote their attention to. Their debate focused on what they considered urgent contemporary issues relating e.g. to peace or the fight against global inequality (Forsoningsforbundet and Christiansen 1974-1995).

During the meeting – and clearly influenced by the group’s internationalism, the contemporary debate on Limits to Growth (Meadows et al. 1972) and the growing environmental concern in the wake of the Stockholm UN Conference on the Global Environment (Ecologist and Earth 1972) - they singled out growing energy consumption and the plans for nuclear power as particularly problematic developments. The young christians voiced their concerns about nuclear power. They highlighted radiation and consequences for the environment, but also for global peace and global inquality, and for subsequent generations – in terms of waste and the exploitation of natural resources. Against the backdrop of this discussion, they decided to campaign against nuclear power, which they considered the most “concrete” expression of their concerns about the pursuit of unlimited growth, that ignored its consequences for the environment and humanity (Forsoningsforbundet and Christiansen 1974-1995, Christiansen 2017).

Since then, this group of mostly young people started organising and involving others, throughout the country. They collected information - also from international sources – on nuclear issues, and met regularly until early 1974. When they eventually decided to set up an organisation, they chose a name which was deliberately neutral, to ensure a broad appeal and enhance credibility: Organisation for Nuclear Information – or more literally – for “enlightenment” about nuclear power (OOA 1974-1995a).

On 31 January 1974, the newly founded **Organisationen til Oplysning om Atomkraft** (Organisation for nuclear information, OOA) held its first press conference in Copenhagen, in response to Elsam's application for the licensing of new nuclear power plants. The organisation not only challenged the nuclear option, but it called for an assessment of alternative energy sources. OOA's press release warned against what they considered an undemocratic and hastily taken decision. They criticised the licencing of the power plants by the minister as a "panikbeslutning" (panic-induced decision). Instead, the OOA called for a period of reflection, of three years, "1. to examine the problems related to using nuclear power, 2. to do further research and assess again alternative energy sources, and 3. to develop a long-term energy policy, which takes ecological and social precautions"(OOA 1974-1995b) (My translation from the Danish original, JHM).

The OOA called for a broad discussion of energy policy in the public sphere, rather than behind closed doors among experts. To them, energy policy was an issue of democratic, rather than technocratic decision-making. For reasons of democracy, they demanded that the licencing should be done by Parliament and not – as the old law of 1962 foresaw – by the minister of education. They also demanded the provision of public funds for an information campaign on energy – in which both the promoters and critics of nuclear power would have a say (OOA 1974-1995b).

Indeed the Danish Parliament took decision-making about nuclear away from the minister and back in its own hands. It postponed the law about the authorisation of nuclear power plants in May 1974. On 12 June 1974, Minister of Commerce (Handelsminister) Nyboe Andersen responded to the call for an open societal debate. He established the Energi oplysnings udvalget (Energy information committee), together with the Danish People's Information Council, a highly respected educational group active throughout the entire country. This body offered resources to those who intended to organise public discussions or meetings to inform people and to debate nuclear power. (Petersen 1996, 169-171). A more detailed discussion of these activities based on original sources can be found in case study 2.

Opposition to the introduction of nuclear energy was clearly growing. OOA not only maintained a very effective central office, but also liaised with numerous grass-roots branches all across the country. OOA's campaigns evolved from an initial emphasis on encouraging discussion and information on nuclear power and energy policy more generally, to a more explicitly oppositional stance. In 1975, they introduced the anti-nuclear sun stickers, politely but clearly declaring: "Nuclear power. No, thanks.", which subsequently spread worldwide (Christiansen 2017). In particular, near the construction sites of planned nuclear power plants, discussions were controversial. Opposition and protest were growing, including various instruments such as the collection of signatures. Near Søra on Vendsyssel on the northern tip of Jutland, and Gyllingnæs near Aarhus in Central Jutland 90 per cent and 87 per cent of the local populations (respectively) signed up against the power plant (Petersen 1996, 171-173). OOA however always remained non-partisan with a view to political parties (Nielsen 2016, Christiansen 2017).

National newspapers like *Politiken* and *Aktuelt* – that previously supported nuclear research – started to question nuclear power. The debate extended beyond the issue of nuclear power, In the wake of the oil crisis, concerns raised by the influential Club of Rome about the "Limits to Growth" (Meadows et al. 1972) and the rise of environmentalism (Jamison et al. 1990), the societal debate considered the entire direction of energy policy in Denmark, including its growth-orientation and growing centralisation. As a response to these debates, and the activities of the OOA (discussed in case study 3, below), the Danish Atomic Energy Commission (AEK) was dissolved in 1976. The Danish government also decided to postpone the decision to licence nuclear power plants, until a solution to the problem of nuclear waste had been found (Nielsen et al. 1999, 85-87).

Protest and mobilisation continued, most notably against those nuclear power plants that "concerned" and "affected" Danes – as the contemporary parlance went (Milder 2010). These reactors were not located in Denmark, but nevertheless in the vicinity of Copenhagen, just across the Sound. The Swedish power plant at Barsebäck, which went critical in 1975, was the target of numerous marches organised by OOA from the 1970s until the 1990s. Not only protestors crossed borders: one reason for Barsebäck's location near Copenhagen was that this location facilitated supplying both the nearby Swedish cities, exporting electricity to Denmark.

Indeed, OOA marched together with Swedish partners in transnational cooperation (Storm 2014, 53-55, 60, Kaijser and Meyer forthcoming 2018). Case study 4 examines this phenomenon in greater detail.

In the face of growing and continued opposition and internal divisions within the Danish political parties , and responding to the fact that no suitable and convincing solution had been found to the issue of storing nuclear wastes, on 29 March1985 an alternative majority in the Danish parliament led by the Social Democrats (including other left-leaning and centre-left parties) decided to exclude nuclear power from the future Danish energy mix, and on 30 April 1985 to remove the reservations from planned construction sites (Sidenius 1986, 377).

The Danish nuclear energy debate of the 1970s was special, as it involved a massive societal engagement with on energy policy more generally. This had an important effect on the long-term debate on nuclear as it spread knowledge on technical and economic issues on energy policy and nuclear power in particular, linking them to wider debates about the future of society, such as concerning centralisation vs. the benefits of small-scale, renewable and regional energy provision (Petersen 1996, 176). In the course of a decade, the continued debate led to the political decision to exclude nuclear energy from Danish domestic energy production. The import of nuclear energy notably from Sweden as part of European networks continued, though. At the same time, the energy debate led to a pioneering role in the development of wind turbine technology, in which Denmark became a world leader (Heymann 1998). This proved not only societally more acceptable, also because, as the the contemporaries highlighted, it conformed to Danish traditions and structures of small-scale, regional energy provision (Van der Vleuten and Raven 2006).

2. Events

As indicated above, with a view to commercial nuclear energy in Denmark itself the history of nuclear energy and society is much shorter than in most European countries, as Denmark never “went nuclear”. However, the nuclear power plants built by neighbouring countries were an issue of public debate and protest in Denmark.. Thus societal engagement with nuclear power had a strong transnational dimension. These two insights inform the choice of events, along with the ambition to broadly cover different periods, and the availability of secondary literature and primary sources.

First, like in many Western publics, the campaigns of the Atoms for Peace initiative sought to promote the peaceful uses of nuclear technology in the 1950s.

The second event – the activities of the Energy Information Committee 1974-76 – provides an exceptional example of public engagement. The Ministry of Commerce (Handelsministeriet) financed an information campaign on energy policy (including nuclear power) that was not top-down, but bottom-up, and included financial support for grass-roots initiatives, rather than providing an official view which benefitted either side.

The third event is the struggle of experts in the media and public events in Denmark in the 1970s. This includes both opinion pieces and letters in major newspapers, written by advocates such as researchers from the nuclear research centre at Risø, and counter-experts, often from abroad, facilitated by the anti-nuclear movement.

The fourth event relates to the long-drawn struggle of the Danish anti-nuclear movement against the Swedish nuclear power plant at Barsebäck, only 20 km away from Copenhagen.

The fifth and final event is the response of the Danish anti-nuclear movement to nuclear power projects in neighbouring countries, even on the other side of the iron curtain in the wake of Chernobyl in the late 1980s.

2.1. Event 1: Public information on energy and nuclear power in the 1950s: Great expectations

In the 1950s, the emerging nuclear energy sector, supported by many European governments and in particular the United States' government, tried to engage the public across Western countries (Melosi 2013, 166-171). At the time, in the minds of many citizens, all things nuclear were largely associated with its destructive forces epitomised by the nuclear bombs on Hiroshima and Nagasaki, and the subsequent nuclear weapons tests in far-flung places (Weart 1988). The international 'Atoms for Peace' campaign (Krige 2006, 2010), kicked off by United States President Eisenhower in 1953 sought to change this image, and highlight the peaceful uses of nuclear power, such as in providing electricity at a competitive rate. In the United States, this campaign was conducted utilising the best available methods of public relations, including Disney's movie "Our Friend the Atom" and the accompanying book of 1956 (Haber 1956).

The first 'event' to be discussed actually consists of two similar events serving the same purpose. Two exhibitions in 1955 and 1957, respectively, were both intended to promote nuclear power and celebrate the modern consumer society arriving in Denmark in the 1950s.

In Denmark, the United States-led Atoms for Peace campaign hit home with an exhibition 'The Atom in Everyday Life' ('Atomet i hverdagen') in the summer of 1955. Devised by the US Information Service (USIS) and also involving Danish nuclear scientists, the exhibition was shown in Denmark's largest cities, Copenhagen, Aarhus and Odense. The exhibition attracted some 140,000 people and 190,000 pamphlets were distributed. Opinion polls conducted after the exhibition demonstrated that 84 per cent of the respondents had "heard or read of any peaceful, non-military purposes of atomic energy" and a large majority of respondents held a positive view of atomic energy (Christensen 2002, 95).

The United States targeted Denmark, and the country's energy policy, also for Cold War security reasons. Ideas of neutralism were traditionally popular in the country, even though it was part of NATO. Neutrality would have potentially endangered the US presence in Greenland (Petersen 2013). Moreover, in terms of energy provision, Denmark was highly reliant on coal from the Eastern bloc, particularly Poland, thus making it responsive to political and economic pressures from the East (Nielsen and Knudsen 2010, 96).

While the first exhibition was part of this kind of transnational intervention in Denmark, the second event, two years later, was more home-grown: “Live your life the electric way!” The poster for the ‘International Electric and Nuclear (literally ‘Atom’) Exhibition’ in Copenhagen in October 1957 promoted all the advantages of the modern life and the convenience of the new electrical appliances that became available during the postwar boom. Nuclear energy was shown to provide the ‘cheap’ and readily available electricity needed for a more convenient way of life. The exhibition fit well into what is usually considered the spirit of the time, a preoccupation with modernity and with the promotion of technological advances in the 1950s. Indeed, at the time, Danish consumer society was on the rise. Growth rates of electrical energy consumption in Denmark, which had been one of the lowest in Europe back in the early 1950s, were among the highest by 1957 (Petersen 1996, 112-115). This made energy planners think of alternative sources to imported coal. From the late 1950s until 1973, however, cheap imported oil from the Middle East provided an ample and inexpensive fuel for the postwar boom (Pfister 2010). Similar to the situation in various other Western countries at the time, this substantially reduced the appetite for nuclear power until the oil crisis.

The 1957 exhibition, which was open for 10 days only, attracted 134,515 visitors (Petersen 1996, 112). A poster advertising the event nicely illustrates the spirit and imagery of celebrating science and modernity (printed off in: Petersen 1996, 113).

The exhibitions did not directly lead to any decision on nuclear power. Nevertheless they were part of the public relations campaigns that accompanied the introduction of nuclear research to Denmark and the founding of the Risø Research Center, with its three research reactors (discussed above).

The event’s importance was not universally recognised at the time. Indeed I selected the event in retrospect, in line with the conventions of a nuclear historiography that tends to stress the importance of the ‘Atoms for Peace’ campaign. At the same time, the actors involved, such as the cultural attaché of the American embassy, of course highlighted the importance of their own actions and their impact on the course of history: "It [the exhibition] came here at a most opportune time, as we all know, Denmark just recently embarked upon a program of all-out support for developing the potentials of nuclear energy. To what extent President Eisenhower's Atoms for Peace proposal has something to do with these Danish developments I can, of course, not say. But I wouldn't be surprised if there were some loose, hard-to-defined causal relations between the two – something in the nature of a mild chain-reaction…" (quoted after: (Nielsen and Knudsen 2010, 96)).

A detailed analysis of these two events is provided in the following table:

Event 1	**Public information on energy and nuclear power in the 1950s: Great expectations** **a) exhibition 'The Atom in Everyday Life' ('Atomet i hverdagen')** Exhibition demonstrating the potential uses of nuclear applications **b) The International Electric and Nuclear (literally 'Atom') Exhibition' in October 1957** Presenting electrical appliances, their practical use in the household. Nuclear power, which is presented in models and drawings is shown to produce the electricity.
Actors: Who was involved (refer to table of potential actors, above)? **Q1:** Who are the main actors for and against nuclear energy involved in the event and what are their political connections?	**Q1:** a) & b) the promoters had the full support of the governments (US, DK) involved Promoters: - National government institution from foreign country: United States information service (USIS) (i.e. transnational dimension) - Scientific body: researchers from the emerging state-funded Risø Nuclear Research Center (set up to develop and promote nuclear power) Promoters: - Companies: Danish electricity providers, Danatom (a private company, for the commercial exploitation of nuclear energy, founded in 1956) - Scientific body: the state-funded Risø Nuclear Research Center (set up to develop and promote nuclear power) - Association (of different players), the Danish Nuclear Energy Commission (AEK); Danish industry associations
Q2: How did the involvement of these actors change over time?	**Q2:** No change at this point, as this was a short-term event.

Q3: Did networks and alliances of actors play a role for this event: If yes: What alliances were formed? Which actors treated which other actors (explicitly or implicitly) as opponents? What transnational cooperations/alliances/flows of information took place?	**Q3:** At the time, a close-knit network emerged among those involved in the new technology in Denmark, and towards the United States, the technological leader, providing state of the art technological, scientific and PR know-how, as well as organisational models, such as the institution of the Atomic Energy Commission (AEK). For details on the actors, see Section 2 Narrative, above).
Q4: Which actors were the "regulators" for this event? What was the level of "trust" they enjoyed?	**Q4:** A distinction between regulators and promoters cannot be made at this early stage.
Q5: Did changing involvement (state/private) change public opinion/trust?	**Q5:** The issue of change in trust due to state and private involvement cannot fully be answered with the information available: The poll data quoted above (Christensen 2002, 95) only suggest growing familiarity with the issue of nuclear power, and a majority positive view, which the organisers of the event of course attributed to their own actions.
When and where did it take place?	Summer 1955, Copenhagen, Aarhus, Odense (Denmark's largest cities / metropolitan areas in the different parts of the country); 18-27 October 1957, Copenhagen
Public Engagement: What type of process was it (communication, consultation or participation)? How did this change over time?	
Q1: What type of public engagement was employed, if any?	**Q1:** Both events involved a Public Communication process, with information being provided and conveyed to a public, in a **top-down communication** process, relying on commercial advertising techniques, and the exhibition of nuclear and electrical energy and appliances.
Q2: How did PR/public engagement by the nuclear establishment change over time?	**Q2:** For these two events, it is not possible to observe change. Beyond the event itself, in any case, the US actors do not continue to be present subsequently. The Danish actors continue to promote nuclear power until the 1980s.
Q3: Who is the initiator of the event? (Promoters, Opponents, State or authorities, mixed origin)? What kind of events did they initiate?	**Q3**: Event is initiated by promoters, involving exhibitions and the distribution of information materials.
Q4: Is there evidence of some type of process of *interaction* between the "promoters" and the potentially "affected"	**Q4:** The type of interaction renders the public a passive recipient that was to be taught a lesson they were expected to accept.

people/stakeholders? What kind of interaction? How did this change over time?	
Q5: Were the events "evaluated"? If so, how? What claims have been made for their success/failure?	**Q5**: As mentioned in the text above, the events were accompanied by opinion polls, which demonstrate an increase in knowledge about and support for nuclear power.
Arguments and Behaviour: What rationale was given by the party that implemented the engagement (if any)?	
Q1: What kind of nuclear-civil society interactions can we distinguish in the broadest sense? Is there any explicit social conflict? What kind? Among which actors? Why? Was there violence or use of force? What sort of protest behaviour took place?	**Q1:** There is no explicit conflict. At the time, nuclear energy was uncontroversial (unlike nuclear weapons were at the time). However, texts and speakers implicitly anticipate arguments about nuclear fission's destructive potential in military technology that citizens are familiar with.
Q2: Who was against nuclear energy? How did they operate, and did they learn from experience? Is there evidence of (reluctant) tolerance / acceptance? What are the main issues/conflicts for those against nuclear energy (e.g. weapons, safety)? What is the promoter narrative? How does this narrative resonate with other actors, e.g. the media? How did it change over time?	**Q2:** There is only information on the behaviour and the discourse of the promoters, not of the affected populations, who probably broadly accepted and tolerated what they were shown. The events provided a forum for a promoter narrative of: Progress, prosperity, convenient and modern life, and the contribution to this made by nuclear energy – soon to be introduced in Denmark: Veteran Danish nuclear scientist Niels Bohr emphasized the following issues in the introduction to the exhibition's catalogue (Petersen 1996, 112-115): the new perspectives that the availability of the enormous amounts of energy available from nuclear power meant, the great challenges the new technology posed to industry and science, and the need to inform a broader population of these challenges and their contribution to society.
Q3: How has government (etc.) responded to resistance? How did government behave towards promoters and supporters of nuclear energy? Which were the main arguments (supporting points of view, justifying behaviour)? How were these arguments framed (relating to larger societal conflicts, the economy, visions of the vision etc.)?	**Q3:** not applicable, as there is no reported incidence of resistance.

2.2. Event 2 / Showcase: The Energi oplysnings udvalget (Energy Information Committee: a public information initiative) 1974-1976.

As a response to the oil crisis, in 1973 the Danish utility Elsam submitted plans to build nuclear power plants. In dealing with the issue of licencing, the Danish Parliament took an important decision. Instead of giving full support to these plans, not least under the pressure of growing protest of the newly founded, but very active *Organisation til Oplysning om Atomkraft* (Organisation for Nuclear Information, literally, 'Organisation for the Enlightenment about Nuclear Power', OOA)(OOA 1974-1995b), it decided to postpone the decision in the summer of 1974, and take time for public engagement and debate about the future of Denmark's energy provision.

Thus, Members of Parliament accepted the OOA's claim that more public information and debate on the advantages and disadvantages of nuclear power were necessary. The Ministry of Commerce (*Handelsministeriet*) set up the *Energi oplysnings udvalget* (Committee on Energy Information). This body was to organise debates via educational institutions, in part to depoliticise the issue and turn it into an issue of knowledge and education. It offered grants to applying groups and organisations and money to fund information meetings, discussion groups, or invite foreign experts on nuclear power (Geertsen 1974-1976). Trade Minister Nyboe Andersen set up the *Energi oplysnings udvalget*, after consultation with the Danish Council for People's Information (*Dansk Folkeoplysningssamråde*t), the country's highly respected institutions of further education.. It was to be administered by Uffe Geertsen, whose background was in engineering, which he taught at a people's "high school" (højskole – further education institution). Thus the *Energi oplysnings udvalget* became linked with those educational organisations, which were part of the "high school (højskole) movement". Founded in an age of educational reform in the 19th century, these high schools were well-established in the area of public education in Denmark. They are a Danish particularity, and enjoyed enormous respect for their work in informing and engaging with citizens (Mejlgaard 2009, 487f). Rather than relying on state-of-the art public relations, as in the case of the Atoms for Peace campaign, the *Energi oplysnings udvalget*'s work was to be conducted in a grass-roots manner (Petersen 1996, 170-

171). Citizens and groups could apply for funding to organise “meetings, study circles, exhibitions or other information activities”. The Energi oplysnings udvalget offered “recommendations of possible topics for study circles, evening lectures or debates”, they sent out “lists of relevant literature and films, slides and exhibition materials”, and for “presenters and study circle teachers”. Finally, they prepared a project “the energy-right town (energi-rigtig by)”, and provided funds for citizens to explore energy consumption and potential energy savings and improvements in energy provision/consumption in their own town (Energioplysningsudvalget 1975b).

Groups from the “high school (højskole) movement” involved in these activities not only advanced the debate about energy across Denmark, but also started searching for alternative sources of energy. These groups contributed subsequently to the very successful development of reliable and efficient wind turbines in Denmark in the latter half of the 1970s (Rüdiger 2014, Heymann 1998).

The *Energi oplysnings udvalget* not only funded events and public meetings, it also published a six volume book series on energy policy, in which the pros and cons of the different existing and potential future energy resources were comprehensively discussed. The editors aimed at a well-balanced presentation of all the arguments at hand and at an account that was comprehensible for non-experts (Henriksen 1975, Geertsen 1975b). The second book of the series was entirely devoted to nuclear power, presenting the views of different actors, including labour unions, utilities, industry and consumers. The nuclear issue was also mentioned throughout the other volumes (Geertsen, Henriksen, et al. 1975, Energioplysningsudvalget 1975a, Degnbol et al. 1975, Geertsen, Algreen-Ussing, et al. 1975, Bondesen et al. 1975, Geertsen 1975a).

This “event” did not directly lead to any decision. However, the two years process of debate on energy, the controversy and growing opposition to nuclear power (also reflected in poll data (Villaume 2012)) clearly informed the government’s decision not to go ahead with nuclear energy in 1976 (see discussion above). I chose the event as an exceptional example of grassroots, but state-sponsored engagement, with very few strings attached. The event itself was not recognized so much by the contemporaries as “historical”, nevertheless as an important national exercise at a turning point in energy policy (Geertsen 1975b), after the end of cheap imported oil. The event is not very much recognised in subsequent debates. Some of the historical overviews on the issue of nuclear energy policy do not mention it (Villaume 2012).

Event 2	**The Energi oplysnings udvalget 1974-76 (a public information initiative, which sponsored grassroots initiatives' information and engagement activities on energy policy including nuclear power)**
Actors: Who was involved (refer to table of potential actors, above)?	*Energi oplysnings udvalget*, a state-sponsored office funding events and consultation on nuclear energy, organised by grassroots and public education groups, including the OOA. It also published books on energy issues.
Q1: Who are the main actors for and against nuclear energy involved in the event and what are their political connections?	**Q1:** Promoters: (present at events, views included in books) - Companies: Utility Elsam, which planned to build four nuclear power plants, e.g. its director E.L. Jacobsen (Jacobsen 1975); - Scientific body: researchers from the state-funded Risø Nuclear Research Center (set up to develop and promote nuclear power), such as C.U. Linderstrøm-Lang co-authored overview of the nuclear issue within Energi oplysnings udvalget's book on nuclear power(Linderstrøm-Lang and Meyer 1975); - Scientific body: Researchers from the: Niels Bohr Institute (Elbæk 1975); - Association (of different players), the Danish Nuclear Energy Commission (AEK); Atomenergikommission: Henning Sørensen, Physicist, advocating the use and the ready availability of uranium from Danish Greenland (Sørensen 1975); - Companies: Industry (Foss 1975): supportive, but not uncritically supportive; - Interest organizations: including labour unions (Møller 1975); - Interest organizations: Newly founded (in 1976) – with support from Risø and the Niels Bohr institute (Elbæk 1975) – pro-nuclear association in Real Energy Information (Reel Energi Oplysning, REO)(Villaume 2012); - Political parties: Individual party members, like Social Democratic MP Morten Lange, who in 1976 considered opponents to nuclear power as driven by “religious zeal” and “emotions”(Villaume 2012); - Media: Local and more conservative newspapers

(including Berlingske Tidinge) supported nuclear power (Villaume 2012).

Receptors / Affected people (mostly opposing)

- Scientific body: Individual actors other co-author of the overview of the nuclear issue within Energi oplysnings udvalget's book on nuclear power: Professor Niels I. Meyer from Denmark's Tekniske Hogskole (Danish Institute of Technology). Meyer took a more critical position,(Linderstrøm-Lang and Meyer 1975).
- Interest groups: Organisation for Nuclear Information (Organisation om Oplysning til Atomkraft, OOA) and its representatives. They contributed to the books (Christiansen 1975). Their local groups also organised events and very actively drew on Energi oplysnings udvalget's money (Geertsen 1974-1976).
- Educational groups from the Danish people's educational council (Dansk Folkeoplysnings Samrådet) and from the "high school movement" organised events, drawing on the funding from the Energi oplysnings udvalget (Geertsen 1974-1976).

As concerns the political connections, while the pro-actors enjoy substantial state/government support initially, this support is waning, as the governing social democrats are increasingly facing opposition and polls indicating the diminishing support for nuclear in the polls. Individual social democrats, like above-mentioned Morten Lange publicly defended nuclear power as the energy of the future.
Interestingly enough, within scientific bodies, but also across different associations and groups, there is substantial pluralism, no uniform commitment to nuclear power, but a rather open search for the most suitable and least expensive (in the long run) solution to Denmark's energy dilemma.

Q2: How did the involvement of these actors change over time?

Q2: The involvement of the OOA definitely was able to expand, between its foundation in 1974 and 1976, due to the supportive political opportunity structures (Kolb 2007, Kriesi 2007) and in particular the resources (Edwards and McCarthy 2007, Jenkins 1983) made available for "nuclear information" via the *Energi oplysnings udvalget*.
Hence, it does not come as a surprise that in parliament, notably among the pro-nuclear

	Conservative people's party, the activities sponsored by the *Energi oplysnings udvalget* were increasingly perceived as state-funded support for anti-nuclear activism. While the social democrats defended the *Energi oplysnings udvalget* in the debate, they did not continue its funding for another year (Petersen 1996, 171). Hence this did not develop into a longer-term exercise of public engagement. However, the activities had reached and involved some 150,000 Danes.
Q3: Did networks and alliances of actors play a role for this event: If yes: What alliances were formed? Which actors treated which other actors (explicitly or implicitly) as opponents? What transnational cooperations/alliances/flows of information took place?	**Q3:** It is hard to trace networks at this stage, as the nuclear cleavage was only emerging at the time. Clearly, the book projects, and the various events, offered plenty of potential for network building. International involvement and transnational exchange, such as the invitation of foreign (counter-)experts (see next event) was greatly facilitated by the sponsorship available through the *Energi oplysnings udvalget.* There were also alliances involving political parties, scientific bodies, and utilities, on the other side: The REO was build up through a network involving the venstre partiet's energy commission, actors from Risø (Per Brøns, O. Walmød-Larsen), from Elsam (Søren Mehlsen) and from the Niels Bohr institute (Prof. Bent Elbek, (Elbæk 1975)). The organisation only had a membership of 1100 people and associations (by 1978), which ensured substantial funding (340,000 DKK in 1977). (Petersen 1996, 176-177)
Q4: Which actors were the "regulators" for this event? What was the level of "trust" they enjoyed?	**Q4.** There were no regulators for these events per se, except for the parliament (providing the funding) and the Handelsministeriet (the Ministry of Commerce), under whose auspices the money was disbursed. However, at this time, the role of the Atomic Energy Commission and Risø as the future regulators of nuclear power plants was controversially discussed and the relevant laws were changed to improve independent regulation of nuclear facilities.
Q5: Did changing involvement (state/private) change public opinion/trust?	**Q5.** The involvement of various actors in the debate did most likely contribute to a more comprehensive understanding of nuclear power, and a loss of simple trust in its potential benefits.

When and where did it take place?	1974-1976, with events taking place across Denmark, sponsored by the *Energi oplysnings udvalget*
Public Engagement: What type of process was it (communication, consultation or participation)? How did this change over time?	
Q1: What type of public engagement was employed, if any?	**Q1.** The events and publications of the *Energi oplysnings udvalget* allowed for participation, as they were initiated by groups of affected citizens (opponents). Often the events financed involved talks by experts and counter-experts, but also discussion among participants on energy policy, e.g. during a weekend seminar, organised by a civic education group, which frequently involved a lot of discussion.
Q2: How did PR/public engagement by the nuclear establishment change over time?	**Q2.** Change over time is impossible to trace during these short-lived events.
Q3: Who is the initiator of the event? (Promoters, Opponents, State or authorities, mixed origin)? What kind of events did they initiate?	**Q3:** While there was state-funding, the individual events sponsored by the *Energi oplysnings udvalget* were organised by grassroots groups – including local OOA groups. The kinds of events included discussion groups, weekend seminars, or talks of invited experts.
Q4: Is there evidence of some type of process of *interaction* between the “promoters” and the potentially “affected” people/stakeholders? What kind of interaction? How did this change over time?	**Q4**. The interaction between proponents and opponents in the book projects demonstrates considerable respect for the position of the other one, and involved cooperation. For the events, it is hard to trace exactly how the proponents and opponents interacted, and how seriously they took citizens' concerns, as there are no records of these meetings available to me. Such records would be necessary to analyse the engagement process in greater detail.
Q5: Were the events “evaluated”? If so, how? What claims have been made for their success/failure?	**Q5:** The event was not formally evaluated. When deploring its discontinuation, the organisers mentioned that they reached 150,000 people.
Arguments and Behaviour: What rationale was given by the party that implemented the engagement (if any)?	The decisions of the Danish Parliament and of the Ministry of Commerce allowed for a wide, open, and multi-faceted debate, by funding events organised by a variety of educational bodies. Funding was also available to anti-nuclear groups, which helped them,

given their lack of institutional funding that the established nuclear sector had, e.g. through the research centre at Risø.

Q1: What kind of nuclear-civil society interactions can we distinguish in the broadest sense? Is there any explicit social conflict? What kind? Among which actors? Why? Was there violence or use of force? What sort of protest behaviour took place?

Q1: There was substantial conflict about the issue of introducing nuclear power to Denmark, however, no use of force. At this stage, the information campaign involved discussion and public information, within schools, weekend retreats, educational centres, rather than protest and taking the streets.

Q2: Who was against nuclear energy? How did they operate, and did they learn from experience?
Is there evidence of (reluctant) tolerance / acceptance?
What are the main issues/conflicts for those against nuclear energy (e.g. weapons, safety)?
What is the promoter narrative? How does this narrative resonate with other actors, e.g. the media? How did it change over time?

Q3: How has government (etc.) responded to resistance?
How did government behave towards promoters and supporters of nuclear energy?
Which were the main arguments (supporting points of view, justifying behaviour)?
How were these arguments framed (relating to larger societal conflicts, the economy, visions of the vision etc.)?

Q2:/Q3: Parts of the government, as well as the utility Elsam, supported the introduction of nuclear power in Denmark, as did the Risø research centre. They argued for nuclear as an alternative energy source after the end of cheap oil.
Initially, there was a great deal of acceptance and tolerance. Many critics argued that this wasdue to a lack of knowledge. Indeed, there is little evidence of book and publications on nuclear energy before 1974. Even the first book of the promoters only appeared in 1974, highlighting that indeed this was the first such publication, responding to the beginning of the debate in 1973/74 (Korsbech and Ølgaard 1974, 7-9).
Basically, the main issues of the debate were the following (Linderstrøm-Lang and Meyer 1975, 12-18):

Pro:

- To ensure cheap and reliable energy provision in the face of rising oil prices and problems of availability.
- There is no alternative (TINA-argument): with growing consumption, and no more cheap oil, nuclear is the only option available.
- Trust in technology arguments.
- Accidents are unlikely, and with growing technological knowledge, can be prevented more effectively.
- There will be technical solutions to the nuclear waste problem.

Against:

- The issue of nuclear waste and the need to protect it for a very long time.
- The risk of accidents and the large-scale damages that such accidents may involve.
- The societal consequences of nuclear power, with a view to societal structures and democracy. The argument suggests that use of nuclear power leads as a consequence to the necessity to impose protection

for nuclear installations, and to centralize decision making and economic power – the "nuclear dictatorship" or nuclear superstate ("Atomstaat") argument. Rather than centralising, and committing to ever larger structures, society should opt for local small-scale energy provision.

- The "limits to growth" (Meadows et al. 1972)-argument: since endless growth is not possible, the way forward should be energy saving and renewables.
- "It's the society, stupid" – argument: The long-term societal implications of nuclear power were so grave, that these issues are for society, not for technicians, to decide (Nielsen 2016).

It is near impossible to assess how these arguments resonated with the wider public, as no detailed information and analyses from contemporary surveys exists.

The debate of the 1970s can best be illustrated by the "stickers' war" between three different Danish associations, active in the discussion on Denmark's future energy provision:

- the Organisation for Nuclear Information, OOA (rejecting nuclear power ("no, thanks")), [http://www.ooa.dk/ ;they discontinued their work in 2000]
- the Organisation for Renewable Energy (Organisationen for Vedvarende Energi (OVE)) OVE (advocating "sustainable (=vedvarende)" energy (which had emerged in the context of OOA in 1975, and is today called Vedvarende Energi; https://www.ve.dk/ and
- the association Real Energy Information REO (advocating nuclear power ("Hvad ellers?="what else?"). Founded in 1976, since 2012 they are called Ren Energi Oplysning (=Clean Energy Information), advocating nuclear energy as CO_2-free. Accordingly their present-day sticker says: "Atomkraft – CO_2-fri energi", encircling a green heart-shaped nuclear symbol): http://www.reo.dk/).

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2.3. Event 3: The struggle of experts (battle in the newspapers among pro-experts from Risø vs. anti-nuclear activists and counter-experts from abroad (1970s)

Even more so than any other environmental issues (Sörlin 2013), the discussion about the introduction of nuclear power in Denmark – as elsewhere (Topçu 2008, Weish 2013) – relied very much on the mobilization of expertise from 1973 onwards. While the advocates of nuclear energy relied on their own technical and scientific expertise, available notably at the nuclear research centre at Risø, the nuclear critics of the OOA invited counter-experts from abroad, who gave talks and participated in discussions at public meetings, challenging public authorities to engage with the issue. The list of anti-nuclear experts invited – presented below – looks like the "who's who" of international nuclear critics, and demonstrates the excellent transnational connections the OOA established from its very beginnings. In the conflict, OOA sought to benefit from the key resources (Edwards and McCarthy 2007) of scientific credibility and legitimacy of these scientists. For instance, on a poster advertising an "evening debate" on 22 April 1976 on "Nuclear energy – putting the future at stake", Hannes Alfvén was presented as "Swedish physicist, professor and Nobel price winner" next to the more political description as "the pioneer of global nuclear critique" (OOA 1976). Furthermore, foreign experts were often invited, since they were not part of the domestic conflict, and thus enjoyed greater credibility (Weish 2013).

At the same time, advocates of nuclear energy, most actively Risø engineer Heinz Hansen (OOA 1974-1989), who was also a founding member of the pro-nuclear REO (Reel Energi Oplysning) (Oplysning 2016), engaged in campaigns in newspapers, writing book reviews, opinion pieces and letters to the editor, challenging the scientific credibility of the experts the OOA presented.

This "event" is again actually a series of events or a continuous event. It can only be loosely linked to the decision of the government to postpone the decision of introducing nuclear power, as the debate involving experts extended beyond that 1976 decision well into the late 1970s. Thereafter the invitation of counter-experts became less frequent.

These events were covered by the media – or actually took place within the media's comment pages or letters to the editor. Hence a certain contemporary relevance in the public sphere can be assumed. None of these events were considered historical, or became a point of reference, neither then, nor in retrospect.

The following list of events with foreign experts the OOA organised between 1973 and 1991 draws on the files of the OOA (OOA 1973-1980):

Date	Invited Expert	Location
21.11.1973	Björn Gillberg	Copenhagen
14.12.1973	Dean Abrahamson	Lyngby - DTH
16.04.1974	Thorkild Bjørnvig Prof. Ove Nathan, Niels Bohr Institut Arne Schiøtz	Copenhagen
21.05.1974	Björn Gillberg Arthur Tamplin	Copenhagen
26.10.1974	Myron Cherry	Copenhagen
28.11.1974	Dean Abrahamson	Copenhagen
2.03.1975	Henry Kendall	Copenhagen
28.04.1975	Amory Lovins	Copenhagen
22.04.1976	Hannes Alfvén	Copenhagen
22.04.1977	Dean Abrahamson	Copenhagen
25.-27.04.1977	Amory Lovins	Lyngby
10.05.1975	Heldagsmøde Alternative Energikilder = One-day meeting on alternative energy resources	Copenhagen
13.06.1977	Robert Pollard	Copenhagen
27.01.1978	Frank von Hippel	Copenhagen
20.02.1978	Amory Lovins	Copenhagen
29.03.1979	Klaus Traube	Copenhagen
08.04.1979	Robert Jungk	Copenhagen
03.05.1979	Amory Lovins	Copenhagen

21.08.1979	Alice Stewart	Copenhagen
30.10.1979	Karl Morgan, George Kneale, Alice Stewart, Rosaly Bertell	Event “Kraeftrisiko ved lave strålingsdosis” = Risk of cancer due to low-level radiation
26.11.1979	Kitty Tucker	Copenhagen
03.03.1980	Donald Geesaman	Copenhagen
8.03.1980	Robert Pollard, Daniel Ford and Steven Nadis, Union of Concerned Scientists	Copenhagen
19.03.1980	Carl Johnson	Copenhagen
09.05.1984	„Alternativ Energiplan 1983“ (Frede Hvelplund, Klaus Illum, Johannes Jensen, Niels I Meyer, Joergen S. Nørgaard, Bent Sørensen)	Copenhagen
26.02.1991	Chernobyl-Photographer Alexander Salmygin	Copenhagen

Event 3	**Mobilisation of counter-expertise through events with foreign experts and the mobilisation of pro-nuclear expertise by Risø employees/REO to challenge and at times**
Actors: Who was involved (refer to table of potential actors, above)? **Q1:** Who are the main actors for and against nuclear energy involved in the event and what are their political connections?	**Q1:** Promoters: *Scientific bodies*: Risø research centre employees, e.g. Heinz Hansen, who wrote opinion pieces etc. In the 1970s, the Risø research centre was the well-connected hub of nuclear expertise and advocacy in Denmark. *Interest groups*: pro-nuclear Reel Energi Oplysning (Real Energy Information), founded in 1976, with Heinz Hansen being one of the founding members(Oplysning 2016) There were network ties and overlapping memberships between Risø, the Niels Bohr Institute/Institute for Theoretical Physics (via Bent

	Elbek, another founding member of REO) and REO (Oplysning 2016). Receptors / Affected People *Interest groups*: OOA (Organisation for Nuclear Information), who mobilised Scientists as experts OOA maintains manifold transnational connections with anti-nuclear groups in Europe (Meyer 2014)
Q2: How did the involvement of these actors change over time?	**Q2.** Change over time is hard to establish. It seems that the conflict tended to harden.
Q3: Did networks and alliances of actors play a role for this event: If yes: What alliances were formed? Which actors treated which other actors (explicitly or implicitly) as opponents? What transnational cooperations/alliances/flows of information took place?	**Q3.** For networks, see answer to question 1.
Q4: Which actors were the "regulators" for this event? What was the level of "trust" they enjoyed?	**Q4.** While Risø was initially expected to become the regulator, this role was withdrawn from it (see above), also due to a lack of trust in their independence.
Q5: Did changing involvement (state/private) change public opinion/trust?	**Q5.** On the basis of the evidence available, changes in trust in public and private actors were not relevant. Generally, many contemporary anti-nuclear activists were sceptical towards the intermingling of public and private interests, and more generally in the profit-interest of private companies.
When and where did it take place?	1973 until 1991, events mostly in Copenhagen, at times also elsewhere, in national media
Public Engagement: What type of process was it (communication, consultation or participation)? How did this change over time?	
Q1: What type of public engagement was employed, if any?	**Q1:** The type of public engagement employed by the promoters, who also initiated this communication, in this case was public communication, mostly in the media.

	The critics of nuclear energy, who initiated these events, inviting counter-experts for evening or weekend discussions, routinely also started out with public communication, with a talk by the expert. However, often the debates actually had an interactive format, conforming rather to the model of public participation.
Q2: How did PR/public engagement by the nuclear establishment change over time?	**Q2.** Change cannot be established on the basis of the documents available.
Q3: Who is the initiator of the event? (Promoters, Opponents, State or authorities, mixed origin)? What kind of events did they initiate?	
Q4: Is there evidence of some type of process of *interaction* between the "promoters" and the potentially "affected" people/stakeholders? What kind of interaction? How did this change over time?	**Q4.** In the case of the newspaper articles by researchers from Risø, this involves a discussion – and usually dismissal – of the information, knowledge and views of nuclear critics. When opponents initiated events, they often sought to invite public authorities, and criticised public authorities for not being willing to engage.
Q5: Were the events "evaluated"? If so, how? What claims have been made for their success/failure?	**Q5:** There is no information available on this, but we can assume that they were at least informally evaluated.
Arguments and Behaviour: What rationale was given by the party that implemented the engagement (if any)?	
Q1: What kind of nuclear-civil society interactions can we distinguish in the broadest sense? Is there any explicit social conflict? What kind? Among which actors? Why? Was there violence or use of force? What sort of protest behaviour took place?	**Q1.** Conflict played out in a war of words, not in violence or use of force. The foreign counter-experts mobilised by OOA clearly highlighted the perceived risks and problematic implications of nuclear power. Conversely, supporters of nuclear power, like Heinz Hansen (OOA 1974-1989), often dismissed the credibility of these counter-experts.
Q2: Who was against nuclear energy? How did they operate, and did they learn	**Q2:** Clearly, in this debate in which highly motivated actors engaged on both sides, who

from experience? Is there evidence of (reluctant) tolerance / acceptance? What are the main issues/conflicts for those against nuclear energy (e.g. weapons, safety)? What is the promoter narrative? How does this narrative resonate with other actors, e.g. the media? How did it change over time?	believed in their cause with substantial zeal, there is no evidence of acceptance or tolerance. While the prominence of different arguments (see Q3) changed over time, the confrontational style did not give way to acceptance or tolerance.
Q3: How has government (etc.) responded to resistance? How did government behave towards promoters and supporters of nuclear energy? Which were the main arguments (supporting points of view, justifying behaviour)? How were these arguments framed (relating to larger societal conflicts, the economy, visions of the vision etc.)?	**Q3:** Arguments of the promoters of nuclear power were often politically framed. Three features were most prominent: - Critique of the scientific credibility of those counter-experts, attacking the quality of their science (what more recently has been characterised as the "junk science" argument in the US context (Oreskes and Conway 2010) - Critique of their political position, e.g. by denigrating them as unreliable left-wingers, who only criticised western corporate nuclear power, and forgot about the dangerous plants in socialist countries (OOA 1974-1989). - Claims that concerns about safety were exaggerated. The arguments of the critics varied with their respective approaches to the problem - "There is no such thing as safe enough": Abrahamson/Tamplin: dangers of low-level radiation. - The "nuclear state"-argument, i.e. the safety requirements of nuclear power will lead to dictatorship (Robert Jungk's notion of "Atomstaat") (Jungk 1977) - Critique of the centralised structure of energy provision - Armory Lovins The arguments in debate clearly link nuclear issues to societal problems, ideological cleavages and visions of society.

2.4. Event 4: Anti-nuclear protest organised by the OOA (Organisation til Oplysning om Atomkraft) (1970s/1980s), notably against the Barsebäck power plant in Sweden (just opposite of Copenhagen)

In 1975 and 1977, at the time of the most vibrant debate about nuclear energy and energy policy in Denmark, two nuclear reactors went on line in the vicinity of the Danish capital. The two reactors of the power plant at Barsebäck, Sweden, were located only 20 km from central Copenhagen, as the opponents routinely highlighted. Its two towering blocks were visible from the beaches and port sides in North-Eastern Sealand, making the perceived threat to Danish citizens symbolically visible. The power plant was originally intended to have up to six reactors. It was operated by the Swedish company Sydkraft, and delivered nuclear-generated electricity also to consumers in Denmark, through a thick cable on the ground of the narrow Sound (Öresund) that separates the Danish archipelago from the Scandinavian peninsula.

As the Danish decision on moving towards developing nuclear power within Denmark had been put on hold in 1976, the Danish anti-nuclear organisation OOA made Barsebäck the main target of its campaigns. Since 1976, OOA organised marches from all parts of Denmark to Barsebäck, for demonstrations together with the Swedish anti-nuclear movement (OOA 1980, 1978, 1979, Nielsen 1976). The OOA specifically highlighted the risk of nuclear accidents, so close to Copenhagen (Storm 2014, 55,59, Petersen 1996, 174-176), while the REO produced a leaflet in 1982, which dismissed these concerns (Korsbech 1982)

The Danish battle against the power plant in neighbouring Sweden continued for more than twenty years (Löfstedt 1996), also involving diplomatic pressure from the Danish government, a Danish-Swedish joint parliamentary commission of enquiry in 1983-84 (Barsebäckvaerket 1985), a motion of the Danish Parliament in 1986 (Folketinget 1986) and direct communication of the OOA with Swedish Social Democrats, until the power plants were finally closed down in 1999 and 2005, after the privatisation of Sydkraft, which was taken over by the German utility Eon (Storm 2014, 67, Kaijser and Meyer forthcoming 2018).

Eventually, the decision to close down Barsebäck can be linked to the engagement of the Danish (and Swedish) population with nuclear power, and their ongoing protest. Indeed, these annual demonstrations can be considered one long-term event in the transnational history of Scandinavian nuclear power and society. Hence, more than the other events, the protest against Barsebäck was recognised by the contemporaries as important and covered by the media, and became a point of reference in subsequent debates. The slogan "Hvad ska' væk – Barsebäck. Hvad ska' ind – sol og vind" (What needs to go – Barsebäck, what do we need instead – sun and wind"), which linked Barsebäck to the need for a transition to small-scale and renewable energy sources, demonstrates the symbolic importance of Barsebäck in the Danish and Scandinavian conflicts about nuclear energy.

Event 4	
Actors: Who was involved (refer to table of potential actors, above)? Q1: Who are the main actors for and against nuclear energy involved in the event and what are their political connections?	Promoters: Companies: The Swedish Utility Sydkraft / Eon Energy, which was the object of the protest, as it was operating Barsebäck Political Parties: Swedish socialists, as addressees of Danish complaints about Barsebäck Affected people: Civil society: OOA as organiser of the protest marches, mobilising thousands of citizens and lobbying the Danish and Swedish governments Regulators: Swedish authorities: closing down Barsebäck Danish authorities: issuing emergency information (Miljøstyrelsen 1986) etc.
Q2: How did the involvement of these actors change over time?	**Q2:** There is no information on this.
Q3: Did networks and alliances of actors play a role for this event: If yes: What alliances were formed? Which actors treated which other actors (explicitly or implicitly) as opponents? What transnational cooperations/alliances/flows	**Q3:** The OOA built up alliances with Swedish anti-nuclear activists.

of information took place?	
Q4: Which actors were the "regulators" for this event? What was the level of "trust" they enjoyed?	**Q4:** The Swedish authorities were the regulators for the Barsebäck plant. Repeated Danish reports on the oversights of Swedish regulators pointed to a lack of trust.
Q5: Did changing involvement (state/private) change public opinion/trust?	**Q5:** There is no information on this.
When and where did it take place?	Throughout Denmark and Sweden, with marches leading from different places in Denmark and Sweden to Barsebäck, annually, from 1976.
Public Engagement: What type of process was it (communication, consultation or participation)? How did this change over time?	
Q1: What type of public engagement was employed, if any?	**Q1:** The public engagement was initiated by the opponents, the Danish (OOA) and the Swedish anti-nuclear movements and involved protest marches, which amount to public participation. The promoter, the Swedish utility Sydkraft invited e.g. a Danish girl's orchestra to play at the "topping out" party of the second reactor in Barsebäck. This event should be characterised as a public communication event. The public communication to the citizens locally about the plant, including assurances about its safety, was targeted at the Swedish communities around the plant (Storm 2014, 53-55).
Q2: How did PR/public engagement by the nuclear establishment change over time?	**Q2:** As concerns change over time in the utilities' PR/public engagement with a view to the protest marches, this would require further research for additional evidence, from Swedish company or state archives.
Q3: Who is the initiator of the event? (Promoters, Opponents, State or authorities, mixed origin)? What kind of events did they initiate?	**Q3.** The events were initiated by OOA and its partners, i.e. the opponents, and involved marches and demonstrations. OOA also engaged in different lobbying activities.
Q4: Is there evidence of some type of	**Q4.** There is very little information available on

process of *interaction* between the "promoters" and the potentially "affected" people/stakeholders? What kind of interaction? How did this change over time?	the process of interaction between the promoters and the "affected people", and the change over time. This would require further detailed study and search for additional primary sources.
Q5: Were the events "evaluated"? If so, how? What claims have been made for their success/failure?	**Q5:** The OOA evaluated their own marches, assessing problems, e.g. in the cooperation with the Swedish side, in order to improve its campaigns (OOA 1978).
Arguments and Behaviour: What rationale was given by the party that implemented the engagement (if any)?	
Q1: What kind of nuclear-civil society interactions can we distinguish in the broadest sense? Is there any explicit social conflict? What kind? Among which actors? Why? Was there violence or use of force? What sort of protest behaviour took place?	**Q1.** There was clearly social conflict, with protest marches. Protest – of Danish citizens – mobilised and organised by OOA, and Swedish citizens - however remained largely non-violent. People marched and sang protest songs and stood their ground in front of the power plant to demonstrate their disapproval.
Q2: Who was against nuclear energy? How did they operate, and did they learn from experience? Is there evidence of (reluctant) tolerance / acceptance? What are the main issues/conflicts for those against nuclear energy (e.g. weapons, safety)? What is the promoter narrative? How does this narrative resonate with other actors, e.g. the media? How did it change over time?	**Q2.** There was very little evidence of acceptance. The goal of the OOA was to close down Barsebäck, as it was considered to endanger the Danish capital region, with the risk of a nuclear accident. This was even more clearly highlighted after Three Mile Island and Chernobyl, and illustrated with images demonstrating that Copenhagen was going to be in the most heavily devastated zone after an accident. Barsebäck was routinely described as the world's worst location for a power plant, due to its proximity to the large Copenhagen conurbation. The promoter narrative was about cheap and reliable energy provision (also for Denmark), and the irrelevance of safety concerns, which were routinely dismissed as far-fetched.
Q3: How has government (etc.) responded to resistance? How did government behave towards promoters and supporters of nuclear energy?	**Q3.** The Danish government did not actively side with the Swedish utility across the Sound. However, after Chernobyl, it issued safety information to Danish households, indicating what to do in case of emergency (OOA 1974-

Which were the main arguments (supporting points of view, justifying behaviour)? How were these arguments framed (relating to larger societal conflicts, the economy, visions of the vision etc.)	2000). To what extent this actually reinforced the protest, as it emphasized the dangers, remains unclear.

2.5. Event 5: Responses to Chernobyl and transnational activities in the context of the "Radiating Neighbours" Campaign of 1986

In the wake of the debate on nuclear power since the 1970s, Chernobyl in April 1986 was viewed by many contemporaries as clear evidence that nuclear power involved actual and considerable risks. As a response to this, the OOA reinforced its routine requests to public authorities about safety procedures (OOA 1974-2000) on risks nearer to home, notably the Barsebäck plant. Public authorities, such as the Danish Environmental Admininistration (Miljøstyrelsen), subsequently distributed information brochures to the public(Miljøstyrelsen 1986). The OOA also embarked on its own attempts at NGO diplomacy. It kicked off the "Radiating Neighbours" campaign targeting all nuclear power plants within 150 km of the Danish borders; in Sweden, West and East Germany. Over the summer of 1986, the OOA collected some 160,000 signatures, which they handed over to the West and East German, and Swedish embassies in September 1986, in a large demonstration to the embassies (Meyer 2016). In the wake of this, the OOA received an invitation to visit the German Democratic Republic in October 1986, to voice their concerns about East German power plant projects, on the Southern coast of the Baltic Sea, in the vicinity of Southern Denmark (Christiansen 1986a). Danes were particularly worried as the East Germans relied on problematic Soviet nuclear technology (OOA 1983-ca.1990). At the same time, the OOA self-assuredly offered to advise the GDR on renewables policy(Christiansen 1986b). They also visited East German anti-nuclear activists at the East Berlin Umweltbibliothek (Heitmann 1986).

While Chernobyl as an event clearly had an impact on nuclear policy East and West, the activities covered under this event only made a small difference. The events were not recognised as important, even though they were transnationally covered in the media (in East

Germany, West Germany and Denmark, as for the visit to East Berlin). The events themselves – unlike Chernobyl – did not subsequently become a point of reference.

Event 5	**Responses by the OOA to Chernobyl: The "Radiating Neighbours" campaign of 1986 (OOA 1983-ca.1990)**
Actors: Who was involved (refer to table of potential actors, above)?	
Q1: Who are the main actors for and against nuclear energy involved in the event and what are their political connections?	**Q1:** Promoters: - Government: East German government representatives (including junior ministers), talking to the OOA visitors Receptors/Affected people: Interest Group: OOA visiting East Berlin, lobbying governments of Sweden, East and West Germany Regulators: National and Local authorities: Distributing information to citizens about what to do after a nuclear accident (Miljøstyrelsen 1986).
Q2: How did the involvement of these actors change over time?	**Q2:** The campaign "Straalende naboer" – "Radiating neighbours" is much more sophisticated than previous ones, combining the collection of signatures, with a protest march and the submission of these signatures to the embassies of the GDR, the FRG and Sweden, and lobbying, direct contacts.
Q3: Did networks and alliances of actors play a role for this event: If yes: What alliances were formed? Which actors treated which other actors (explicitly or implicitly) as opponents? What transnational cooperations/alliances/flows of information took place?	**Q3:** Transnational networks and alliances with West German activists played an important part in finding civil society activists in GDR to visit, next to the official visit of the GDR state authorities.
Q4: Which actors were the "regulators" for this event? What was the level of "trust" they enjoyed?	**Q4:** Upon their visit to East Berlin, the Danish OOA activists sought to talk to the East German regulators, potentially also in order to enquire about their trustworthiness.

Q5: Did changing involvement (state/private) change public opinion/trust?	**Q5:** This is unknown.
When and where did it take place?	1986, Copenhagen region / East Berlin
Public Engagement: What type of process was it (communication, consultation or participation)? How did this change over time?	
Q1: What type of public engagement was employed, if any?	**Q1.** Public engagement in the context of the OOA's "Radiating Neighbours" campaign in Denmark included public communication, i.e. the distribution of information to citizens, the collection of some 160,000 signatures, protest in front of the embassies, and an invitation to talk with high-level embassy staff. In East Berlin, it involved participation along the lines of diplomacy, in which the OOA was given polite, but often not very far reaching concessions, e.g. that an article on renewable energy sources was distributed in an East German newspaper.
Q2: How did PR/public engagement by the nuclear establishment change over time?	**Q2.** Change over time is impossible to trace here.
Q3: Who is the initiator of the event? (Promoters, Opponents, State or authorities, mixed origin)? What kind of events did they initiate?	**Q3.** The events were initiated by the opponents, by their protest (including a night guard protest in front of the Soviet embassy in Copenhagen one year after Chernobyl). An OOA delegation indeed visited East Berlin to talk to authorities and civil society groups (closely surveyed by the GDR secret service)
Q4: Is there evidence of some type of process of *interaction* between the "promoters" and the potentially "affected" people/stakeholders? What kind of interaction? How did this change over time?	**Q4.** The interaction, as indicated, was characterised by lobbying/diplomacy/asking critical questions on behalf of the OOA, and by public information by the authorities.
Q5: Were the events "evaluated"? If so, how? What claims have been made for their success/failure?	**Q5:** Surely informally, as this was common practice among the OOA, but there is no evidence.

Arguments and Behaviour: What rationale was given by the party that implemented the engagement (if any)?

Q1: What kind of nuclear-civil society interactions can we distinguish in the broadest sense? Is there any explicit social conflict? What kind? Among which actors? Why? Was there violence or use of force? What sort of protest behaviour took place?	**Q1.** In the aftermath of Chernobyl, there was conflict and protest, however, not of the violent kind. Protest was peaceful and symbolic.
Q2: Who was against nuclear energy? How did they operate, and did they learn from experience? Is there evidence of (reluctant) tolerance / acceptance? What are the main issues/conflicts for those against nuclear energy (e.g. weapons, safety)? What is the promoter narrative? How does this narrative resonate with other actors, e.g. the media? How did it change over time?	**Q2.** There is no evidence of peaceful acceptance among those active in protest. The main critique relates to the safety issue, the example of Chernobyl plays an important role. Fear of an accident is the overwhelmingly important argument. Government is encouraged by OOA to update their safety information and plans, so as to be well-prepared.
Q3: How has government (etc.) responded to resistance? How did government behave towards promoters and supporters of nuclear energy? Which were the main arguments (supporting points of view, justifying behaviour)? How were these arguments framed (relating to larger societal conflicts, the economy, visions of the vision etc.)?	**Q3.** Government response in Denmark is to engage in diplomatic exchange with neighbours who maintain power plants, and encourage them to improve safety or close down. Government in GDR seeks to win a diplomatic victory by demonstrating their openness to Danish protest, and willing to talk about the issue. However, they insist that they will have to produce energy and that nuclear energy is the best way to do this. Nevertheless, after Chernobyl they accept that they will have to improve their safety, and thus delay construction. In GDR, the vision of high energy-consumption and industrial progress is still officially the guiding concept, with any opposition to it strictly monitored and at times openly suppressed.

3. Facts & Figures (assembled by Aisulu Harjula, Lappeenranta University of Technology)

The purpose of this section is to give an overview of nuclear power in Denmark. It contains such data as number of reactors, reactors' locations, technical and chronological details of reactors' construction as well as statistics on electricity production, periodization and social connections to nuclear constructions. This data can be used as a supplementary material to the other sections of this country report, to help understand the country's overall situation. Key dates and abbreviations used in this report are presented in the beginning of this section.

3.1. Key facts

- Danish researchers contributed importantly to nuclear research, notably Nobel Prize laureate nuclear physicist Niels Bohr (1885-1962).
- The backbone of Danish nuclear research in the post-war period were three research reactors at the **Risø Research Centre** on Roskilde fjord which are now decomissioned.
- Denmark has no nuclear power plants. Imported nuclear power is supplied to its grid, mostly from Sweden, and to lesser extent from Germany, as well as water power from Norway.
- Low level nuclear waste from three research reactors remained in Denmark after the closure of the research reactors of the **Risø Research Centre**. Spent fuel has been sent back to the US. The government has been searching for a repository place within the country.
- Greenland is a prospective place to mine uranium. Recently the Danish government issued legislation that created a legal framework to export Greenland's uranium. Uranium will be supplied under bilateral nuclear cooperation under Euratom and IAEA.
- Denmark offers incentives to encourage the use of renewable energy. Danish researchers and entrepreneurs have been among of the pioneers of wind power since the 1970s.

3.2. Key dates and abbreviations

Key dates:

1921	The Institute for Theoretical Physics was founded by Niels Bohr in Copenhagen.
1922	Niels Bohr received the Nobel prize in physics "for his services in the investigation of the structure of atoms and of the radiation emanating from them."
1939	Nuclear fission was proved for the first time experimentally.
1957-1960	The Danish Atomic Energy Commission commissioned three research reactors.
1965	The Institute for Theoretical Physics was renamed to Niels Bohr Institute.
1975	The second research reactor DR-2 was shut down because of the decision to substitute it with a bigger research reactor DR-3.
1985	The Danish parliament decided that nuclear power plants will not be built in the country.
1988	Use of HEU was abandoned and instead of it LEU was used in the research.
1999	The Danish parliament decided to reform energy policy with a view to electricity provision that enables competition and promotes renewable sources.
1999	The third research reactor DR-3 had a leak in drain pipe. Decision was made not to put it back to operations. Used fuel was shipped to USA.
2000	The third research reactor was shut down.
2001	The second research reactor was shut down.
2001	Production of uranium fuel for research reactors was stopped.
2007	Government established a plan to provide 30% of energy consumption coming from renewables by 2020 and 50% of electricity consumption from wind energy.
2007 - 2016	Preparations and legislation about uranium mining in Greenland
2016	A legal framework to export uranium from Greenland was created. Greenland is independent to mine uranium but its export requires Danish authorization.

Abbreviations:

HEU	High enriched uranium
IAEA	International Atomic Energy Agency
LEU	Low enriched uranium
WMP	Waste management plant
MW	MegaWatt

3.3. List of reactors and technical and chronological details

The tables below show the list of research reactors, operators as well as the dates of their operation.

Table 1 - Research nuclear reactors in Denmark

Name	Use	Operator	Type & MWt	Operations start	Shutdown	Decom-missioning
DR-1	research, education	Risø National Laboratory	low power 0,002 MW	1957	2001	2006
DR-2	physics research production of radioactive isotopes	Risø National Laboratory	5 MW	1959	1975	2005-2008
DR-3	neutron physics research, materials tests, production of radioactive isotopes for medicine and industry	Risø National Laboratory	heavy water 10 MW	1960	2000	by 2020

Table 2 – Decomissioned nuclear facilities in Denmark

Facility	Operations start	Shutdown	Decommissioning
Fuel fabrication facility		2001	2015
WMP	1964	1989	2008-2012

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WP2

Finland

Short Country Report

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Deutsches Museum

DIALOGIK

Europos humanitarinis universitetas

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Swedish Defence University

GRE

KTH

LUT Lappeenranta University of Technology

Universidad Pública de Navarra

UPMC Sorbonne Universités

The University Of Sheffield.

Science Museum

Sociedade Portuguesa de Inovação

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Executive summary

This report belongs to a collection of 21 short country reports on the History of Nuclear Energy and Society (HoNESt, project Ref.662268). The reports tackle the complex sociotechnical system around nuclear energy. Nuclear developments, notably nuclear energy, are closely intertwined with social, economic, environmental, political and cultural spheres. Nuclear energy is also a globalized system involving transnational transfers of knowledge, materials, technologies, people and products including electrical power, medical elements, toxic wastes and other environmental hazards, materials, capacities and knowledge that must be carefully safeguarded. Nuclear energy is a complex social and technological phenomenon that influences societies but is also shaped by societies.

The short country reports are designed to assemble information and research results on the history of the relations between nuclear energy and society about all the different country cases in an accessible manner, and to document the findings with references.

The purpose of the country reports is threefold, addressing three different audiences:

1. to provide basic elements of narrative and analysis for further historical research by HoNESt researchers,
2. to provide information, context and background for further analysis for HoNESt's social science researchers,
3. to provide accessible information on nuclear-societal relations in the various countries for the purposes of outreach and communication with stakeholders (civil society, industry, associations, policy makers, journalists).

Key issues in the Finnish nuclear history

Finland joined the atomic family in the middle of the 1950s when the Atoms for Peace – program was launched and the first international conferences were organized. Although Finland needed desperately new sources of energy, it was understood that atomic energy could not provide an instant solution to the demand of inexpensive energy. Before commercial power reactors could be built, significant investments had to be made into research and education. In addition, it was calculated that at least a decade was needed before one commercial reactor could go critical. Therefore, nuclear energy was, and it still is, regarded as one sources of energy when the energy policy decisions are made.

Finnish energy policy has had since the late 1940s one strategic goal; to increase the domestic supply of energy and to decrease nation's dependencies from direct energy imports (gas and electricity) and indirect imports of fossil fuels. Massive investments in hydro, thermal and nuclear energy plants have been made during the past 70 years, but the goal of the energy policy is still out of reach. The latest estimation made by the Finnish government shows that even if all current energy projects are successful, Finland could cut the energy dependency to 50% by the end of this decade.

Although it is widely accepted fact that Finland can never construct an energy system that is fully independent from foreign sources of electricity and fuels, high level of self-sufficiency is and has been the main goal of the energy policy. Because of this, nuclear energy has established a permanent position in the Finnish energy system. Currently Finland has four nuclear reactors that collectively supply less than 30% of the total consumption of electricity. The fifth reactor project is seriously late, but it is estimated to be finished before the end of this decade. The sixth reactor project has been accepted, but it still waits for the final political decision from the Parliament. If and when these two new reactors will go critical, they will replace the old reactors that have operated since the early 1980s. From the energy policy point of view Finland will be a nuclear country till the end of this century.

One key concept is the "triangle of power". Nuclear power projects in Finland have been controlled and governed from the day collectively by authorities (Radiation Safety Agency), nuclear companies (IVO/Fortum and TVO) and government agencies (AEN, KTM). This triangle of power has had almost unlimited powers to establish the rules of the game and enforce rules in all situations and all circumstances. The triangle of power was born in the 1960s when the first nuclear power stations were negotiated. It was understood that no political organ can match the arrogance of the superpower and multinational companies. However, the triangle of power proved to be a fearless opponent, patient regulator and pedant interpreter of every norm and standard. This unique construction was able to say no to the highest political authorities in Moscow and Washington, stop the construction of a billion euro power station and limit the production of the nuclear power station that had been waiting to get critical for many years.

Finnish nuclear history is also full of flexible actors. Politician who had invested reputation and political credibility to the nuclear power projects were able to turn around and vote against the nuclear energy. Nuclear power companies and utilities who had made long term plans and investments to new reactors were able to adopt alternative strategy and abandon or delay nuclear projects if the circumstances were against them. And finally ordinary people in communities, towns and cities could vote for nuclear energy, but next day change their minds and demonstrate against the same proposition. Flexibility has given the decision makers time to think, consider and reconsider alternatives before the final decision has been made. And even then it is possible that the tide turns and the decision is reversed.

1. Historical Context (narrative)

This section provides the basic historical context to the interaction between nuclear industry and civil society in Finland. The historical narrative aims at providing relevant context to the events as well as the showcase.

1.1. Introduction to the historical context

Structure of the report

This short country report from Finland contains four parts. After the introduction we present a historical narrative that focuses on the interaction between nuclear energy and society in Finland since the 1950s to the present. This section is followed by detailed analyzes of six events in chronological order. At the end of the report a showcase is presented. It demonstrates particular characteristics of the social interaction with the nuclear industry in Finland. The report has also a section of facts and figures.

Nuclear history of Finland has begun in the late 1940s and continues till now, and most likely will continue in the future. Nuclear energy in Finland has never been regarded as a “national” energy because it has been influenced by flows of transnational ideas, ideologies, knowledge and technologies as well as by transnational actors and their agendas. This does not demonstrate that Finland has been a helpless victim. Instead, she has rather been an active and independent player able to define her role in the nuclear family. Moreover, nuclear energy has connected Finland not only to her neighbors, but also to countries beyond her close neighborhood. This has been achieved by the transfer of nuclear technologies from East and West, participation in the work of transnational nuclear organizations and collaboration with other nuclear countries.

It would take a book or rather several books to write a complete nuclear history of Finland. In the limited space of this report many important issues have been left out. On the other hand, there is no reason to repeat what has been written before but to provide novel ideas and points of view. This report is released as a part of 22 short country reports in the interdisciplinary research project HoNESt. Our hope is that this report contains information that can and will be used in the comparative and transnational research on nuclear energy.

The choice of the report's content has not been an easy one to fit the limited space. We have solved the problem by using a structure which approaches the nuclear history of Finland on two levels. First, the historical narrative analyzes the interaction between nuclear industry and the Finnish society on the macro level. After that six events contrast the same historical development on the micro level. At the end of the report there is a showcase which integrates the macro and micro levels of analyzes.

Sources and a few words of the research traditions

Finnish nuclear history is well documented. Most important stakeholders have stored both private and public collections in public archives in which they are available for research. There are also collections of nuclear operators (private and public electricity utilities and nuclear power companies) and collections of pro- and anti-nuclear associations. Interviews and other oral history documents are available in private and public archives.

Research on the Finnish nuclear history is relatively extensive and mostly based on the archival sources. Sociological research focuses on current issues and utilizes surveys, interviews and secondary literature. Unfortunately there has been lack of multidisciplinary research on the topic. Historians and social scientists have worked separately and focused on different areas of the Finnish nuclear history. Therefore it is difficult, if not impossible to construct a comprehensive picture of the Finnish nuclear history. There are missing areas that need to be researched. There are also historical constructions and thought patterns that should be exposed to critical analyzes.

The historical research on nuclear energy in Finland was dominated by the academician Erkki Laurila for a long time. He was a multitalented person who became the central figure in Finnish atomic energy in the early 1950s. Laurila was a physicist by education but he made his career in engineering and science and technology administration. He wrote several books on nuclear energy and Finnish society. Especially his first book "Atomienergian tekniikka ja politiikka" (Technology, politics and atomic energy in Finland) published in 1967 was the most dominant work in the field for a long time. His second book "Ydinenergiapolitiikan harhailut" (The Aberrant Nuclear Energy Policy) demonstrated rather a political statement than a critical analysis.

Although Laurila was not a professional historian, he was able to compound historical narratives that combined historical facts and personal experiences. According to him, Finland did not rush into nuclear age but followed the industry's development in other European regions. Laurila also emphasized political and ideological aspects of nuclear power. Finland, which is located between East and West and "squeezed" between two hostile superpowers, was unable to make independent decisions concerning nuclear energy. Therefore, nuclear energy in Finland could never be a "democratic" decision. Instead, it was managed and governed by politically, socially and technically superior individuals. Neither nuclear enthusiasts nor opportunists could influence nuclear power decisions in Finland, but only those who could understand political, technological and economic realities, needless to mention that Laurila himself became the chairman of the Atomic Energy Commission and the President's chief advisor in nuclear and energy affairs (Laurila 1967; Laurila 1977).

Laurila's arguments have been re-evaluated by the younger generation of historians. Karl-Erik Michelsen and Tuomo Särkikoski have studied critically and from original sources the development of nuclear energy policy in Finland from 1950s to the present. (Michelsen 1993; Michelsen 1999; Michelsen and Särkikoski 2007; Särkikoski 2011). Meanwhile, Petri Paju (2008) has demonstrated a broad view on the Finnish technology policy during the 1950s and 1960s. The latest historical research confirms Laurila's interpretation at least partially, but argues that the picture has more colors. Indeed, the nuclear history in Finland was shaped by a small group of politicians, engineers and corporate managers who exercised what Gabrielle Hecht has called "technopolitics" (Hecht 2009).

Historians have been more interested in Loviisa nuclear power plant than in the other plant Olkiluoto which was built at the same time as Loviisa. Loviisa NPP attracted all the political and ideological drama on the scene, while Olkiluoto became a turn-key project that was managed by the Swedish company ASEA Atom. Olkiluoto project was concluded without major political debates.

However, in nuclear energy nothing is predictable. Nowadays Olkiluoto NPP attracts a dramatic attention because in 2003 the energy company Teollisuuden Voima (TVO) received a permission to finally build the "fifth reactor" in Finland. This reactor has been planned, debated and decided for more than 20 years. The French company AREVA and the German company Siemens are jointly constructing the nuclear power plant that should have been commissioned by 2010 but the project is still unfinished. Therefore, Olkiluoto project is scrutinized by social scientists, historians and environmental scientists because its completion accumulated various problems and troubles. Besides that, Olkiluoto NPP will serve as a location for the first ever permanent repository for nuclear waste.

Social scientists in Finland have only recently begun to pay attention to nuclear energy (Olli Tammilehto 1994). Traditionally the sociological research in Finland has focused on issues related to the development of the welfare state. However, because of increasing environmental awareness, the emergence of anti-nuclear movements and the growing political influence of the Green Party, social scientists have become interested in nuclear energy and especially in the management of nuclear waste. Currently the research interest has moved to the climate change issues. Public debates are intensifying on the role of nuclear power in the future energy and climate policy; and nuclear energy is no longer considered as the only solution for the future energy needs. (Raittila et. al. 2002; Litmanen 2008; Kojo 2004; Lammi 2004; Kyllönen 2004; Lovio et.al 2016).

Methods and concepts

History can be written in a number of ways. Traditionally, political history has dominated the scholarship but as Eric Hobsbawm (Hobsbawmn 1997) has pointed out, the use of "ideas" and "ideologies" as an explanation for history has declined since the end of the WWII. Instead, there has been a decisive turn to social and economic factors. Social and economic history investigates social changes by focusing on social structures, interactions between civil society and institutional actors, social groups, various stakeholders and institutions. Social history also considers various discourses between social groups.

This project has a special challenge because historians and social scientists are expected to work together and collaborate. According to the initial call, historians collect evidence and analyze changes in the nuclear history and provide this information to the social scientists for further analyzes. Although the linear model of information flow appears to be simple, there are many methodological issues that need to be clarified before the research can start. Our society is full of information, and although the project narrows its scope to the interaction between the nuclear industry and the civil society, the information basket is enormously large and deep.

It is crucially important that historians and sociologists understand and agree on the content of information that is collected and used in this project. This is not a simple task because traditionally these two disciplines have not been the best neighbors. However, they can complement each other as Peter Burke (Burke 2005) concludes. Historians' key ability is in explaining how societies change over time and sociologists master in generalization of patterns. Historians use chronology to build comprehensive stories and sociologists focus on contemporary phenomena.

Historians prefer narratives that are built on facts. They dislike theories and concepts. Sociologists, on the other hand, do not use narratives. Instead, they prefer theoretical frameworks and concepts. Historians anchor narratives in geographic areas, while sociologists tend to generalize social change on the basis of contemporary experiences that can take place wherever. (Burke 2005).

This project tries to overcome these problems by focusing research on the interaction between the nuclear industry and the civil society. The interaction assumes that there are less political, economic and technological histories of nuclear energy and there is more space for public debates and discourses. This project questions how the perception of nuclear energy has changed over time and who have participated and engaged in these changes. In Finland, the change has been slow but obvious. From the 1950s to the 1970s, nuclear energy discourses were dominated by scientists, engineers, corporate managers and politicians. The watershed was the 1970s, when the first nuclear power station was built. Local politicians and decision makers, also individuals and groups who opposed the nuclear industry appeared on the scene. Although the debates were either local or national, they were influenced by transnational flows of ideas and ideologies. Nuclear energy debates are therefore simultaneously local, national and transnational.

This causes the question of a nation. Short country reports by definition should explain nuclear development in a particular country. This is again a difficult precondition because nuclear energy does not fit inside the borders of a single country easily. Soviet Union, for example, pressured Finland in nuclear matters, and recently Russia as well as Western countries. If the short country reports focus only on the nuclear developments in one country many important issues are missed without an explanation.

National nuclear histories are not in conflict with transnational nuclear histories. Transnational history approach is, as Sven Beckert (Beckert 2006) and others have described, an evolving approach whose starting point is the interconnectedness of the human history as a whole. While this approach acknowledges the extraordinary importance of states, empires, and the like, it pays attention to networks, processes, beliefs, and institutions that transcend these politically defined spaces. The concept of a nation is not identical to the concept of a nation state. Transnational history understands the nation as an actor that is not a subject of the historical research but a player who enjoys a certain role in a complex environment.

Eric Hobsbawm (Hobsbawm 1997) who has studied the European history for more than half a century has concluded that there is no historically homogenous Europe, and perhaps there will never be one. However, we define Europe, and it is its diversity and the dialectical interaction of its components that characterizes its existence. Without recognizing these factors it is impossible to understand and explain the evolution of important processes such as modernization and industrialization.

Nuclear energy is intimately connected to the modernization and industrialization processes in all European countries. It is the only energy source that is completely man-made and is a product of scientific and technological developments that took place in several European countries in the early part of the 20th century. Therefore, both nuclear science and technologies have crossed national borders from the day one of their existence. Physicists, chemists and engineers who worked on discovering the secrets of the atom were dependent on the circulation of knowledge and theories. The first technological applications had been invented before and during the World War II, then the open transfer of knowledge and technologies across the national borders was halted for more than a decade. However, in the early 1950s the initiatives by the President Dwight D. Eisenhower and the United States' efforts restarted the circulation of knowledge. (Hewlett and Holl 1989).

The Cold War divided the world, but the circulation of the nuclear technologies and knowledge continued. It can be argued that nuclear energy was one of the few things that could drill holes to the Iron Curtain. Although transnational connections were strictly regulated and all deals had to be negotiated at the highest political level, the circulation of tacit knowledge and technologies continued to spread from one political system to another. Mediating organizations played a major role in this, such as IAEA, EURATOM and later WANO which managed the risks, coordinated the uranium chain and safeguarded the interface between the military and civilian use of nuclear energy. (Holloway 1994).

1.2. Contextual narrative: Nuclear energy and Finland, from 1950's to the present

The framework

Today Finland produces 66,1 TWh of electricity annually. Four nuclear power reactors cover little less than 34% of total amount of the electricity production. If all four reactors were to be disconnected from the national grid simultaneously, the electricity system would most likely collapse. At this point of history Finland is dependent on nuclear energy.

However, a vivid public debate is happening about the future of the Finnish energy policy. The Smart energy consortium argues that energy systems are in transition and major disruptions are expected. Investments in renewable energy sources have increased during the past ten years, and many countries have decided to phase out nuclear energy. Technological innovations have created new trajectories that point towards decentralized energy systems. They will create new business models and opportunities. The Smart energy consortium opposes nuclear energy. Although nuclear power is almost a carbon free energy source, it does not fit in to the future energy scenarios. Nuclear energy represents a centralized energy production and an authoritarian technology. Future energy systems are decentralized, intelligent and flexible. (Lovio 2017).

Nuclear energy belongs to the industrial society. When a peaceful use of the atomic energy was introduced in the middle of the 1950s, industrial societies needed an inexpensive, clean and abundant source of energy. Nuclear energy boosted transition from the agrarian society into modern industrial society. Nuclear power stations need educated operators, systematic scientific and technological research and organized society that governs, manages and controls the nuclear industry.

Nuclear energy is also connected to the modernization process. Technological determinists might even argue that it was this inexpensive and abundant source of electricity that guided the social development towards modernization. Those who do not believe in technological determinism argue that there are many modern industrial societies, for example Austria and Denmark, which never built nuclear power stations.

Without taking sides for or against nuclear energy, it is worth remembering that energy systems are always part of seamless social systems. Agrarian societies without energy intensive industries do not need centralized electric power systems. When Thomas Edison installed his electric light and power system in the lower Manhattan in the 1880s, he wanted to replace the local gas lighting system. Never did he dreamed that one day his system will be a global one. As Thomas P. Hughes (Hughes 1983) has shown, national and transnational networks of power were built by system builders and managers who understood the economic value of the centralized and large scale electricity production. Electricity was produced in large and centralized power stations and transmitted through massive transmission lines to cities, factories and rural communities. Nuclear power came later in this development, but relatively quickly it became an important part of the centralized energy system.

Nuclear energy has been debated ever since it was invented. However, the debates intensified during the 1970s when negative effects of the nuclear industry became known. At the same time critical voices were raised against the industrialization and modernization. People started to worry about air and water pollution, deforestation, massive urbanization and extinctions of flora and fauna. Progress that was celebrated few decades ago, then provoked fear and anxiety. Ulrich Beck, Rachel Carson, Aurelio Peccei and Alexander King raised concerns concerning the rapid pace of economic development. According to Ulrich Beck, modern industrial society accumulate risks until they overweight benefits. This argument seemed to first come through in Three Miles Island in 1979 and few years later in Chernobyl.

Nuclear debates and environmental concerns multiplied in the first decade of the new millennium, although globalization and information revolution pushed Western societies into post-industrial phase. The trouble moved to Asia, where the industrial revolution in China opened new markets and speeded up economic growth, but increased CO_2 emissions and environmental damage. Nuclear accident in Fukushima destroyed the fragile trust that had been built after Chernobyl, and many countries decided to abandon nuclear energy. The post-industrial West started to move away from centralized energy systems into decentralized systems that are dominated by renewable energy sources. Meanwhile China, India and other industrial countries in Asia continued to build nuclear reactors and conventional thermal power plants in order to secure inexpensive and abundant source of energy. (Kumar 2005).

Climate change does not recognize geographic boundaries but threatens life on this planet. International climate agreements from Kyoto to Paris have tried to reduce CO2 emissions. In order to achieve ambitious goals, conventional thermal plants must be closed or de-carbonized and rich emission sources must be redesigned and regulated. No time can be wasted or the climate change will get out of control. It has been understood that energy systems based on renewable energy sources are the ultimate target. But how to do the transition and how long it would take to replace the old centralized systems by the decentralized ones. Nobody wants to do sudden dramatic changes, because they would create unpredictable economic and social consequences. Hence, nuclear energy has become a part of the solution. If global warming pollution must be decreased at rate of 6% annually, the ambitious target cannot be fulfilled without nuclear energy. Together they will help to reduce CO2 emissions which is the first priority.

This solution is denounced by those who emphasize the complexity of nuclear energy. Although it is almost CO2 free, nuclear power stations are capital intensive and investments in nuclear energy are deducted from renewable energy sources. In addition, building new nuclear power stations and modernizing old ones delays the transformation from centralized into decentralized energy systems. (Leiserowitz 2006).

History of modern Finland can be written into this framework. Finland industrialized after the war and the modern industrial society was built during the 1950s and 1960s. The development was interrupted by the oil crises in the middle of the 1970s and the industrial society never really recovered from the crises. Instead there was a slow movement towards the post-industrial society during the 1980s. Industrial and post-industrial societies were developed in parallel until 1990 when the Finnish society experienced dramatic political and economic changes. Soviet Union collapsed and Finland integrated to the European Union. During the past two decades energy intensive industries have moved to Asia and other low labor cost countries and high technology industries and service economy has taken over.

The role of nuclear energy in modern Finland follows the same time frame. First two nuclear power reactors were built during the 1960s and 1970s without anyone opposing the projects. After the energy crises the attitudes towards industry, large scale energy production and economic growth changed. The fifth and sixth reactor have been on the political agenda since the 1970's and finally the Parliament gave permission to build the fifth reactor in 2003. Following this decision the sixth reactor received the preliminary permission in 2013. Also two older reactors have been modernized and their life cycle has been extended to 2030.

This does not mean, however, that Finland has returned to the industrial society. Nuclear power has a different role in post-industrial Finland. Proponents of nuclear energy claim that new reactors are necessary if Finland is going to fulfill its commitments in the global fight against climate change. Also it has been argued that new reactors are safe and they can improve the energy independency. Opponents of nuclear energy emphasize the structural changes in the Finnish society. Finland is no longer dependent on energy intensive industry, but the consumption of electricity is fragmented. Instead of feeding electricity to giant factories, energy companies today are serving small and midsize companies and environmentally-aware customers. Therefore, nuclear power stations are not the ideal types of energy sources for today's needs. Post-industrial society needs flexible, sustainable energy systems that can respond quickly to the changing needs of customers.

Modern industrial Finland (1945-1973)

Finland was neither industrial nor modern when the President Dwight D. Eisenhower introduced the Peaceful Use of Atomic Energy initiative in front of the UN General Assembly in 1953. Finnish energy production capacity had lost almost one fifth after the war when the large parts of Eastern Carelia and Petsamo were annexed to the Soviet Union. Meanwhile the demand of energy had rapidly increased because of the war reparations and reconstruction. Finland was ordered to pay $300 million worth of industrial goods to the Soviet Union to compensate for the war damages. This giant task took 7 years and sliced annually more than 5% of the GDP (Kekkonen 1952a).

Although war reparations boosted industrialization, Finland was still mostly agrarian in 1950. About 50% of the total population of 4,4 million lived and worked in the countryside. Helsinki, the capital and the biggest city had only 370 000 inhabitants. Vyborg, the second largest city was lost to the

Soviets after the war. The initiative from the United States sounded interesting, but how could a small and isolated country participate in the ambitious scientific and technological project?

It took less than a year after Eisenhower's initiative when the atomic energy project was put in motion. Finnish Science Academy drafted a letter to the Finnish government asking funding for the atomic energy research. The letter was signed by Professor A.I.Virtanen, the Nobel Prize winner in Chemistry in 1945, and 11 members of the Academy (Tiitta 2004).

The government decided to move forward quickly. Although the nuclear power stations were far in the future, peaceful use of atomic energy could be used for several other purposes. Finland had tried to become a member of the United Nations, but the Soviet Union had denied the access. Atoms for Peace – initiative was coordinated by the United Nations and therefore it could open doors for full membership. Secondly, in order to build and operate nuclear power stations, Finland needed to establish high quality scientific and technological research and education institutions. Helsinki University of Technology was waiting to move from the downtown campus to the Otaniemi campus, but the project had been delayed for years. Atoms for Peace initiative could be used to enhance this project, too. Thirdly, Eisenhower's initiative called for international collaboration and this was exactly what the Finnish scientists, engineers and corporate managers needed after the war. Finally, the nuclear energy project could inspire Finnish engineering and high technology companies to invest in research and development. In sum, Atoms for Peace project was one of the few positive initiatives after the devastating war. It promised better future by enhancing industrialization, urbanization and the development of modern industrial Finland (Michelsen 1993).

Finnish government appointed the Energy Committee to prepare Finnish participation in the Atoms for Peace process. The committee predicted that new hydro power stations in Lapland and the reconstruction of the national grid would satisfy the need of electricity until the beginning of the 1960's. Conventional thermal power stations were needed to complement the hydro power and balanced the irregularities of the production of electricity. Finland had signed bilateral trade agreements with Soviet Union in 1950 and the agreement guaranteed the imports of crude oil, coal and natural gas. The Energy Committee concluded that the first commercial nuclear power reactor could start in the beginning of the 1970s. Since then the economic growth and industrialization required new nuclear reactors almost annually. This would require systematic investments in education of nuclear engineers and operators and ambitious research on nuclear sciences and technologies. Finnish energy policy aimed to improve the self-sufficiency in energy production and to limit the need to import fossil fuels and electricity from abroad (Michelsen – Särkikoski 2005).

As the Energy Committee had predicted, most of the electricity was produced in the hydro power stations before 1960. Conventional thermal power stations were helping to balance the production and about one fifth of the total production of electricity and heat came from burning oil, coal and peat. Finland was able to maintain a high level of self-sufficiency and only 5% of the total consumption of electricity came from the imported resources.

Finland industrialized rapidly during the late 1950s and early 1960s. The growth was unstable during the latter part of the 1950s, but the government used financial policy instruments to enhance export industries. The currency was devaluated several times during the 1950s and 1960s. Domestic energy production was able to respond to the economic growth, but not for long. The consumption of electricity had already climbed from 8,8 TWh in 1960 to almost 22 TWhs in 1970 and the prediction for the next decade showed that the growth would continue. In order to satisfy the need, Finland had two alternatives. Conventional thermal power stations could carry a bigger load or Finland could start to invest in nuclear power. The first option was technologically easier, but it would put additional stress to the trade balance that was already negative throughout the 1960s. Nuclear power stations, on the other hand, used imported fuel, but the cost of fuel was relatively low compared to the total value of production (Voimalaitoskomitea 1974).

Two nuclear power projects were launched in the early 1970s. The state owned energy company Imatran Voima (IVO) built the first nuclear power station on the Island of Hästholmen, just outside of Loviisa. The second project was managed by Teollisuuden Voima (TVO), a private utility owned by the Finnish industry. Loviisa NPP had two Soviet designed pressure water VVER-reactors and Olkiluoto NPP installed two ASEA-Atom manufactured boiling water reactors. Together four reactors would produce more than 2000 MW of electricity that would cover almost one third of the demand for electricity.

But both projects were helplessly late. IVO had spent almost five years in the political and ideological jungle before the decision was made to order two VVER-reactors from the Soviet Union.

TVO’s project was plagued by labor and management problems. According to the initial time table both nuclear power stations were supposed to feed electricity to the national grid by 1970, but the deadline was pushed back year after year. Finally nobody was able to say when the power stations were ready and how much the project would eventually cost (Michelsen-Särkikoski 2005).

Although both nuclear power projects were late, the popularity of the nuclear energy remained strong. Nuclear energy was clean and efficient way to produce large amount of electricity. Nuclear reactors represented progress and values of the modern society. Very few critical voices were heard but the environmental movement that was organized at the end of the 1960s paid little attention to the nuclear power projects (Tammilehto 1994).

Nuclear power was a part, but not the most visible part of the modern industrial Finland. During the 1950s and 1960s Finland came out of the isolation and integrated to Europe without forgetting her special relations to the Soviet Union. Finland was located in between West and East and concretely on the Iron Curtain. Loviisa nuclear power plant became the symbol of this polarized situation. The reactors came from the East, but the safety and control technology was purchased from the West. IVO engineers with experts from several countries helped to assemble this complex nuclear power station. Olkiluoto nuclear power station connected Finland to Sweden and to the Western nuclear community.

Modernization process accelerated during the 1960s. Rapid industrialization brought economic benefits which were allocated back to the welfare state. Domestic migration moved hundreds of thousands of people from the rural areas into towns and cities. Industries and services gave employment and the welfare state took care of basic needs. Finland climbed in less than two decades from the third income level to the top level in Europe.

Much of this depended on energy production. It was impossible to build modern industrial society without secure supply or electricity and heat. In Finland this was especially important, because much of the country is located in the arctic environment. Finland was not self-sufficient in energy production, hence contacts had to be built with the neighboring countries for imports of fossil fuels and electricity. One of the most important agreement was the bilateral trade agreement with the Soviet Union. Finland exported industrial and consumer goods to the East and imported oil, coal and minerals. Before the nuclear power stations were ready, almost half of the energy production in Finland was based on imported oil and coal. This arrangement resulted from the internal mechanism of the bilateral trade. When the Soviet markets grew, the exports of energy products to Finland also had to increase accordingly. This fueled industrialization and modernization process in Finland (Hirvensalo, Sutela 2017).

Post-industrial Finland (1973-2016)

Nuclear energy did not replace any other source of energy, but it increased the total electricity production. This was needed to secure the electricity supply to industries, cities, towns, and municipalities. Finland believed in economic growth and everything possible was done to enhance industrialization and modernization of the society. This is why so many waited anxiously that four nuclear power stations would be connected to the national grid. Almost 2000 MWs of electricity promised inexpensive electricity that was critically needed for investments in industry, infrastructure and consumption.

As mentioned above, the Finnish energy policy aimed at higher degree of energy independency. This aim was pushed further because the imports of oil, coal and minerals connected Finland to the Soviet Union. Nobody knew how to break the tie. If Finland had purchased higher valued industrial goods from the Soviet Union, the imports of fossil fuels would have decreased. Unfortunately there were not enough high technology industrial goods that had any markets in Finland or outside Finland. This is why nuclear power reactors and steam turbines were very important. They tested the Finnish market, but it turned out to be a disaster. IVO engineers had to redesign the reactors in order to fit the Western safety standards. Needless to say, no more Soviet nuclear reactors were ordered. The raw material trade continued and in 1972 Finland and Soviet Union agreed the biggest ever oil import deal. In next five years the Soviet Union agreed to export 30 million tons of crude oil to Finland (Michelsen, Särkikoski 2005, Keskinen 1987)

The energy markets changed dramatically in 1973 when the Saudi Arabian government decided to cut the production of oil and raise the price. The shock wave hit the Western world and all major economies slumped into depression. In Finland, the crises came late because the Soviet oil kept the economy for two more years. However, the government reacted swiftly. Room temperatures were lowered to 18 degrees and every other street light was turned off. Shops and supermarkets were not allowed to have commercial lights, and the speed limit on highways was dropped to 80km per hour.

Alternative energy sources were investigated but no immediate solution was found. Finland had abundant resources of wood and peat but the necessary infrastructure was missing. Hence, the focus turned to nuclear power companies. They had struggled to get projects finished, and then? There was a factual need for inexpensive electricity which could replace oil. However, nuclear energy alone could not rescue the Finnish economy. Heating and power generation, and the traffic consumed millions of tons of oil. This could not be replaced by electricity in short period. As a matter of fact, this problem was not only in Finland. About 25% of global electricity was generated of oil in 1973, and the share of nuclear power was only 3%. The development of civilian use of nuclear power was slow. Western societies industrialized, urbanized and modernized mostly by pumping and burning oil (Ferenc L. Toth, Hans-Holger Rogner 2006).

Industrialization and modernization of Finland received very few critical comments. Men who had fought the wars and women who had waited for them at homes engaged in building the welfare society and they saw no reason to criticize the progress. Although industrial and urban development destroyed the old Finland, no organized resistance was found. The most intense debates took place in Kuusamo, North-Eastern part of Finland, where power companies struggled to gain ownership to the last free flowing rivers (Käsmä 2015).

Oil crises made people understand the true value of energy. The age of predictability was over and the world moved into the age of uncertainty. Finnish economy slumped into stagflation – an economic situation which any country had never experienced before. Production of paper, pulp and timber dropped almost by 25%, and industrial production fell almost by 5% in 1975. The economic growth dropped to zero and no-growth continued to the end of the decade. When the unemployment rate hit a new record, the President Kekkonen stepped in. He dissolved the government and formed what was known as “the emergency government”.

Oil crises affected the trade-balance which had been negative since the 1960s. Export and import prices increased by 40% and inflation reached 17%. The Bank of Finland feared that the foreign currency deposits were running out, and Finland requested emergency loans from the International Monetary Fund (Kuusterä, Tarkka 2012).

The first oil crisis was followed by the second one, and the third one hit Finland and the Western world in the early 1980s. Trust in oil was gone for good, and it was time to reconsider the basics of the energy policy. Finland directed attention to the domestic energy sources, especially wood and peat, but also to hydro power resources that were still untouched. According to the report by the "Power Station Committee" in 1974, Finland needed in the future at least 30 nuclear power stations which should be located in different parts of the country. In addition, Helsinki and other large cities were to be serviced by small-scale "environmentally safe" nuclear power plants that produced electricity and heat which would feed district heating networks (Voimalaitoskomitea 1974).

Oil crises put pressure on the first nuclear power projects that were hopelessly late. IVO promised to do the outmost to complete the project, and the first reactor in Loviisa went critical prematurely in February 1977. One year later TVO started the Olkiluoto 1 reactor. The second reactors in Olkiluoto and Loviisa were connected to the national grid in 1980 and 1981 respectively.

Many things changed during the oil crises. Previously decisions had been made by the political elite behind closed doors. This decision making tradition was challenged by the post-war generation whose ambitions, ideologies and behavior disrupted old traditions. The "rebellious" generation did not believe in the top-down policy making but demanded open and transparent dialog between people and the ruling elite.

The post-war generation in Finland was not a homogenous group of young people. The ideological map covered ideas and beliefs from far left to the far right, and everything in between. The post-war generation was strongly influenced by ideas and ideologies developed in Europe, the United States and the Soviet Union. Although political flags were different, the goals, aims and values were more or less the same. The post-war generation questioned beliefs in continuing economic growth, imperialism, colonialism and the nuclear arms race. Young generation developed ideas of global village, world peace and sustainable economy and environment (Virtanen 2012).

Younger generation of politicians and activists were willing to take part in energy policy debates in the 1970s but they found out very soon that the old techno-bureaucratic system was still in place.

Finnish energy policy was still dictated by strong stakeholders who represented the energy industry, the Ministry of Trade and Industry and labor unions. This triangle was solid and almost impossible to penetrate because the three largest political parties supported it. The main principles of the Finnish energy policy were decided in closed cabinets but not in popular vote or in referendum as it happened in Sweden, Austria and Italy (Salo 2015, Sunell 2004).

When the four nuclear reactors started to supply nuclear electricity to the national grid almost simultaneously, the second oil crises was still holding back the economic growth in Finland. There was no more lack of electricity. In contrary, nuclear power reactors produced plenty of electricity that few conventional thermal power stations could be temporarily closed. How long this situation would continue or was this a permanent situation? Energy companies relied on statistics and predictions. There was no evidence that the demand of energy and electricity would slow down in the future. The growth continued, and in order to satisfy the demand it was time to start building additional capacities.

Environmental and anti-nuclear groups opposed this view and encouraged the industry, communities and municipalities to look at the energy demands critically. In order to save energy and environment, new life-styles should be introduced and adopted. Less consumption required less energy. Policy makers had their point view. Finland depended on foreign imports of fossil fuels and electricity, and in the future these dependencies should be eliminated. Finland had unused fossil fuels and hydro power resources, and several new nuclear power stations should be built in order to cover the growing demand.

Two major accidents changed the future of nuclear energy for good. The meltdown of the light water reactor in Three Mile Island nuclear power station demonstrated how difficult it was to predict catastrophic accidents in the complex systems. Seven years later the explosion in the RBMK reactor in Chernobyl demonstrated how the lack of governance and mismanagement caused a catastrophic accident at the nuclear power station. In Finland, both accidents were studied carefully and the conclusion was that neither Three Mile Island nor Chernobyl accident could happen here (Michelsen, Särkikoski 2005).

Chernobyl accident put brakes on nuclear energy program in Finland. Perusvoima Oy, a joint venture between IVO and TVO, had already received a building permission for 1000 MW nuclear power station in 1986. The plan was withdrawn, and the power company decided to wait for a better situation. It was in 1993, when the Finnish parliament received a new proposal. It was accompanied by heavy lobbing from the industry and labor unions. It was also expected that the Parliament would allow the new project to move forward because Finland desperately needed large scale industrial projects that could reduce the unemployment crises. Finland had sunk in a deep economic slump in 1991 because the Soviet Union collapsed, and the domestic financial markets were deregulated prematurely. In 1993 more than 300 000 people were listed as unemployed.

The Parliament declined the nuclear power project, and for many this signaled changing attitudes towards nuclear energy and the energy policy in general. Instead of investing in nuclear power, the Finnish parliament decided to support sustainable developments and environmental friendly energy solutions. This was possible because the industrial production had suffered during the economic crises. Energy intensive industries struggled to compete in global markets, and many companies decided to close the factories in Finland and move the production to Asia.

Meanwhile a new paradigm seemed to emerge. NOKIA mobile phones conquered the global markets, and the ICT-cluster developed new business opportunities. According to social scientists, Finland was moving rapidly away from the industrial society into post-industrial or knowledge society. Factories or nuclear power stations were no longer needed because high technology companies innovated sustainable energy sources. If more electricity was needed, it was purchased from the Scandinavian electricity markets or Russia, or Estonia. Self-sufficiency was no longer the central issue in the Finnish energy policy. Instead, it was a flexible and decentralized energy system that utilized smart grids, intelligent energy networks and energy saving (Kyllönen 2004).

This optimistic view of the future was shared by many, but also opposed by many experienced politicians and professionals. Renewable energy sources were coming, but it was far in the future when they could take over the current energy system. Finland needed new nuclear power stations, because the four older reactors had already reached the end of their lifespan. Without nuclear energy Finland was forced to invest in conventional energy, and this decision defied the international agreements against the climate change.

Only years after the Parliament handed down the negative decision. The Ministry of Trade and Industry started to prepare a new energy strategy. The guiding principle was written in the following way: "All environmentally friendly and sustainable energy production technologies should be included in the strategy". This sentence signaled to nuclear energy companies that the Finnish government was supporting nuclear energy. Although environmentalists had previously defined nuclear power as a non-carbon-free source of energy, the Finnish authorities believed that it could be used in the battle against climate change (Litmanen 2004).

The Finnish government took a major initiative in 2001 when the nuclear waste company Posiva Oy received a permission for building in Finland the first permanent nuclear waste repository. Two years later the Parliament gave to TVO a building permission for the so called "fifth reactor". It was planned to be a 1600MW nuclear power reactor built by the French-German consortium for TVO. The timetable was tight, and the company promised to connect the EPR reactor to the network in 2009. Five years later the government supported nuclear energy again: it allowed Fennovoima Oy planning another 1600MW nuclear reactor. The goal was to have both new reactors operating before in the early 2020 (Litmanen 2004).

Both nuclear power projects have become great disappointments. The construction of the fifth reactor has been tarnished by delays after delays, and the costs have more than doubled. The reactor might go critical in 2018, but the exact date has not yet been confirmed. Fennovoima project has had equally many dramatic changes, and the final building permission is still pending in the Finnish parliament. Meanwhile, climate change advances rapidly, and radical actions are necessary to control rising temperature. The price of electricity has dropped, and it is questionable whether nuclear energy is economically feasible in the future.

How to conclude? If compared to many other countries, Finland is clearly an exception. Finland has never given nuclear energy up, although there have been credible arguments and organized social groups to oppose nuclear power. However, the need to secure self-sufficient energy production has overruled all other arguments. Finland has not given the goal up to increase the level of self-sufficiency, although the society has transformed from the industrial one into the post-industrial society. Nuclear energy is still one of the cornerstones in the Finnish energy policy. Moreover, nuclear energy is also supported by majority of Finnish people. According to current surveys, about 45% of Finns favor nuclear energy, and only about 25% vote against it.

1.3. Presentation of main actors

Transnational approach to history focuses on actors who move across national borders. Actors can also be in connection with transnational institutions and flows of knowledge, ideas and information. In this country report we have divided actors in six groups:

1. Nuclear administrators and regulators: This group was born already in the middle of the 1950's when Finland entered the atomic age. The group consists authorities from Ministry of Trade and Industry (KTM/ TEM), Atomic Energy Commission (AEN), Atomic office and The Radiation safety agency (STUK). Also the members of the Finnish parliament and the government belongs to this group.
2. Nuclear lobby: This group has been active since 1953 when the civilian use of nuclear energy started. Nuclear lobby consists labor unions (SAK and EK), power companies (IVO/Fortum, TVO and Fennovoima), electricity utilities (local and municipal electricity companies and private utilities), and foreign and domestic nuclear technology companies (ASEA-Atom, AEG, Atomienergia Oy, UKAEA, Finnatom, Atomenergoexport, AREVA, Rosatom, Oivavoima and IVO Engineering). Also belonging to this group is the nuclear waste management company Posiva and B + Tech.
3. Nuclear operators: This group is made of nuclear power companies (IVO, Fortum, TVO and Fennovoima) that operate nuclear power plants in Finland.
4. Nuclear community: This group includes nuclear scientists and engineers and scientific institutions (Universities, State Technical Research Center and other research units), nuclear energy associations Finnish Nuclear Society, FinNuclear r.y, Energiataloudellinen Yhdistys Ekono) and pro-nuclear organizations (Ydinenergianuoret r.y)
5. Anti-nuclear movement: This group began active in the late 1970's. The group consists environmental parties and environment protection organizations (The Greens, Greenpeace, The Finnish Nature League, Friends of Earth Finland, Pro Hanhikivi Group).
6. Transnational nuclear institutions: Transnational governance of nuclear energy has been a part of Finnish nuclear history since the 1950's when Finland joined transnational nuclear

community. This group includes several transnational institutions (IAEA, IEA, OECD, WANO, Euratom).

7. Lonely wolves: There are and there has been active individuals who have supported and opposed nuclear energy since the 1950's. They have reached across professional lines and participated in public discussion on positive and negative aspects of nuclear energy.

2. Showcase: Collective memory and the uneasy nuclear collaboration between Finland and Russia/Soviet Union

Finland and Russia have a history together that extends back to more than thousand years. During the 19th century Finland was an autonomous part of the Russian Empire. When Finland gained independency in 1917 and Russia evolved into the Soviet Union, connections between the countries were halted for more than two decades. The Second World War opened the window between Finland and the Soviet Union again, and after two bloody wars the countries adopted the policy of peaceful coexistence. It lasted throughout the Cold War, but when the Soviet Union collapsed in 1991, Finland quickly joined the European Union to ensure economic benefits of the common market and to get collective security guarantees from the West. Although political, economic and cultural relations between Finland and Russia have changed over time, the geopolitical realities have stayed unchanged. Finland is small but important country next to the superpowerful Russia. There is more than 1000 kilometers of common border that separates but also connects the two countries.

Finnish-Russian relationship has been defined as troubled or “uneasy”. Russia’s foreign policy is based on bilateral collaboration and throughout history the Kremlin government has used soft and hard diplomacy to make sure that Finland stays within its sphere of interest. Direct and indirect influence has naturally affected Finnish foreign and domestic policy. Russia’s opinion on political, economic and also social issues must have been taken into account when Finland has decided her own stand. This has been very clear especially in energy policy. Russia is an energy superpower and most of its national income is based on production and export of various energy goods. As Steven Woehrel (2010) writes, the line between Russian energy policy and foreign policy is far from clear and many countries next to Russia are concerned that Moscow may use their energy dependency to interfere in their domestic affairs or to force them to make foreign policy concessions.

Finland depends and has depended on Russian energy source for more than a century. There are currently two transmission lines crossing the Finnish-Russian border and approximately one fifth of electricity consumption in Finland is covered by imports from Russia. Since the World War II Russia has been the biggest oil, gas and coal importer and most of the enriched uranium comes also from Russia. According to Professor Veli-Pekka Tynkkynen (2015), the energy dependency from Russia is today more than 60% of the total energy production in Finland.

We investigate the case of the “sixth reactor” as a showcase. It is an ongoing project that is aiming to build a 1200 MW nuclear power station in Pyhäjoki community in the North-Western part of Finland. The project is coordinated by Fennovoima Ltd, the youngest nuclear power company in Finland. Fennovoima has already received the in-principle permission from the Finnish parliament, but the final verdict is pending. The project started in 2007, but it has faced several problems since the beginning. Even today, many anti-nuclear activists have raised doubts about the project. Nuclear energy is no longer an economically superior source of energy because the price of electricity dropped down, and the energy policy in Finland and other European countries favor renewable and alternative energy sources. Nuclear energy is almost emission-free, but it is not considered to be one of the renewable energy sources because it is burning uranium and other radioactive materials. They are currently not recyclable. However, nuclear energy has been regarded as one of the most important source of energy in the battle against climate change. It is argued that without nuclear power stations the international climate agreement cannot be fulfilled.

What makes the sixth reactor interesting is the Russian energy giant Rosatom. It has entered the project and acquired little less than half of the shares. Rosatom is also financing the project, and the sixth reactor will be a new 1200 MW AES-2006 reactor that was developed by Rosatom few years ago. The reactor will be installed by the Rusatom Overseas. According to the current timetable, the construction work will start in 2018, and the nuclear power station will be operating commercially in 2024.

There are many unanswered questions. First, Fennovoima-project was launched in 2007 for increasing the domestic energy production and to decreasing the dependency on foreign imports of electricity. Finland imports electricity from Scandinavian electricity markets, Russia and Estonia. The biggest share comes from Sweden but the fastest growing electricity imports come from Russia. Last year alone the growth was almost 50%. Therefore, it can be assumed that Fennovoima nuclear power station is going to produce the share ofelectricity that is currently imported from Russia. According to definition, this will decrease imports and improve self-sufficiency level.

However, there will be another type of dependency. Rosatom will install the reactor, and most of the instrumentation comes from Russia. Therefore, although Fennovoima nuclear power plant cuts the need in importing electricity from Russia, Finland becomes depended on Russian nuclear technology.

This strange arrangement has been criticized in Finland but nothing has been done to change the situation. The Finnish government had number of occasions to stop the project and cancel the deal with Rosatom. The Finnish parliament has also had several occasions to put the end to the project. However, Fennovoima moves on, although it has broken rules and regulations, and time after time the authorities have complained the management of the project. Currently the Radiation Safety Agency (STUK) is conducting an additional evaluation on the Fennvoima safety culture.

What makes this interesting is that a very similar project took place more than 40 years ago when the first nuclear power plant was going to be built in Finland. Imatran Voima (IVO) searched for a nuclear technology company from the West which could deliver a turnkey project for two 400 MW nuclear power reactors. An open international bidding brought great number of good offers but all of them were turned down because Finland was pressured to accept a Soviet-designed VVER-reactor.

In this case study we assume that there is a pattern that determines the Finnish-Russian-Soviet collaboration in nuclear affairs. We investigate this pattern through the concept of collective memory. The theory and concepts were first articulated by Maurice Halbwachs in 1992. He emphasized the social aspects of memory. Although everyone has an individual memory, there is also a memory that is shared by many. Hutton (1993), Zelizer (1995), Dudai (2002) elaborated the theory further by investigating ways in which shared memories are created and how they are modified and preserved. They concluded that the collective memory is created by a network of people who share information about common experiences. The memory is stored in narratives, documents and collective activities, and also in institutions. Collective memory can be activated when similar situations occur. People who are a part of the network and who have been exposed to the pool of knowledge choose to follow the patterns of behavior. As Hoelscher and Alderman (2004) argue, collective memory is more a process than an event. It can be found in corporate cultures or cultures of institutions. The patterns of behavior might be unknown to outsider, but well-known and even internalized to those who belong to institutions or companies. In sum, we assume and even argue that there is collective memory that shapes the interaction between Finland and Russia/Soviet Union in nuclear energy. Collective memory is created in projects and transferred through human and institutional interaction into following projects.

3. Events

It is a difficult task to go back to history and choose a handful of events that demonstrate the interaction between nuclear industry and civil society. In fact, these two are constantly interacting because nuclear industry cannot operate without organized society.

For the purpose of this report, a following selection criteria has been used: The events demonstrate how the interaction has taken place in all levels of society and simultaneously in Finland and abroad. Because the nuclear energy is transnational by nature, all chosen events present the interaction from this perspective. Causal effects are complex and many times difficult to pin point.

We have also chosen events that represent the interaction between nuclear industry and civil society in time. Time is an important concept for historians who are trained to explain changes. Nuclear history in Finland has moved from “official sphere” to the “public sphere” during the past 70 years. The choice of events demonstrates this change, too. Nuclear energy has also come from the distant cabinets into open society who discusses positive and negative effects and consequences of the nuclear energy freely and openly. The choice of events demonstrates also how Finland has become more democratic during the past 70 years. Nuclear energy is always located in the crossroads of the society where political ambitions, economic expectations, social norms and individual emotions collide. Because of this we could have chosen thousands of events, but we decided to focus on these, realizing that our choice can be criticized.

3.1. Event 1: From isolation into transnational networks

In December 1953 President Dwight D. Eisenhower walked to the podium to address the United Nations General Assembly. The title of his speech was the Atoms for Peace: “The United States knows that if the fearful trend of atomic military build-up can be reversed, this greatest of destructive forces can be developed into a great boon, for the benefit of all mankind. The United States knows that peaceful power from atomic energy is no dream of the future. That capability, already proved, is here today. Who can doubt that, if the entire body of the world’s scientists and engineers had adequate amounts of fissionable material with which to test and develop their ideas, this capability would rapidly be transformed into universal, efficient, and economic usage?” (D.D. Eisenhower

1953). Eisenhower's speech was immediately registered in Finland. The largest daily newspaper, Helsingin Sanomat, praised the initiative. Scientific and engineering communities also studied the proposal with great enthusiasm. Finland had been isolated from the high technology and big science research but at that time the tide was changing. Atoms for Peace program offered a chance to conduct ambitious scientific research and to get access to classified information. (Rauhan atomi, HS 13.12.1953).

The Finnish government founded a special committee to make necessary recommendations for the future energy production in Finland. Professor and the Nobel laureate A.I.Virtanen was expected to be the chairman of the committee, but Virtanen had criticized the Soviets and he was declared a persona non grata. His place was taken by Professor Erkki Laurila, an experienced scientist and engineer, who was a personal friend of the Prime Minister and soon-to-be President Urho Kekkonen. Laurila accepted the nomination but with one condition. He refused to lead "the Atomic Energy Committee', but instead "the Energy Committee". Laurila realized political and ideological tensions that were built in the Atoms for Peace program, and he did not want to tie his hands before the work had even started (Michelsen, Särkikoski 2005).

The Energy Committee asked Haralf Frilund, the head of the EKONO ltd., to draft a long term prognosis on the demand of electricity in Finland. The statistics showed that the demand of energy would increase approximately five to seven percent annually until the 1970s, after that the curve would slowly level off. However, the demand of electricity increased much faster or at the rate of 10 % annually, and this trend continued also after 1970.

Finland had extensive hydro power resources but they were located in the Northern part of the country. It would take a long time before Arctic rivers could be harnessed and transmission lines could be built across the country to the South coast of Finland. Meanwhile, the growing demand had to be satisfied by thermal power stations. Finland had enough peat and wood resources but it was difficult and expensive to harvest them. Atomic energy was an attractive alternative. However, it was estimated that the first commercially feasible reactors would come to market in the late 1960s. Before that Finland had to establish research and education system that would train nuclear scientists and engineers, and also future nuclear operators (Energiakomitea 1955).

Erkki Laurila had no time to engage in the enthusiasm that surrounded the Atoms for Peace program. He was trying to put together a politically feasible agenda. He knew that underneath the positive propaganda the two superpowers were pressuring small countries like Finland to join their “nuclear camp”. American representatives started early, and in 1954 the Ambassador of the United States donated the “atomic library” to Helsinki University of Technology. The Soviet Union responded quickly by arranging the “Atomic Fair” in Helsinki. Newspapers and magazines were full of propaganda that promised inexpensive and inexhaustible source of electricity. In addition, isotopes and medical use of radiation were going to cure cancer and other sicknesses and help to cultivate more productive plants for agriculture.

Laurila preferred modest but pragmatic attitudes towards atomic energy. It was intimately linked to nuclear weapons and the military industrial complex. Therefore, it was a potential threat to the Finnish neutrality policy. Laurila wanted to keep doors open to the West and East. In order to prove that he respected also the Soviet nuclear science, he sent Professor Nils Fontel to Moscow where the Soviet Academy of Sciences organized an international conference for atomic energy in 1955 (Laurila 1967).

Finnish delegation was invited to participate in the First International Conference for the Peaceful Use of Atomic Energy. The conference was organized by the United Nations and held in Geneva in August 1955. Finnish delegation had six members and they were seated in French alphabetical order, right behind the United States delegation. This was a glorious moment because in front of the unknown Finnish scientists and engineers sat the scientists and engineers who had worked in the Manhattan Project.

This was also the first time when Finnish scientists and engineers felt that they had equal opportunity to participate the international conference. During the three week conference hundreds of scientific and technological papers were presented and world famous nuclear scientists gave lectures. The grand exhibition hall in the Palace des Nations was filled with reactor designs and research instruments. There was also a full size test reactor, and everyone who dared to look inside the reactor saw a mysterious blue glow of Cerenkov radiation. (Laurila 1967).

Professor Pekka Jauho, a member of the delegation remembered: “Every day new scientific secrets were revealed and every day new and more efficient power plant designs were displayed. There were sessions where one could listen to the scientists and engineers who had developed nuclear weapons on both sides of the Iron Curtain discussing now on how the peaceful use of atomic energy could benefit the whole mankind.” (Pekka Jauho 1998).

The Geneva conference 1955 ended a decade long isolation that had blocked Finnish scientists and engineers out of the international scientific community. The symbolic value of the conference was indispensable. The Geneva conference also relaxed political and ideological tensions and helped to establish a transnational network of scientist, engineers, corporate managers and authorities. Atoms for Peace program was also the first genuinely transnational event that brought together experts from both sides of the Iron Curtain. As Erkki Laurila pointed out, the conference helped to clear stereotypical views and misconceptions, and at the end of the conference everybody had to agree that “the laws of nature applied equally on both sides of the Iron Curtain” (Laurila 1967).

3.2. Event 2: Finnish nuclear power project 1955-1962

When the fall semester started in 1955, Erkki Laurila did not return to his ordinary work as a professor of technical physics in Helsinki University of Technology. Instead he took a leave of absence and traveled to the United State to get the first-hand experience of the American nuclear power program. He was driving around the East coast of the United States by a used automobile he purchased in Washington D.C. Laurila spent three months interviewing nuclear scientists and engineers, and top level authorities. He also visited major research and development laboratories in Princeton, New York, Boston and Chicago.

The visit to the United States helped Laurila to situate Finland in the broader picture of nuclear energy. The civilian use of nuclear power was just beginning, and all reactor constructions were still on the experimental stage. Eisenhower’s initiative suggested an international uranium bank in which nuclear superpowers could deposit enriched uranium in order to deliver it later to countries that were qualified for the program. This proposal turned to be too idealistic. Nuclear superpowers preferred to keep the uranium trade in their own hands by using the bilateral trade agreement for controlling the uranium chain. (Laurila 1956).

Erkki Laurila concluded that there was no need to rush into investing to heavily in nuclear power. Reactors were going to be developed, and prices would come down as manufacturing reaches the commercial level. Uranium chain had to be controlled and governed by the United Nations. Instead, Finland should spend wisely time before full-size nuclear power reactors would come to market. Finland needed research and training programs as well as networks with Western countries. Laurila departed from organizational models that were used to organize nuclear research in Sweden, Denmark and many other European countries. Laurila did not like the idea of a single large institution, but rather a network of small research units that collaborate with each other and with foreign institutions. As the history of the Manhattan project showed, the project organization was perhaps the most effective one in solving complex problems. (Laurila 1967)

Following Laurila's advice, the Finnish government established the Atomic Energy Advisory Commission (AEN) in 1957. Its task was to coordinate and control nuclear power program in Finland. Erkki Laurila naturally was chosen as the head of the organization. The AEN was officially located in the Ministry of Trade and Industry, but in the real life Laurila run the organization independently and without any control from the bureaucracy. The funding came directly from the state budget, and he had a sole power to decide who got the money and how the resources were allocated.

The AEN established a network of research institutions that were independent but connected to the AEN via funding and the research agenda. The most important institutions were Helsinki University of Technology and the State Technical Research Center (VTT), both situated side by side in the new university campus outside Helsinki. University of Helsinki received funding for nuclear chemistry laboratory. The biggest investment was the test reactor, Triga Mark II, which was purchased from the United States in the early 1960s. It was installed in the nuclear technology laboratory in Helsinki University of Technology and turned on in 1962. (Laurila 1967).

The AEN also launched a training program which sent young engineers, physicists and chemists to nuclear research laboratories and universities in the United States and England. Finns were offered three to four months long basic courses on nuclear engineering and reactor technology. Longer and more fundamental studies were done in Argonne, Oak Ridge and Lawrence Livermore National laboratories. First, all contacts were made and travel fees paid from the AEN budget. Then, in the late 1950s the Finnish industry started to send engineers and managers to the United States. Training programs helped to build a critical mass of experts who could organize the Finnish nuclear power program in the future. (Laurila 1967).

There was, however, an embarrassing problem. Some young scientists and engineers who got chance to visit the United States or Sweden did not want to return home. This was understandable because the standard of living in Finland was lower comparing to the living standard in Sweden and Denmark, and it is needless to mention the United States. Erkki Laurila feared that brain drain would empty his critical mass before a nuclear power project would even start. The problem was solved by offering the returning experts a steady job with a pay that was higher than for example in universities or research centers. This solution was criticized by inspectors and authorities, but in vain. Erkki Laurila had support from the President, and this connection could not be challenged in Finland.

Other problems emerged in the late 1950s when the Soviet Union offered similar training programs for Finnish scientists and engineers. It became clear very quickly that the Soviets were not interested in educating Finnish scientists but in learning more about their experiences in the United States. Laurila understood the danger in this political game. His program was built on trust and if Americans would find out that tacit knowledge slipped from Finland into the Soviet Union, the Finnish training program would be closed. Laurila needed help from the West, and the best and easiest way to educate the critical mass of nuclear engineers was to send them out to the world class research institutions. The training project advanced knowledge, but it also gave motivation to the young scholars.

The AEN tried to establish connections to the Scandinavian countries. The first opportunity came in June 1955, when the Nordic Council established a program for atomic energy cooperation between the Scandinavian countries. At first, Finland was excluded from the program but through the personal efforts of Professor Pekka Jauho, the first Finnish delegation participated in planning sessions in Copenhagen in 1955. Six months later all four Nordic countries established a permanent institution for theoretical studies on nuclear sciences (NORDITA).

NORDITA was supposed to be a politically neutral research institution but in the late 1950s other Scandinavian countries tried to give the institution also political tasks. Finland could no longer participate in the NORDITA meetings but the collaboration was organized through another organization, “Nordiskt Kontaktorgan för Atomenergifrågor”, which operated under the Nordic Council.

Having established networks with Scandinavia, the United States and also the Soviet Union, Erkki Laurila felt that Finland was ready to apply membership in the International Atomic Energy Agency. The Soviet Union opposed the idea, because the political role of the IAEA was unsettled. The Soviets feared that the transnational institution would become an institution which is fully controlled by the United States. It had taken several years and negotiations before the IAEA was established. Finland was invited to be one of the 67 founding members, but the Finnish government turned down the offer. It was understood that Finland would be nothing more than one small nation among the others if she were to accept the founding member status. However, Finland would be recognized as a competitive nation if the IAEA would send a separate invitation to Finland to join the organization. This strategy worked, and Finland became the first invited nation to the IAEA in September 1958 (Fisher 1997).

3.3. Event 3: Transnational organizations and the Cold War politics

Memberships in the IAEA and NORDITA opened gates for circulation of knowledge and ideas. The IAEA published technical and scientific knowledge, arranged seminars and conferences, developed safety standards and trained scientists and engineers. In 1961, the Agency alone organized ten large conferences which covered such topics as small and medium power reactors, plasma physics, controlled thermonuclear fusion, the use of nuclear techniques in tropical medicine and in entomology, and development of the nuclear law. (Fisher 1997).

Circulation of knowledge and ideas from the IAEA and NORDITA to Finland were crucially important during the early years of the nuclear power program. Travelling from Finland to Europe was still difficult and expensive. Very few people had ever travelled abroad. Politically, Finland was under the surveillance of Moscow, and the Kremlin government guarded jealously efforts that pulled Finland closer to the Western Europe. The Western orientation became an especially heated topic after 1957 when the agreement for the European Common Market (EEC) was signed in Rome. Accompanied with the general agreement, the founding members of the European integration signed also an agreement that enhanced collaboration in the civilian use of atomic energy (EUROATOM).

It was no secret that the Soviet Union disliked the EEC and EURATOM. In March 1957, the Soviet Foreign Ministry gave the following statement out: “The plans for creating EURATOM and the Common Market are in manifest contradiction with these aims. The first thing that strikes the eye is that all those taking part in EURATOM and the Common Market will be subjugated to NATO aims, the aggressive character which is widely known. Under the circumstances the creation of EURATOM and the Common Market would inevitably lead to a further widening of the rift in Europe, to an aggravation of tension in Europe, would complicate the establishment of economic and political cooperation on a European basis and give rise to fresh difficulties in the solution of the problem of European security.” (Harrywan 1997).

This claim did not come without a concrete proof. EURATOM and the US Congress agreed in August 1958 that the nuclear power plants in Western Europe should be built under the US supervision. From the Soviet point of view this agreement created a bilateral bridge between the United States and Western Europe for the technology transfer. Although the agreement was specifically only for the civilian nuclear technology, it was impossible to separate the civilian and military application in nuclear technologies. The Kremlin government interpreted it as a hostile act against the Soviet Union. (Fisher 1997).

From the point of Moscow’s view, the integrated Western Europe was able to resist political and ideological pressures from the Soviet Union much better than individual countries. In addition, there was a hidden agenda in the EEC and EURATOM agreements. The Soviet Union suspected that the United States and other Western countries tried to help West Germany to gain access to nuclear technology. Therefore, it was in the Soviet Union’s interest to limit the role of EURATOM in the nuclear community. Several attempts were made and, for example, Moscow objected the proposal to give EURATOM an observatory status in the IAEA. (Howlett 1990, Lindroos 1997).

Finnish-Soviet relations had evolved without major conflicts since the death of Josef Stalin in 1953, but the peaceful coexistence was disrupted in 1958 when the Social Democratic Party returned to the power in Finland. The Kremlin reacted swiftly. The Soviet Ambassador in Helsinki returned to Moscow and trade negotiations between Finland and Soviet were halted. The United States sensed the opportunity, and Washington offered Finland an economic aid which would compensate losses in the Soviet trade. At this point the President Kekkonen blew the whistle and forced the Social Democratic Party out of the government. (Rentola 2008).

The political crises in 1958 affected also the Finnish nuclear power program. Erkki Laurila had managed to get Finland out of isolation in collaboration with the Scandinavian countries. The membership in the IAEA was also an important connection to the international nuclear community. However, more collaboration was needed to keep the technological developments up. Several new types of reactors were coming to markets, and transnational organizations such as EURATOM, IAEN, NORDITA, and OEEC organized research and training programs for member states. Finland had access to the IAEA and NORDITA, but what about EURATOM and OECD?

Finland had rejected the Marshall Plan that promoted economic development in Western Europe after the war. This decision was forced by the Soviet Union who tried to keep Finland within its own sphere of interests. The Marshall Plan was coordinated by the OEEC which later on developed in OECD. Finland stayed out of the organization that was regarded by the Soviet Union as a hostile agency and a part of NATO. This interpretation made it impossible for Finland to apply for membership. President Kekkonen tried to reverse the Soviet attitude towards OECD several times, but in vain. The Soviet Ambassador in Helsinki Viktor Lebedev explained patiently that OECD was not enhancing East-West trade relations. Instead it was enforcing political hegemony of the United States and NATO. Therefore, it was not in the best interest of Finland to seek membership in the organization. (Rantanen 2008)

Erkki Laurila tried to find ways to bypass the political dead end. The OEEC was starting a nuclear research project in Halden, Norway. It was crucially important for Finnish scientists and engineers to participate in the project. The project investigated characteristics and functions of a new type of boiling water reactor which used natural uranium and heavy water as a moderator. Altogether twelve OECD member states had already signed the agreement for a three year research program. There were also other interesting projects starting under the OEEC umbrella. In the United Kingdom, the Dragon project developed a high-temperature gas-cooled reactor, and the Eurochemich project in Mol, Belgium, studied the processing of irradiated fuels. (Dalrymble 2014).

The Halden project was crucially important to the Finnish nuclear power program. Sweden had already decided to build natural uranium reactors, and the same technology was favored by the AEN. Finland had rich uranium resources, and heavy water could be obtained either from Norway or Greenland. Additionally, Halden reactor was built inside a mountain and was connected directly to the local district heating system. This concept fit well in the Finnish industrial landscape. Paper and pulp factories and small municipalities could receive both electricity and heat from the nuclear power plant.

Although the Soviet Union refused to let Finland join OECD, Moscow allowed the Finnish government signing an agreement with the Halden project in 1959. There are several reasons behind the unpredictable behavior. After the Hungarian revolution in 1956, the Soviet Union tightened grip on Eastern Europe, but Finland was a special case. Finland was viewed as a loyal neighbor who could be used to improve the Soviet image in the West. Nikita Khrushcov tried to ease political and military tensions in Northern Europe and also lure Denmark and Norway out of NATO. Finland was used to illustrate how the Soviet Union was able to establish good and friendly relations to the “capitalistic” Western country on the other side of the Iron Curtain (Rentola 2008).

3.4. Event 4: Surprise in Moscow

Summer days in Moscow can be hot and humid when the continental weather front from Siberia comes to embrace western parts of Russia. Local people escape the heat to parks or small summer houses and huts outside the city. This idyllic picture was disrupted by a small group of men, all dressed in black suits, white shirts and black bow-ties. They had come by train from Helsinki to negotiate with the Soviet colleagues on nuclear energy cooperation between Finland and Soviet Union (Michelsen, Särkikoski 2005)

There had been several similar meetings before, but this time the agenda was loaded with tension. Imatran Voima (IVO), the state owned energy company had struggled to find a contractor for the first nuclear power station. The international bidding had started already in 1965 and after two unsuccessful rounds IVO was not able to declare the winner. The Finnish government had terminated the process, but because of the political pressure from Moscow, the negotiations were restarted in 1969. The group of men in black had come to Moscow to learn more about the offer made by the Soviet nuclear power company Technopromexport. (Särkikoski 2011)

IVO engineers had already visited the nuclear power stations in Obninsk and Novo Voronesh. Both experiences were far from satisfactory. The safety culture in the Soviet nuclear power stations was poor and the Soviet reactors were big and clumsy if compared to the high technology products in the West. It was impossible to install VVER-reactors in Finland without major redesigns and modifications. How these modifications could be made and how much would they cost? These big issues were discussed now in Moscow.

The first meeting set the tone for the summit. Soviet experts saw no need to improve the security of the reactors. Soviet nuclear technology represented the highest technological and scientific level in the world and the Soviet Union had long experience in nuclear technologies. Soviet scientists had calculated that a catastrophic accident in a nuclear power station was beyond statistical probability.

This was not a very good start. IVO engineers would never purchase nuclear technology that was dangerous and unpredictable. This rule was non-negotiable. If Technopromexport wanted to continue negotiations, this attitude had to change. VVER-rector had to be redesigned to pass the western safety standards. This meant radical alterations in reactor construction. IVO's agenda consisted of four points. First, the Finnish radiation legislation required that both the nuclear reactor and the reactor building were protected by a gas tight containment. Secondly, IVO demanded that the reactor and the power station had to be designed according to the American (ASME) standards. Thirdly, IVO wanted an open an unrestricted access to all manufacturing units in the Soviet Union in order to secure quality control. And finally, IVO needed a full service uranium deal which included both deliveries of enriched uranium to Finland and disposal of nuclear waste back to Soviet Union. (Michelsen, Särkikoski 2005, Kalevi Numminen)

The Soviet delegation looked at the agenda with disbelief. The Soviet nuclear elite was not accustomed to taking orders or advice from the colleagues who had no personal experience on nuclear energy. The head of the Soviet delegation, Academician Anastas Petrosjants, couldn't quite control his temper and in the opening speech he openly blamed the Finns for incompetence and unjustified demands. VVER – reactors were safe and reliable. Soviet scientists and engineers had calculated that the risk of catastrophic accident was too small to be detected. Hence, this is why the VVER-reactors were built without expensive gas tight steel containments. Soviet Union were planning a mass production of nuclear power reactors and unnecessary safety measures would make the reactors too expensive. The second point on the agenda was equally impossible. It was out of question that the Soviet engineers would accept the American technical standards. The Soviet standards were as good if even better than the ASME standards. The fourth request was impossible, because the Soviet federal law denied access to any foreign person in the factories or manufacturing units that belonged to a military industrial complex. The only issue which could agree upon was the uranium deal. The Soviet Union could supply IVO with enriched uranium and receive nuclear waste. (Särkikoski 2011)

Both teams worked under heavy pressure. Soviet government had given an order that Technopromexport had to get the contract. Meanwhile, IVO had already spent many years and too much money in the bidding competition that was going nowhere. IVO's customers were demanding rapid decisions on how the power company was going to satisfy the growing demand of electricity in the future. If the Soviet deal would collapse, IVO was forced to invest in the conventional thermal power. This decision had to be made quickly, because time was running out.

The negotiations proceeded slowly and no compromise was in sight. Finnish delegation continued to demand the containment, ASME-standards and access to the manufacturing factories. Soviet delegation opposed all major redesigns and modifications of the VVER-reactor. According to the Soviet experts, the Novo Voronesh -version of the pressurized reactor was bigger than Western light water reactors and there was more room for cooling water. Hence, the containment would be a massive steel construction, but without any true purpose. All VVER reactors were working fine and no safety problems had been reported. The second claim on the ASME standards was politically and also technologically impossible. Soviet factories used Soviet standards and it was impossible to recalibrate machines according to the American standards.

The final day of the meeting was coming and still no compromise was in sight. Anastas Petrosjants, who must have felt the heaviest pressure gave another emotional speech. He compared Finland to a spoiled woman who had to be pleased with expensive gifts and decorations. Steel containment was nothing more than a luxury item. Engineer Baturo complained that the Finns were like crazy bridge builders who builds a bridge along river instead of across the river. Academician Erkki Laurila, the head of the Finnish delegation was not intimidated by the outrage. Finnish engineers were trained to be cautious and careful. It was better to predict the danger than to correct the mistakes. Laurila ended his reply on the old Finnish proverb: “It is better to take a long detour than choose the short cut that takes you through the danger zone.” (Laurila 1982)

The meeting ended in a surprise. The chief negotiators, Minister of trade and industry Väinö Leskinen and his Soviet colleague A. Skatchkov left the room for a private meeting. Soon the door opened and Leskinen walked back to the room: “Now it is ordered!” Nobody could understand what had happened and what had been decided. The document revealed that contract was signed between the Soviet Union and Finland and not between IVO and Technopromexport. Finland purchased two Novo Voronesh -type nuclear power reactors and two 220 MW steam turbines. The total cost was 450 FMK from which 180 FMk. was earmarked to the Finnish nuclear engineering consortium FINNATOM. The second document revealed that in fact the Soviet Union only delivered the reactors and turbines and it was IVO whose responsibility was to design and manage the project. This way it became possible to add safety elements, steel containment and computer based instrumentation (Särkikoski 2011).

3.5. Event 5: Becoming the “Atom town”

Finnish nuclear experience moved from research and education stage into industrial level in the late 1960s. After long and difficult negotiations it was decided that the first commercial power station would be built by Imatran Voima (IVO), a state owned utility. The private utility, Teollisuuden Voima (TVO) would get the next project.

IVO had searched locations for nuclear power station already in the beginning of the 1960s when the company conducted a joint feasibility study with the Canadian General Electric for a natural uranium heavy water reactor. Search teams were sent to the west coast of Finland where a number of promising locations were discovered. However, land owners and community politicians were suspicious about nuclear energy. There were without doubt tremendous economic benefits, but nuclear power was also risky and unpredictable. The risk was a complex issue that could not be easily understood and explained. Engineers and scientists tend to be overly optimistic. The risks were there, but the probability was less than nothing. Anti-nuclear groups spread alternative truths about the nuclear risks. Nuclear technology was novel technology and nobody was able to tell for sure how the reactors behaved under heavy pressure for decades. There were also other open questions concerning nuclear waste and possible terrorist attacks against nuclear power stations. For local politicians and landowners these questions weighted heavily against the economic benefits of nuclear power. The lesson that was learned from a feasibility study was that sophisticated diplomatic skills and communication methods were needed to persuade local decision makers to accept the nuclear power project. (HWR-275 soveltuvuustutkimus, osa 2. 1965).

This time IVO searched communities along the south coast of Finland. The wish list was long and specific. The ideal location had to be safe and easy to protect against unfriendly visitors. Nuclear power stations needed an open access to the sea for cooling water. In addition, there had to be also abundant source of fresh water. Industrial infrastructure was not necessary but appreciated, because the construction work required good roads and harbor. The power plant had to be in close proximity to the national grid in order to lower transmission costs.

Several promising targets were found west of the capital Helsinki. Hanko is the southernmost tip of Finland with a busy harbor that handles most of the exports and imports. The location was Tvärminne, a small coastal community about one hour drive from Helsinki. Tvärminne had neither harbor nor railroad connection, but the community had a good open access to the sea and plenty of free space for construction. The last option was Porkkala community, located less than 50 kilometers from Helsinki. Porkkala was an attractive place if the hot discharge water from the nuclear power plant would and could be used for heating residential areas in urban areas. Porkkala had dramatic past because the Soviet Union confiscated the area after the war and Finland had to lease the area to the Soviet army for the next 50 years. When Stalin died in 1953 and the Kremlin government adopted new policy towards Finland, Porkkala lease was cut and the area returned to Finland in 1955 (Två atomverk… Hbl. 24.6.1993).

IVO negotiated with all three communities, but none of them responded favorable. Hanko had free space for the nuclear power plant, but the town hesitated to make a decision. Tvärminne community was reluctant to even consider the possibility. University of Helsinki had marine biology research center in Twärminne and the community wanted to remain industry-free zone. Porkkala was interested, but the nuclear power project did not fit in the future plans of the community. Porkkala wanted to develop its unique natural environment to serve summer guests, golf players and farmers.

The mayor of Loviisa, Karl Gunnar Wahlström, was listening to the radio on the afternoon of February 15th 1966 and he heard the news about IVO´s unsuccessful negotiations with Porkkala community. Without hesitation Wahlström picked up the phone and called IVO headquarters where he was connected to the company lawyer Jorma Rahko. Wahlström told Rahko that Loviisa would be happy to find a place for the first nuclear power plant in Finland. Rahko, surprised by the unexpected phone call promised to wheel the news to IVO´s top management (Michelsen, Särkikoski 2005)

K.G. Wahlström was thinking about Hästholmen, an island about 1,5 kilometer long and 0,6 kilometer wide and located just 15 kilometers out of Loviisa municipality. The town itself was a small bilingual coastal town whose best days were in the past when fishing and agriculture gave employment and welfare to approximately 15.000 inhabitants. Now the times had changed and Loviisa was suffering from unemployment and loss of industrial enterprises. This development had sent young people and educated middle-class professionals out of town to search for a better future. K.G. Wahlström wanted to reverse the tide and nothing fit better in his plans than the first nuclear power project. It was not only a major investment, but also the biggest ever industrial project in Finland. For sure, it would bring fame and fortune to Loviisa and encourage other businesses to invest in Loviisa (Björn Wahlström 25.1.2001).

K.G. Wahlström was an impulsive leader who tend to act first and check facts later. When the initial enthusiasm had cooled down, it was time to answer a handful of open questions. First, it was not certain that Loviisa was the full legal owner of the island of Hästholmen. There was an old document, dating back to 1746 and issued by the King of Sweden that gave the neighboring community Ruotsinpyhtää rights of possession to the island and the waters around it. This privilege had not been nullified although Finland departed Sweden almost 200 years before and became independent from Russian Empire in 1917. Depending on legal perspective, Hästholmen was jointly owned by Loviisa and Ruotsinpyhtää. This fact did not please IVO who required that the property where the nuclear power station was going to be built belonged was owned by only one legal owner (Michelsen, Särkikoski 2005).

K.G. Wahlström had also forgotten to ask the opinion of local fishermen, farmers and summer guests. They were the core of the Swedish folk party (RKP) constituency that was the biggest political force along with the Social Democratic Party (SDP) in the bilingual town of Loviisa. Fishermen were worried about thermal pollution and also possible leaks of radioactive waters into the sea. Summer residents came mostly from the capital region and it was not in their interest to get a massive nuclear power station to spoil the beautiful sea view.

K.G. Wahlström did not let these problems to disrupt his mission. This was “a onetime only opportunity” that should not be missed. It was estimated that the construction work alone would bring about 1000 new jobs to town and when the plant was operating Loviisa would get more than 400 well paid middle class residents. Nuclear power station represented “progress and modern age which had bypassed Loviisa” as the local newspapers remembered to point out. Loviisa town council supported Mayor Wahlström and the town wanted to show solid unified face towards IVO and make sure that the power company would indeed choose Hästholmen as the location for the first nuclear power station (Rosenberg 2004).

IVO hired two experts from the State Technical Research Center to evaluate the price of the property and the report by Professors P.O. Jarle and Olli Kivimäki concluded that indeed the Loviisa had overestimated the value of the island. Proper price would be only one fifth of what K.G. Wahlström and Loviisa town council had proposed. Although disappointed, the town council gave in and the deal was sealed just before the mid-summer in 1966. IVO agreed to pay 1,1 million FMK in cash for 250 hectares of land on the Island of Hästholmen.

Local newspapers celebrated the agreement. Östra Nyland (RKP) predicted that the nuclear power plant will attract other industries to the town and the town will grow rapidly in the future. Loviisan Sanomat (non-political) believed that the nuclear project would give the town the “atomic kiss” that would wake up the “Sleeping Beauty“. Loviisa would get in the prestige group of most industrialized towns in Finland (Atomkrft, Östra Nyland 30.6.1966, Huima edistysaskel. Loviisan Sanomat 30.6.1966).

Now the project advanced rapidly. Local contractors cleared rocks and forests to build a 20 kilometer long “atom road” from Loviisa to Hästholmen. Geological survey sent two geologists to Hästholmen to investigate the rock foundation and research vessel Aranda patrolled Hästholmen waters to study marine biology and ecology. All studies showed that Hästholmen was the perfect location for the nuclear power plant. IVO planned to start the construction work in 1967 and five years from that the first nuclear power plant would go critical.

This is when everything started to go wrong. IVO had not yet closed the international bidding for the nuclear power project. The painfully slow evaluation was ongoing and behind the scenes nuclear companies and national governments lobbied to get their reactor offer accepted. IVO tried to follow fair game rules and technologically and economically the three best offers came from AEG, Westinghouse and Canadian General Electric. There was also the offer from Atomenergoexport, but it had entered the competition late and the offer was poorly prepared. The VVER-440 reactor was too big, too expensive and without required safety arrangements (Särkikoski 2011).

It was IVO’s responsibility to end the bidding and announce the winner. With plenty of hesitation, the company decided to go for the AEG reactor. It was technologically most advanced and it promised the best economic results. But nuclear energy did not follow the fair game rules. For Finland, it was politically impossible to buy the first nuclear reactor from West Germany. Soviet Union would never accept such a decision. Even if the reactor would come from West Germany, IVO would never get enriched uranium from anywhere. Prime Minister Alexey Kosygin confirmed this to President Kekkonen who visited Moscow in 1967. Soviet Union was the only country to sell nuclear fuel to Finland and Moscow would not give enriched uranium to other reactors than those designed and built in the Soviet Union (Särkikoski 2011).

IVO's nuclear power project was sliding into a total catastrophe. The company was committed to evaluate fairly all offers, but the project was eventually decided by the Finnish and Soviet governments. This would tarnish IVO's domestic and international reputation for good. IVO tried one more time to rescue the project by giving the final word to company shareholders. This was an unprecedented decision and never before had shareholders made a decision that usually belonged to the board and the managing director. Because the state was the biggest shareholder in IVO, the outcome of the meeting reflected the political opinion of the Finnish government. As expected, no decision came out of the meeting and IVO was left without alternatives. The company closed the bidding and a polite letter was sent to all who had participated: "We regret that for reasons beyond our control this enormous work has this time not lead to a favorable result" (Michelsen, Särkikoski 2005).

When the news about IVO's struggle reached Loviisa, Mayor K.G. Wahlström and the town council panicked. They had invested personal and political capital to the project that was now a project fading away. If the nuclear power project would not materialize, there was nothing Loviisa could do to improve its economy and employment. This is what Wahlström told to IVO's board of directors who visited the town few weeks later. Heikki Lehtonen, the CEO of IVO promised that IVO was doing everything to continue the project and that the moratorium was only temporary. Also Finnish government brought little comfort with the decision that the order by the King of Sweden was no longer valid and Hästholmen belonged to Loviisa (Rosenberg 2004).

The breakup of the nuclear lockout needed political consensus that was directed from the highest political level. It was decided that IVO continues to negotiate with Atomenergoexport for two VVER-440 MW reactors. Meanwhile 16 members of the power association "Nuclear" (Voimayhdistys Ydin) established the utility Teollisuuden Voima Oy (TVO). This new coalition started discussions with the Swedish nuclear technology company ASEA Atom for two 600 MW boiling water reactors. This decision released the political tension and solved the energy policy question. Four nuclear reactors would take care of about 30% of the electricity consumption in Finland. It was also decided that

IVO's nuclear power station would be located on Hästholmen and TVO's NPP on the island of Olkiluoto in Eurajoki community on the West coast of Finland.

When the decision was made and the contract between IVO and Atomenergoexport was signed, mayor Wahlström could finally take a deep breath. Delays and disappointments were finally over and Loviisa was becoming the first nuclear town in Finland. The media sent reporters to Loviisa to capture the feelings and expectations of ordinary people, entrepreneurs and decision makers. Ristö Valkeapää, reporting for the biggest daily news in Finland, Helsingin Sanomat, was surprised when he found not a single critical voice in Loviisa. He had expected more, because Soviet technology was regarded as technologically backward and unreliable (Kalevi Numminen 2001).

However, if Valkeapää had visited Hästholmen and interviewed those whose life was going to be permanently different because of the nuclear power station, the response would have been different. Fishermen community in near Hästholmen feared that thermal pollution would damage the fragile marine ecology of the Gulf of Finland. Summer residents decided not to organize opposition, but they demanded high compensations from the town. He would have also met Herbert Blomqvist, a fisherman who lived in an old family house on the opposite side of Hästholmen. Blomqvist became the "lonely wolf" in Loviisa. Blombqvist who had no official education studied all reports, borrowed literature from the library and searched all sources to understand what was going on in the nuclear power station that welcomed him every morning when he sat down to have his morning coffee. Blomqvist never gave up and his criticism stretched from thermal pollution to safety culture to technological fragilities of the VVER reactor. IVO tried to chase him away, but he stubbornly applied for a special permission to keep his house in the territory that was declared "safety zone" (Rosenberg 2004).

Loviisa became the atom town, because Mayor Wahlström took initiative and personally pushed the project through difficult times. Personal engagement was a decisive factor and if compared to other potential locations, Wahlström was able to exercise political powers that tested democratic principles.

Because of the nuclear power station, Loviisa was able to break the economic downspin. The population grew rapidly during the 1970s when the construction project went on. Also other economic activities intensified because of the nuclear power project. The social structure of the town changed, when the Swedish speaking majority lost its dominant position to the Finnish speakers. During the 1970s there were strong ideological tensions when Atomenergoexport brought hundreds of workers from Soviet Union to Hästholmen. They were not allowed to mingle with the Finnish workers, but they were isolated in the barracks that were surrounded by a high fence. This was a difficult lesson to the Finnish construction workers who were politically radical and ideologically orientated towards Soviet Union.

As Arto Henriksson, the editor in chief of Loviisan Sanomat, wrote, the image of atom town has kept Loviisa as a hostage for decades. Even if no more reactors will be built on Hästholmen, the town will still be remembered as the first atom town in Finland. Public perception to nuclear energy in Loviisa has remained surprisingly positive throughout the last 50 years. Latest surveys show that vast majority of the members of the town council would welcome a new reactor any day. Those who oppose nuclear energy, usually support alternative energy source. Today there is a plan to build a large windmill park right next to Hästholmen (Rosenberg 2004).

3.6. Event 6: First nuclear debates

Nuclear debates started in most Scandinavia countries in the late 1960s. Sweden had maintained a clandestine nuclear weapons program since the end of the war, but once the secret leaked out, the Social democratic government was forced to terminate the program in 1966. However, it took another six years before all the remnants of the project were shut down.

This did not calm down nuclear debates. Sweden, Finland and Norway were building nuclear power stations and the questions of risk, safety and governance of nuclear power engaged scientists, public intellectuals and politicians in a vivid debate. Nuclear debates were not held in a vacuum, but they became intermingled with environmental and social policy debates. The debates were influenced by the events that took place in the United States and other parts of Europe. However, the geographic line was drawn on the Iron Curtain. The discussion went on and affected policymaking in the Western world, but the autocratic rule in the East kept the discussion silent.

Finland was simultaneously on the two sides of the Iron Curtain. Nuclear and environmental debates started in Finland in the late 1960s and continued in the 1970s and 80s. However, the discourse was sharply divided according to political lines. Western nuclear power and Western environmental problems were strongly criticized, but nuclear power in the Soviet Union and in the Eastern European countries was accepted without critical comments (Otway et. al. 1978).

One of the most vocal anti-nuclear advocates in Scandinavia was Professor Hannes Alfvén, a Nobel Prize winner in physics in 1972. He was working half time in the University of California, San Diego, where he was influenced by the radical anti-nuclear and environmentalist groups. He took the ideas back to Sweden where he openly criticized the Swedish nuclear energy program. Thorbjörn Feldin, the head of the Central Party listened to Alvén's arguments and Feldin led Sweden to the referendum in which Sweden decided to phase out nuclear power.

Heikki S. von Hertzen, the CEO of the Public housing agency in Finland, also listened to Hannes Alfvén. Von Hertzen had already gained fame as an urban planner and he designed the famous garden city of Tapiola in the 1960s. Von Hertzen searched for new locations west of Helsinki, but his search was interrupted by Imatran Voima (IVO) in spring of 1973. IVO was building the Loviisa nuclear power plant, but the company was also planning the next step in the nuclear power program. IVO announced an ambitious plan that contained six 1000 MW nuclear power reactors to be built in the near future. It had chosen the location in Kopparnäs, a small coastal community about 40 kilometers west of Helsinki. IVO's plan was the biggest ever nuclear power complex in the world and naturally it was also the most expensive ever industrial investment in Finland. In addition to the new complex in Kopparnäs, IVO planned to build four 1000 MW reactors in Olkiluoto near the TVO's nuclear power plant. Kalevi Numminen, the head of IVO's atomic energy division, justified the massive investment in 1973: "Our calculations show that in the future we need to build one 1000 MW nuclear power reactor every year and later one equally big ones in every other year. We can collaborate with TVO, but both companies must be committed to increase the capacity of nuclear in the future." (Två atomverk till Kopparnäs 24.7.1973).

Kopparnäs community investigated IVO's plan with mixed feelings. A giant nuclear power complex would change the community and its environment for good. This was not what Kopparnäs was planning. The small community had experienced dramatic changes after the war when the Soviet Union first occupied the area, but then without warning returned it back to Finland in 1955. A decade of occupation destroyed what used to be a beautiful Degerby agricultural community owned by the Grönblom family. Red Army destroyed all houses and dwellings and the lands were ruined. Grönblom family decided to leave the estate and property was sold to IVO.

IVO saw Kopparnäs as one of the potential locations for the future nuclear power complex. The property was close to the sea and fresh water reserves were close enough in the Pirkkala community. There was already a good infrastructure and the area was close to Helsinki and close to the national grid. IVO had investigated possibilities to pump the discharge waters into the district heating network. This option would reduce the thermal pollution in the sea and also make the nuclear power station more profitable. Helsinki needed a novel heating solution and the district heating collaboration with the nuclear power station was one of the most promising ones (Kopparnäsin voimalat... HS 12.7.1973).

Kopparnäs community council could not make the decision. IVO's plan was too extensive and complex and it was impossible to estimate all the consequences. The project would multiply tax revenues, but also turn the quiet coastal community into a massive construction site that would go on for decades. Nuclear power complex would also alter the ethnic structure of the community. The dominant language in Kopparnäs was Swedish, but construction workers and nuclear operators would most likely speak only Finnish.

Kopparnäs community tried to evaluate the environmental consequences of the project. If the discharge waters were directed to the district heating network, the thermal pollution in the Gulf of Finland would cause no harm to the marine biology. However, six large scale reactors would need massive amounts of cooling water and fresh water and also an industrial size infrastructure. Nuclear power stations would also destroy the image and identity of Kopparnäs.

IVO hurried to get the project through the bureaucracy. In May 25th 1973 the company handed the planning permission to Jan-Magnus Jahnsson, the Minister of Trade and Industry. IVO encouraged the Finnish government to move swiftly, because the company wanted to start making detailed plans and arrangements. Loviisa nuclear power project was almost finished and the first reactor was going to be ready by the end of year 1975. IVO had already ordered the blueprints for a 800 – 900 MW boiling water reactor from the Swedish nuclear power company ASEA-Atom. In addition, IVO negotiated with Atomenergoexport for a 1000 MW upgraded version of the VVER reactor (ASEA-Atomin jättivoimalaa… HS 2.6.1973).

That is when Heikki von Herzen stepped in. He wrote a long article in which he reflected the anti-nuclear ideas of Hannes Alfvén. IVO was making a huge mistake by investing in the fission reactors. They were old-fashioned, risky and economically infeasible. IVO's plan was especially dangerous because a 6000 MW nuclear power complex right next to Helsinki threatened the very existence of the capital. If something went wrong either in Loviisa (east of Helsinki) or in Kopparnäs, Helsinki must be evacuated. How and by whom this kind of a massive operation could be done in a hurry (Alfvén 30.8.1973).

Von Hertzen provided two alternative visions. First, IVO should take a time-out and wait until the fusion reactors were commercially available. During this "time-out", IVO could develop low-energy technologies and conserve energy. Good examples were available in Sweden, where the Swedish Parliament had already decided not to continue nuclear energy projects. Sweden focused on energy saving and alternative energy sources. Finland could follow the example. Helsinki had already a district heating network and it could be easily stretched out to Kopparnäs.

Heikki von Hertzen also complained that IVO's plan violated the Finnish foreign policy. President Kekkonen had initiated in 1963 "The Nordic Nuclear Free Zone". The initiative was made right after the world had witnessed the Cuban Crises and almost the Third World War. The President was afraid that similar situation could take place in the Baltic Sea region. The Nordic Nuclear Free Zone eliminated the risk of nuclear war by prohibiting nuclear weapons in the Nordic region. IVO's plan challenged the initiative, because; "fission reactors are a part of the military industrial complex and they produce plutonium. All reactors produce plutonium and therefore it is possible that plutonium ends in the hands of terrorist or military groups that can built nuclear weapons."

Heikki von Hertzen followed up his article with an open letter that was addressed to the Finnish Government. Von Hertzen demanded that the government immediately abandons all nuclear fission projects. Future efforts should be focused on the energy conservation and low energy solutions. The government should also redefine the concept of peaceful use of atomic energy. It should include all fission nuclear power plants which produced plutonium. Finally, von Hertzen demanded that the government and the parliament should reject all new nuclear projects and no new nuclear power projects should be allowed in the close proximity of the capital or any other populated city. (von Herzen 7.7.1973).

Heikki von Hertzen's provocative actions started a nuclear debate that heated up in the summer of 1973. Bjarne Regnell and Björn Wahlström from IVO responded to the criticism by pointing out that there was no scientific evidence to support von Hertzen's claims. Nuclear technology was based on the systematic scientific research and rigorous testing of materials and processes. No nuclear facility was allowed to be built or operated without special permissions from the radiation safety authorities. IVO had followed every norm and rule set by the Finnish and international authorities. Safety culture was a holistic approach and it was constantly upgraded.

According to Ragnell and Wahlström, nuclear power was a better source of energy than coal and oil. Nuclear energy had risks, but they could be managed and governed by the professionals and nuclear authorities. Nuclear legislation in Finland was up to date and it allowed no shortcuts to power companies. Finnish nuclear power plants were safe and secure and the national nuclear power program should not be compared to Sweden because Finland never had military nuclear power program. In Finland, nuclear power was a necessary part of the national energy system. Finland depended on the foreign imports of electricity and fossil fuels. If Finland decided not to build more nuclear energy, the trade balance would tip even more to the negative side (Ragnell 11.8.1973).

Kirsti Erä-Esko challenged previous articles by taking up the moral aspects of nuclear energy and nuclear waste. She argued that small amounts of radioactivity escaped every day from the nuclear power plants and accumulated in the environment. Therefore, both workers and people who lived close to the nuclear power plants were in danger. Some countries were also dumping nuclear waste into the oceans. Erä-Esko claimed that the nuclear industry played Russian roulette with radioactivity and the waste. Wherever the waste was going to be stored, it would radiate for the next hundreds of thousands of years (Erä-Esko 7.8.1973, Erä-Esko 8.8.1973).

Professor Erik Spring criticized Erä-Esko's emotional interpretations. Radioactivity is a natural phenomenon and people are exposed all the time to radiation from nature. Medical profession was also continuously exposed to the radiation and x-rays were common practice in every hospital. There were reasons to moralize nuclear energy, because nuclear power plants were controlled by professionals and governed by the authorities. There was no need for expensive nuclear safety laboratories because nuclear technology was produced abroad and Finland had nothing to do with the reactor developments (Spring 9.8.1973)

Nuclear debate continued until the end of the summer. The final word was given to industry advisor Leo Neuvo from the Ministry of Trade and Industry. He laid down the hard facts. Finland depended on energy imports and the level of self-sufficiency had dropped since the early 1960s. Meanwhile the demand of energy continued to grow almost 6% annually and there was no sign of levelling off. At this point Finland could supply only 28% of the total demand from her own domestic sources. If no new nuclear power stations were built, self-sufficiency would go down to 10% by 1990. Even if all the still unused energy sources were utilized, nuclear power was an option that would increase the level of self-sufficiency (Suomen riippuvuus… IU 28.9.1973).

IVO buried the plan in the late 1973, because Loviisa project was seriously delayed and the oil crises hit Finland. The government issued emergency regulations and the consumption of electricity and energy were cut down. Industrial production slumped and there was no need for another nuclear reactor. IVO downscaled the future plan and the 10 000 MW target was reduced to a 1000 MW nuclear power reactor. IVO was satisfied if the government permitted the company to build the famous “fifth reactor”. One big reactor would be enough for next ten or maybe even twenty years (Arvoitusten ydinvoima, IU 5.10.1973).

Although Kopparnäs was saved from “nuclear occupation”, the debate continued. IVO came back to the political arena with a new nuclear power plant that would serve Helsinki and surrounding regions. This debate went on for the next three years without conclusion. Helsinki decided to build the reactor, but the decision was turned around and eventually there was no new reactor (Helsingin atomiyhtiö syntyy tänä vuonna H.S. 1.7.1973).

The first nuclear energy debate touched many issues, but the most important one was the very presence of a nuclear power station. IVO’s plans took nuclear power reactors right next to the large urban areas. This caused fear and anxiety. Loviisa and Olkiluoto were far away from urban centers, but Kopparnäs was less than 40 kilometer away from Helsinki. The question was how safe it was to live right next to a nuclear power station. Academician Erkki Laurila had full confidence in nuclear energy. He could very well live next to the nuclear power station, because “no technology that has been invented by man has been so thoroughly researched, tested and inspected as nuclear energy.”

4. Facts & Figures

The purpose of this section is to give an overview of nuclear power in Finland. This section contains such data as number of reactors, reactors' locations, technical and chronological details of reactors' construction as well as statistics on electricity production, periodization and social connections to nuclear constructions.

4.1. Data summary

- There are in total four reactors in Finland which produce 30 % of country's total electricity at capacity load factors over 85% (in the past 10 years the load factor has been 95%).
- There is a fifths reactor under construction at the moment, and there is a plan for the sixth reactor.
- Finland was the first country that has announced building of a new nuclear power plant after Fukushima disaster. It seems that Fukushima disaster has not influenced decisions about nuclear power in Finland.
- There is little local opposition against new nuclear power site in Hanhikivi.
- Majority of public is of positive opinion about nuclear power.
- So-called Finnish Mankala model of joint ownership between energy-intensive industry and electricity production utilities prevents rise of electricity prices and allows industry purchase electricity at the price of production cost. This model is also considered to be effective in risk sharing.
- According to the World Nuclear Association (2016) Finland has advanced supplies for radioactive waste disposal.

4.2. Key dates and abbreviations

Key dates:

1950s	Beginning of the Finnish nuclear energy program – research and education. Discovery of rich natural uranium deposits that can supply several reactors.
1958	Sub-critical reactor in the Helsinki University of Technology
1959	The first research reactor at University of Helsinki went critical
early 1960s	The first power company Imatran Voima (IVO) owned by government conducted study with Canadian General Electric company to build heavy water reactors supplied with

	natural uranium. Finnish authorities abandoned natural uranium option due to nuclear weapon fuel proliferation risk.
1962	The third research reactor (Triga Mark II) installed (supplier – General Atomics Ltd.)
mid 1960s	Second phase of nuclear energy program – shift to full-production of electricity. Government's plan to have about 1500 MW by the end of 1970.
1965	IVO started international bidding that received international offers from major nuclear manufacturers and followed with difficult political negotiations.
1960-70s	Contract between Finland and USSR to build the two first reactors in Finland of VVER-440 type. Loviisa was chosen as a site.
1969	Foundation of the second nuclear energy company Teollisuuden Voima (TVO) by several energy companies in Finland
1970s	TVO contract with Swedish ASEA-atom for two 600MW BWRs.
1974	Building of Olkiluoto 1 nuclear reactor by TVO and ASEA-atom
1975	Building of Olkiluoto 2 nuclear reactor by TVO and ASEA-atom
1977	Connection of Loviisa I nuclear reactor to the grid (built by IVO and the consortium of Finnish engineering companies (FINNATOM)
1978	Connection of Olkiluoto 1 to the grid
1979	Three Miles Island nuclear accident
1980	Connection of Loviisa 2 nuclear reactor to the grid (built by IVO and the consortium of Finnish engineering companies (FINNATOM)
1982	Connection of Olkiluoto 2 to the grid
1986	Chernobyl disaster and public protests against nuclear power
1993	Finnish parliament rejects proposal of buidling of Finland's fifth nuclear power reactor
1995	Foundation of Posiva nuclear waste company by IVO and TVO
1996	Finnish government decides that sending used uranium fuel out of the country was illegal
1998	Foundation of Fortum company from merging of IVO and Neste Oy – Finnish oil company
2002	Finnish parliament votes (107-92) for approval of buidling of Finland's fifth nuclear power reactor. It is a first decision to build a new nuclear unit in Western Europe over a decade.
2004	Finland became a party to the Paris convention on nuclear liability by OECD
2007	Finland's third nuclear power company Fennovoima Oy was established with number of owners from electricity consuming industries. Initially pushed by German EON energy giant that later sold its 34% shares to Rusatom Overseas (Russian Rosatom) due to German nuclear moratorium. The number of owners in Fennovoima was fluctuating significantly over time.
2007	Finnish government refuses applications to license uranium exploration in South

Finland.

2010 Finnish government rejects application for decision-in-principle to construct new Loviisa 3 unit but gives 5-year permission to Fennovoima to construct a new NPP in Simo or Pyhäjoki and to TVO to construct Olkiluoto 4, also to Posiva nuclear waste company to construct an extended final disposal repository of spent uranium fuel.

2012 TVO plans to build Olkiluoto 4 nuclear unit

2013 ROAS Voima Oy is established in Finland by Rosatom in order to hold a stake of the Fennovoima company

2014 Finnish government signs a new agreement with Russian government that enables Rosatom to supply a reactor to Hahnikivi (Pyhäjoki) that solves liability from nuclear accidents damages by enabling mutual applicability between Finnish and Russian international convections

2014 TVO decided to cancel Olkiluoto 4 project after getting rejection from Finnish government to extend an application for a construction license for 5 years. Othervise TVO would have to apply in 2015 but because of dealy with Olkiluoto 3 company had no time to prepare construction plan.

2015 Finnish government insisted that 60% share in Fennovoima's €7mlrd project should belong to EU company.

2015 Anti-nuclear protests against new reactors. People claim “it is a mistake of 100 000 years”

2016 Production of a documentary film about Olkiluoto nuclear site

2016 Expecting that license to build Hahnikivi 1 project will be granted to Rosatom

Abbreviations:

BWR Boiling water reactor

IVO Imatran Voima, first nuclear power company

IAEA International Atomic Energy Agency

TVO Teollisuuden Voima, second Finnish nuclear power company

WNA World Nuclear Association

4.3. Map of nuclear power plants

Figure 1 represents a map of nuclear power sites in Finland. There are two sites Olkiluoto and Loviisa that were established in 1970-1980s.

Figure 1 – Nuclear power plants in Finland. Source: WNA, 2016

4.4. List of reactors and technical, chronological details

Table 1 below shows the list of reactors, suppliers, operators as well as date details. All the reactors named in the Table 1 are commercial. VVER reactors in Loviisa were built with 5 years delay because they had to be built in accordance with Western standards. Later, after collapse of USSR, the Loviisa plant was fully modified to Western safety standards (new Western instruments, systems, etc).

Table 1 –Operational and projected nuclear power reactors in Finland

No	Name	Operator	Supplier	Type	Mwe net	Construction began	Grid power	Shutdown planned
1	**Loviisa-1**	Fortum	USSR	VVER-440/ V-213	488	1971	1977	2027
2	**Loviisa-2**	Fortum	USSR	VVER-440/ V-213	488	1972	1980	2030
3	**Olkiluoto -1**	TVO	Asea Atom	BWR	860	1974	1978	2039
4	**Olkiluoto -2**	TVO	Asea Atom	BWR	880	1975	1980	2042
5	**Olkiluoto -3**	TVO	Areva, Siemens	EPR	1600	2005	2018*	
6	**Olkiluoto -4**	TVO		EPR, ABWR, ESBWR, EU-APWR, or APR-1400	1450-1650	cancelled 2014		
7	**Hanhikivi -1**	Fennovoima	Rosatom	VVER-1200/ V-491	1150	2018	2024	

*Olkiluoto is delayed to 9 years, it was planned to connect the reactor to the grid in 2009.

Olkiluoto 3 project initially was scheduled to be connected to the grid already in 2009 but is delayed at high cost to 9 years due to complications in governmental construction requirements. For that reason TVO decided to cancel its Olkiluoto 4 project and apply for a new decision-in-principle later.

Owner's share in all three Finnish nuclear energy companies are quite complex but major of the shareholders come from high intense industry or nuclear industry. Fortum that was established from merge of IVO and Neste Oy companies has 27% share in TVO. Other 57% of TVO’s shares belong to industry of paper and pulp: Pohjolan Voima Oy which shareholders are UPM and Stora Enso major paper manufacturers. Other private owners are from heavy industry that demands cheap energy. Fortum is owned 51% by the state and is a public listed company. Fortum has 43% of Swedish Oskarshamn NPP and 22% of Swedish Forsmark NPP.

4.5. Data on public opinion and periodization of nuclear developments

Anti-nuclear movements occur in recent years in little scales consisting of limited amount people (approximately from 12 to 40). Movements are against uranium exploration in Lapland and against new NPP in local municipality of Pyhäjoki where Hanhikivi 1 is waiting to be built.

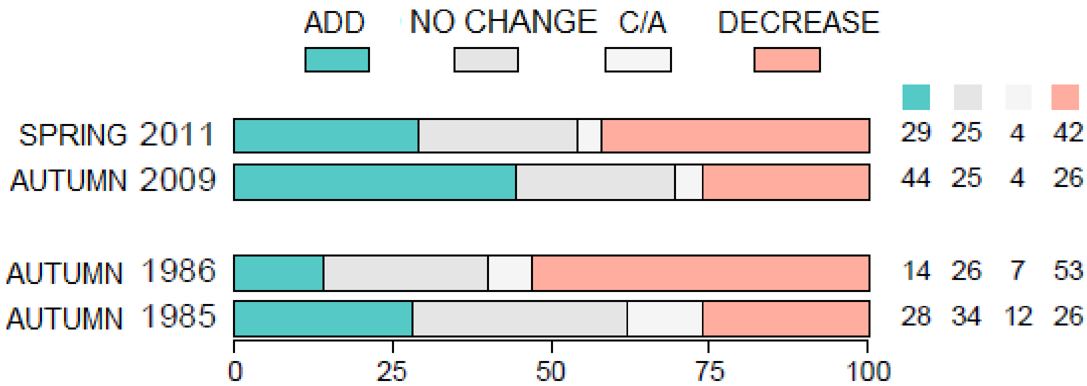

Figure 2 – Fukushima vs. Chernobyl: first influence of disasters towards public opinion of nuclear development in Finland, %. Responses: Green - use of nuclear power should be added; Grey – do not change use of nuclear power; Pink - use of nuclear power should be decreased. C/A means cannot answer. Source: Energiateollisuus 2011.

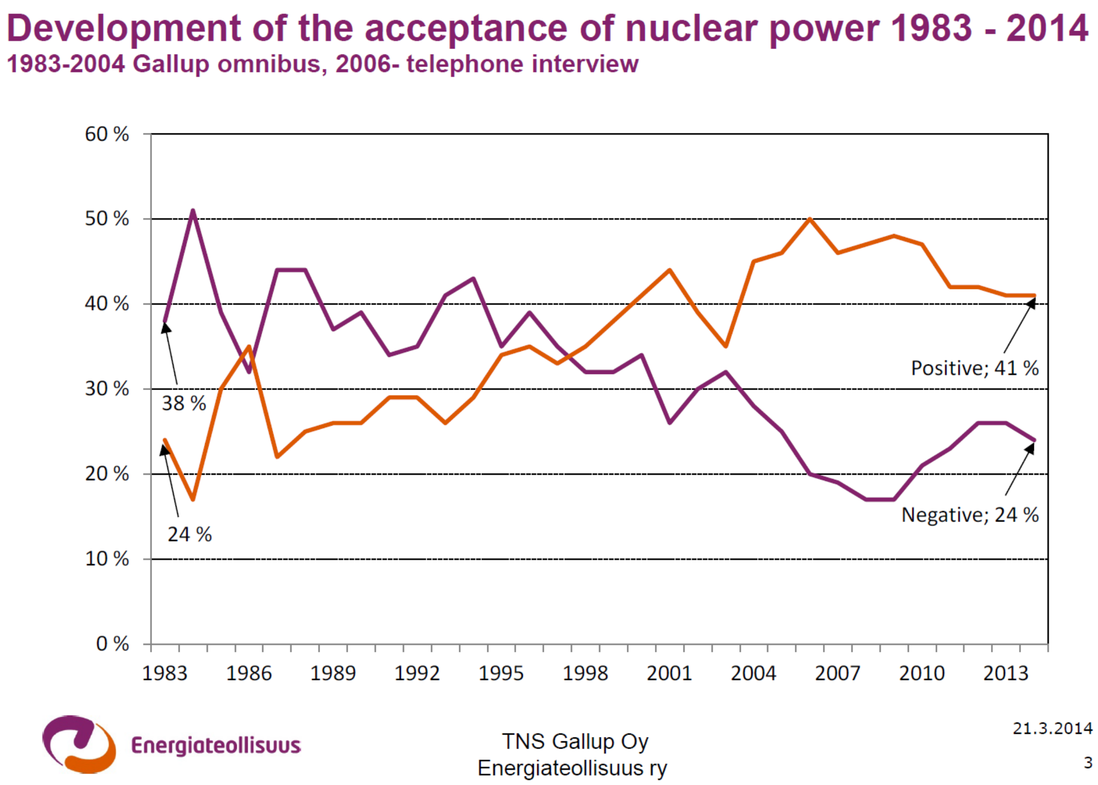

Figure 3 – Development of the acceptance of nuclear power 1983 – 2014. Source: Energiateollisuus 2014

4.6. Periodization

History is usually understood as a continuous flow of things and issues. What happened right now become history in the next moment when the clock moves one minute or hour ahead. Historians try to make sense on what has happened in the past by creating comprehensive and logical narratives. As William A. Green points out, "scholars assert that history constitutes a seamless garment, but they cannot render the past intelligible until they subdivide it into manageable and coherent units of time. Once firmly drawn and widely accepted, period frontiers can become intellectual straightjackets that profoundly affect our habits of mind – the way we retain images, make associations, and perceive beginning, middle, and ending of things."[1]

Nuclear history in Finland has traditionally been divided in five or six periods. The first period starts from the early 1950's and continues to early 1960s'. The turning point was the decision to move away from the educational phase into full size nuclear power production. This period continued until

1 William A. Green, Periodization in World and European History. Journal of World History, vol. 3, no. 1/1992, p. 13.

the early 1980's when the first four nuclear reactors went critical. The next period stretches to the turn of beginning of the new Millennium when the Finnish government and the Parliament permitted the construction of the fifth and little later the sixth reactor. This decision was coupled with the decision to allow to deposit the nuclear waste permanently in Finland.

This periodization reflects the development of the nuclear energy in Finland and it reflects some of the main developments and turning points of the nuclear energy in Europe and beyond. One of the aims of this short country report is to set up a mirror against which the other country reports can be reflected developments in their particular countries. Perhaps it could be possible to challenge the current periodization and open the time-line for novel ideas

4.7. Additional data on electricity production, consumption, nuclear power share and demand forecast

The following figure shows the power system in Finland.

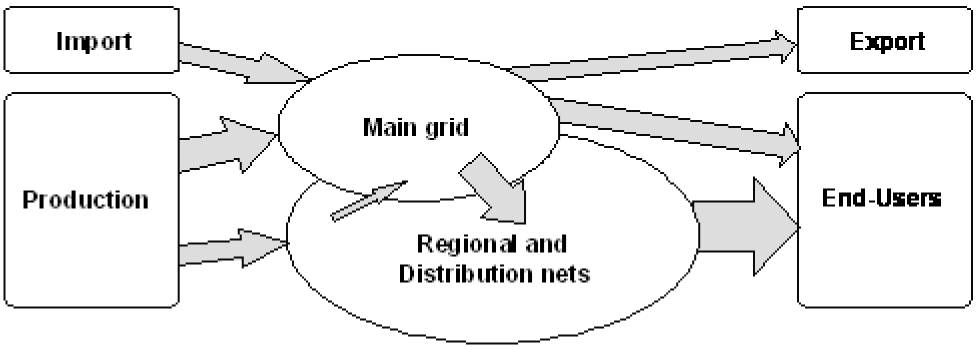

Figure 4 - The Finnish power system. Source International Atomic Energy Agency, 2009

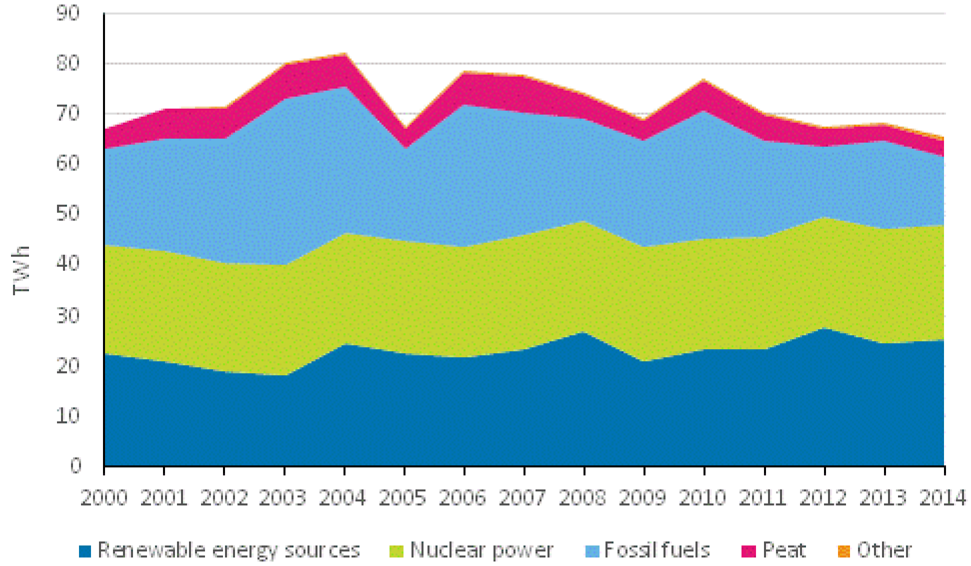

Figure 5 - Electricity generation by energy source 2000-2014. Source: Official Statistics of Finland 2014.

5. References

This report has been written using several different kinds of sources. As mentioned above, the nuclear history in Finland is relatively well researched and the researchers have used primary sources and interviews. Much of this material has been available and used as a background material for this report. In order to save space, only small amount of references are mentioned in the text. For the future research, this list of reference contains key sources that can help those who are interested in exploring the nuclear history of Finland further. I will also include some of the most interesting primary sources that are digitalized, but not available for public use.

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Erkki Laurila:

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France

Short Country Report

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DIALOGIK

EHU Europos humanitarinis universitetas

TU/e Technische Universiteit Eindhoven University of Technology

Friedrich-Schiller-Universität Jena

Swedish Defence University

GRE

KTH

LUT Lappeenranta University of Technology

upna

UPMC Sorbonne Universités

The University Of Sheffield.

Science Museum

spi Sociedade Portuguesa de Inovação

CONTENTS

Executive summary

This report belongs to a collection of 20 short country reports on the History of Nuclear Energy and Society (HoNESt, project Ref.662268). The reports address issues concerning the complex sociotechnical systems around nuclear energy. Nuclear developments, notably nuclear energy, are closely intertwined with social, economic, environmental, political and cultural aspects. The development of nuclear energy is also part of a globalised system involving transnational transfers of knowledge, materials, technologies, people and products, such as electrical power, products of nuclear medicine, radioactive waste and other environmental hazards, materials, capacities and knowledge. As a complex social and technological phenomenon, nuclear energy influences society while at the same time being shaped by society.

The short country reports seek to assemble information and research results on the history of the relations between nuclear energy and society in an accessible manner, and to document the findings with references.

The purpose of the country reports is threefold, addressing three different audiences:

1. to provide basic elements of narrative and analysis for further historical research by HoNESt researchers;
2. to provide information, context and background for further analysis for HoNESt's social science researchers;
3. to provide accessible information on nuclear-societal relations in the various countries for the purposes of outreach and communication with stakeholders (civil society, industry, associations, policymakers, journalists, etc.).

This report focuses on the history of the relations between nuclear energy and society in France. It traces the development from the immediate post-War period, when civilian nuclear developed hand in hand with France's ambitions to create its own nuclear deterrent and independent strike force; to the present-day situation of a country facing crucial choices concerning the future of its substantial yet ageing nuclear fleet. The history of French nuclear sector can be divided into ten periods: 1) the post-war nuclear technocracy; 2) launching of the civilian nuclear programme in 1952; 3) the second nuclear programme (1959-1965); 4) the "war of the systems" at the end of the 1960s, which led to the adoption of the American light-water technology and the demise of the national gas-graphite system; 5) launching of the massive nuclear programme by the Prime Minister Pierre Messmer in 1974 as a response to the first oil crisis; 6) the accident at Three Mile Island (see US Country Report), which triggered safety improvements, but also marked the first openings of the hitherto highly secretive nuclear technocracy; 7) the inauguration of a period of doubt and mistrust that ensued after the eventually failed attempts by the authorities to conceal the impact of Chernobyl fallout in 1986; 8) the transformations at the turn of the century generated by the electricity market liberalisation imposed by the EU, the promise of a “nuclear renaissance”, and the re-emergence of radical contestation against nuclear at the end of the 1990s; 9) the attempts by the French to gain leadership in the international nuclear renaissance especially through technology exports – and the attempts to democratise public debate on nuclear (2003-2009); and 10) a period of crisis, as the French-led nuclear renaissance failed to realise, and the nuclear sector faces increasing economic and technical challenges of upgrading the nuclear fleet to enable needed extensions of reactor life-spans.

Throughout its entire history, the French civilian nuclear programme has been partly shaped by the French policy of nuclear deterrence and has retained considerable degree of secretiveness. However, the opaque, highly centralised nuclear technocracy has gradually been forced to open up and become more transparent, largely in reaction to waves of public opposition, but also as a result of pressures from international legislation.

In addition to a brief chronological narrative outlining the above-mentioned periods, this report describes in somewhat more detail a number of key events in French nuclear history. The “war of the systems” in the late 1960s crucially shaped relationships between the key players – notably the Atomic Energy Commission (CEA) and the utility, Électricité de France (EDF) – but also triggered the learning, capacity building, and reorganisation necessary for the launching of the massive nuclear programme of the 1970s. The “Chernobyl cloud affair” shook public trust in the nuclear establishment in France and gave decisive impetus to the development and institutionalisation of counter-expertise in the area of nuclear power in the country. The sudden decision by the Socialist-Green government to definitely close down the Superphénix industrial prototype fast breeder reactor in 1997 was a traumatic experience for many engineers and other actors involved in the development of fast breeders; seen by many nuclear engineers until the late 1970s as the logical culmination of any serious civilian nuclear programme, and a promise of an exhaustible source of affordable electricity. The three national consultations concerning the construction of a European Pressurised Reactor (EPR) plant in Flamanville, Normandy and the national radioactive waste management policy in 2005-2006 constituted a milestone in the opening up of the French nuclear policy to civil society. Finally, the concept of reversibility has constituted an essential element in the evolution of the national radioactive waste management policy towards greater transparency and inclusiveness, yet such ‘opening up’ remains unavoidably incomplete. Despite the advancement of openness, French nuclear policy still remains very much an affair of the state, with highly unequal relationships between the citizens and the powerful public and semi-public actors.

1. Narrative of the Historical Context

1.1. Introduction to the historical context

The French nuclear history has been, ever since its beginning in the aftermath of World War II, marked by considerable secrecy and state-centrism – a heritage reinforced by the close connection between the military and civilian applications of nuclear power, and the particularities of France's national history. It has been argued that France's military and civilian nuclear sector is characterised by a culture of secrecy distinct from that of other nuclearized countries (e.g. the UK and the USA), stemming from a succession of experiences: two invasions, one military defeat, one occupation, two costly victories, an exclusion from nuclear research conducted by the Allied forces during the Second World War and soon after, and a difficult resurrection after 1945 following the wars leading to decolonisation and loss of its Empire (Baconnet 2014, 41-49). The history of civilian nuclear power in France can therefore been seen as a gradual and sometimes painful evolution of the powerful nuclear technocracy – until recently invariably led by graduates from the prestigious engineering schools – towards greater openness in relation to the civil society. Obviously, such opening up remains partial and highly incomplete, yet the French "nucleocracy"[1] has covered quite some distance in this regard, from the beginning of the nuclear programme in the post-War years, when the Atomic Energy Commission (CEA) held a virtually free reign over both the military and civilian parts of the sector, to the present day with various attempts at democratising the debate on nuclear policy.

The following brief presentation of French nuclear history distinguishes ten major periods: 1) the post-war nuclear technocracy; 2) launching of the civilian nuclear programme in 1952; 3) the second nuclear programme (1959-1965); 4) the "war of the systems" in the end of the 1960s, which led to the adoption of the American light-water technology and the demise of the national gas-graphite system; 5) launching of the massive nuclear programme by the Prime Minister Pierre Messmer in 1974 as a response to the first oil crisis; 6) the accident of Three Mile Island, which triggered safety improvements, but also marked the first openings of the hitherto highly secretive nuclear technocracy; 7) the inauguration of a period of doubt and mistrust that ensued after the

[1] The term "nucléocrate" was first used by Simonnot (1978) as a denomination of the pro-nuclear elites within the state apparatus and notably amongst those emanating from the "grands corps".

eventually failed attempts by the authorities to conceal the impact of Chernobyl fallout in 1986; 8) the transformations at the turn of the century generated by the electricity market liberalisation imposed by the EU, the promise of a "nuclear renaissance", and the re-emergence of radical contestation against nuclear at the end of the 1990s; 9) the attempts by the French to gain leadership in the international nuclear renaissance especially through technology exports – and the attempts at democratising public debate on nuclear (2003-2009); and 10) a period of crisis, as the French-led nuclear renaissance failed to realise, and the nuclear sector faces increasing economic and technical challenges of upgrading the nuclear fleet to enable needed extensions of reactor life-spans.

1.2. Contextual narrative

Post-war nuclear technocracy

In the immediate post-War period, the development of nuclear energy in France was largely shaped by the primary objective of acquiring the capacities needed for the construction of an atomic bomb. Before the War, French scientists had been at the forefront of international R&D in the area of nuclear physics, but the War and the German occupation had led to France falling behind.[2] In the post-War era France sought to "catch up" and re-establish the country's technological and military might through the development of technological excellence in the nuclear sector. The two key actors in the development of nuclear were created immediately after the War. In 1945, the Atomic Energy Commission, CEA, was created, and became responsible for R&D in the area. CEA soon developed into an organisation largely independent from any social or political control. It enjoyed a triple independence in relation to the broader research community, the army, and the political sphere, while developing strong ties with the military-industrial complex (Larceneaux 2014). In 1946, EDF (Électricité de France) was constituted by nationalising the existing private companies into a state-owned electricity company to provide affordable electricity to the largest possible number of citizens. Félix Gaillard, a young radical-Socialist member of Parliament, was nominated as Secretary of State of the Economy, and became a fervent defender of a French nuclear programme. The first French experimental reactor, the Zoé 'pile', reached criticality on 15

[2] Leading nuclear physicists in the early post-War years included Frédéric Joliot-Curie, Pierre-Gilles de Gennes, Jules Horowitz, Roland Omnes, and Bernard Gregory.

December 1948, whereas the second pile (EL2) was based on heavy water technology, which French scientists had pioneered during the war years.

In the 1950s, there was a near consensus among politicians and across the political parties that France should build an atomic bomb (Topçu 2010, 46-47; referring to Fontanel 1986 and Legras-Maïllon 2003). The first atomic bomb test was conducted in the Sahara desert on the 13th February 1960, and the first hydrogen bomb on 24 August 1968 in French Polynesia (Soulié 2012). Public opinion was on the whole favourable to the French nuclear weapons programme,[3] as the French pacifist movement focused on opposing French wars in Algeria and Indochina (later Vietnam). The creation of five CEA military nuclear installations between 1954 and 1957 did not generate significant opposition (Topçu, 2010, 45). Inside the CEA, opposition against nuclear weapons arose in the early 1950s, following the eviction of Joliot-Curie because of his communist and pacifist leanings (Hecht, 2009) 59; Topçu 2010, 46-47). The opponents, motivated by both pacifist and economic reasons, were soon brought “back into line”, and did not change CEA’s policy (Topçu 2010, 46). The trade unions were somewhat ambivalent concerning the military nuclear programme: e.g. the CEA section of the CFDT union only criticised the programme for reasons relating to economics and workers’ rights (Legras-Maïllon 2003, 57-64). While the opposition soon died out within the CEA, it generated some echo notably amongst university elites (e.g. the Ecole Normale Supérieure) in the mid-1950s (Topçu 2010, 47).

The official declaration, by Felix Gaillard in April 1958, of the fabrication of a French atomic bomb gave rise to opposition movements, but did not greatly affect public and media opinion. A number of anti-bomb organisations were created and demonstrated against the tests[4], but it was only after the end of the war in Algeria, 1963, that the anti-nuclear weapons movement truly gained force, notably with the creation of the politically neutral Mouvement Contre l’Arme Atomique (MCAA) by the journalist Claude Bourdet and an eminent biologist, Jean Rostand. A number of similar movements

[3] According to opinion surveys conducted by Ipsos, between December 1957 and March 1958, only 28% of the population was against the nuclear bomb, and almost half considered the French military nuclear effort insufficient (Topçu 2010, 44).
[4] For example, the French Federation against Nuclear Armament was created in 1959; in November 1959 engineers from to the French peace movement denounced the test explosions in Sahara; the French Pugwash movement demonstrated against the problems of nuclear; and the national council of the peace movement called for an immediate stop to atomic tests after the third test explosion in 1960 (Wittner 1997).

were created.[5] As in many other countries, the signing of the Partial Nuclear Test Ban Treaty, on 5th August 1963, weakened these anti-war movements, yet some of the members of these groups became a few years later key figures in the new environmental movement (Topçu 2010, 49).

Launching of the civilian nuclear programme (1952-1957)

The official reasons for the launching of the civilian nuclear programme were similar to those in other nuclear-weapon countries at the time: harnessing "the atom" for peaceful purposes, satisfying the country's acute and growing need for energy, and securing its energy independence (Hecht 2009; Dänzer-Kantof & Torres 2013, 38-39).[6] France sought to become the leader of the second rung of countries in the race for the peaceful application of nuclear power – behind the three pioneers in the military use of nuclear energy: the USA, the USSR, and the UK. The first nuclear programme, presented to Parliament by the Secretary of State, Félix Gaillard, hence aimed mainly at producing plutonium for military purposes,[7] through collaboration between CEA and EDF resulting in gas-graphite technology using natural-uranium. The choice of graphite-gas technology was motivated by the poor availability of heavy water in France, but also by a desire to side-line Joliot-Curie and his team, whose proximity with communism and hence opposition to atomic bomb were well known (e.g. Hecht 2009, 59). Natural uranium was chosen partly because of necessity: France did not have the resources needed for industrial-scale production of plutonium or enriched uranium, and the US refused to provide enriched uranium to France – fearing proliferation and leakage of information to the Soviet Union, in part because of the central position of communists in France's nuclear programme at the time.

In the parliamentary debate, only the communists opposed the first nuclear programme, partly because of its suspected links with military applications of nuclear. There was little need to justify the programme to the population, because decision-making was firmly in the hands of the government and the engineers. Energy independence had been somewhat of an obsession of the

[5] These included notably two organisations led by socialists – "movement for disarmament, peace and freedom" (MDPL), the "league against the strike force" – and a cross-party coalition, "committee against the strike force", which also included trade unionists.

[6] For instance, Pierre Guillaumat, when presenting the first 5-year nuclear plan to Parliament on 24th July 1952, argued: "since a century already, the development of great industrialised nations has been founded, ultimately, on their energy resources (Dänzer-Kantof & Torres 2013, 24).

[7] The objective was to produce at least 50 kg of Pu 239 – sufficient to construct 6-8 atomic bombs.

French elites since the 1920s, because of poor or absent oil and coal resources, and has inspired several generations of French engineers (Dänzer-Kantof & Torres 2013, 24). Decisions concerning nuclear energy were taken by small groups of experts graduated from elite engineering schools, which exerted direct influence on decision-making, and sometimes had direct relationships with the president (Beltran 1998; Hecht 2009; Dänzer-Kantof & Torres 2013, 187; Larceneaux 2014). Parliament played virtually no role at all. The role of the so-called Corps des Mines – engineers from the Ecole des Mines – has remained vital until today.[8]

In the 1950s and 1960s, France constructed eleven gas-graphite, light-water and heavy-water reactors – none of which is still in operation today. A plant for extracting plutonium from the gas-graphite reactors started operation at Marcoule in 1958. While having initially been aimed at producing only plutonium, EDF envisaged using the plant for small-scale electricity production, by recovering the hot air from the reactor's cooling system. CEA and EDF hence concluded in May 1954 an agreement on the first experiment in the recovery of nuclear energy (Dänzer-Kantof & Torres 2013, 69-70). Gas-graphite technology opened the prospect of a fully national nuclear production, since the fuel would be sourced and processed in France, and the spent fuel reprocessed and reused in fast breeder reactors. In the late 1950s a decision was made to construct a plant for uranium isotope separation at Pierrelatte, to provide fuel for gas-graphite reactors. By the early 1960s, CEA had nearly total control of the entire nuclear cycle, from the uranium mines in Africa and France, through the Marcoule plutonium extraction plant and the Pierrelatte uranium separation plant, to the first reprocessing plant at La Hague. Gas-graphite technology came to absorb the bulk of nuclear R&D, conception and equipment of nuclear power stations in France between 1953 and 1968. Until 1970-72, the majority of nuclear plant orders in France consisted of gas-graphite technology, which also supplied the majority of nuclear electricity in France until the Fessenheim plant came on line in 1977.

As early as 1951, fast breeder reactors were foreseen as the logical culmination point of the nuclear programme: the first generation of reactors would consist of "primary piles", producing electricity from natural uranium, while the "secondary piles", fast reactors, would produce more plutonium than

[8] Some have described the France of the 1960s and 1970s as a kind of a "Republic of engineers" – not only in the area of nuclear, but also in other industries such aeronautic, telecoms, space industry, and high-speed railways (Beltran 1998; Dänzer-Kantof & Torres 2013, 187).

they would use (Jobert & Le Renard 2014). The technology had its golden age in the 1960s, with the encouraging experience from the construction and operation of the Rapsodie experimental reactor, the Phénix prototype reactor, leading to the construction of an industrial prototype reactor, Superphénix (see Event 3, section 3.4). Once the American PWR technology won the 'war of the systems' (see Event 1, section 3.2) at the end of the 1960s, fast breeders were relegated to a secondary position, as a mere long-term "insurance" and a potentially interesting area of R&D (Jobert & Le Renard 2014).

The second nuclear programme (1959-1965)

When taking office in 1958, President Charles de Gaulle changed the French defence doctrine. Until then the country had sought to operate within the western alliance, the bomb representing merely a minor addition helping France to gain leadership in the European nuclear scene, ahead of Germany – and to help put additional pressure on the US. With de Gaulle's policy of national independence, an independent "Strike Force" became the main objective of French nuclear policy. Views on Euratom became in this context increasingly ambivalent and divided also trade unions and political parties: the organisation was seen, alternatively, as a "Trojan horse" in the service of the Americans, a means for France to establish its leadership among European nuclear nations, or a path to German technological dominance in Europe (Hecht 2009, 131-162; Dänzer-Kantoff & Torres 2013, 69-70). Development of civilian nuclear energy was at the beginning of the 5th Republic driven by a unique convergence of objectives: economic progress, independent "strike force", and the reestablishment of the nation's "greatness" both at home and abroad.

The second nuclear programme, launched in 1959, relied on the "national" gas-graphite technology. It foresaw the construction of one reactor every 18 months, with a total capacity of 850 MW by 1965. The scaling-up to commercial-scale reactors occurred even faster than planned, and the total installed capacity reached 2525 MW.[9] To satisfy the needs of the industry, CEA built another reprocessing plant in La Hague – to complement the existing Marcoule plant. The La Hague plant entered into operation in 1966. The country's energy industry was highly dispersed until the 1960s, when the consolidation of EDF laid the foundations for the creation of a significant national nuclear industry.

[9] Including the Spanish Vandellós plant, operated at 25% by EDF. See the Spain Short Country Report.

Through active advocacy, the American nuclear manufacturing companies managed to convince EDF engineers of the benefits of their light-water reactor (PWR) technology, which used enriched uranium (Hecht 2009, 274). In 1960, EDF was authorised to construct, together with Belgium, a joint reactor (Chooz) close to the Belgian border. For EDF, the principal objective was to provide an alternative to the gas-graphite reactors (Dänzer-Kantof & Torres 2013, 81-84). This decision turned out to be decisive a decade later in the "war of the systems", as a source of learning-by-doing (see Event 1, section 3.2). Together with the construction of another French-Belgian PWR reactor, in Tilhange, it laid the bases for a future French nuclear programme, for the Frenchification of the PWR technology (Hecht 2009; Dänzer-Kantof & Torres 2013, 169-174). In the meantime, especially the collaboration with the British United Kingdom Atomic Energy Authority (UKAEA, equivalent of CEA) and Central Electrcity Generating Board (CEGB, equivalent of EDF) provided further experience on the construction of gas-graphite reactors. Construction times and costs were brought down rapidly,[10] although the cost still remained higher than for conventional thermal plants and for the PWRs. EDF's ambition of cost-reduction sometimes clashed with CEA's primary preoccupation – the needs of military applications. Both CEA and EDF experimented also with other technologies. For example, EDF sought to promote competition between PWR and boiling water (BWR) technologies (Dänzer-Kantof & Torres 2013, 175-176).[11]

President George Pompidou took office after de Gaulle on 20 June 1969 and continued his predecessor's policy of national independence. Pompidou was a keen promoter of nuclear energy, wishing to avoid the problems of French oil-dependence, which he had encountered during his prime ministership under de Gaulle. The policy of national champions had indeed been launched already a few years earlier, and announced officially with the launching of the 5th nuclear plan in 1966 (Dänzer-Kantof & Torres 2013, 192). Once the war of the systems had been settled in favour of PWR technology, the reactors were ordered in "block orders", as part of public sector planning (Commission 2014, 77-78). The first of the six "blocks", CP0, decided in 1970, consisted of six 900 MW reactors (4 at Bugey and 2 in Fessenheim).

[10] Construction times were divided by three, from 18.5 and 12.5 months for the two first reactors to 5-8.5 months for the three subsequent ones.

[11] Furthermore, a heavy-water reactor at Brennilis (grid connection in July 1967) had to stop operating as early as 1985, because of technical problems.

First steps towards true safety regulation were taken in the early 1960s. In 1960, a dedicated safety unit, CSIN,[12] was created within the CEA. In 1963, a decree stipulated that all nuclear installations would be subject to authorisation by an interministerial safety commission, CIINB.[13]

Launching of the "all nuclear" policy after the oil crisis: the "Messmer Plan"

The first oil crisis spurred the government to the launch a massive nuclear programme named according to the then Prime Minister, Pierre Messmer, on 6 March 1974. The "Messmer Plan" foresaw the construction of 13 reactors by 1980, 50 reactors at 20 sites by 1985, and 100 reactors on 40 sites by 2000, at an estimated total cost of 177 billion francs (Aykut 2012, 285). The ultimate objective was "all nuclear": nuclear power was eventually to satisfy the country's entire electricity demand, with the intermediate objective of 70% nuclear electricity by 1985. A major means of achieving these objectives was to expand electric space heating. In reality, a total of 56 PWR reactors were constructed in 15 years – still an exceptional industrial achievement – raising the share of nuclear in electricity provision from 4% in 1970 to 24% in 1980 and further to 74% in 1990 (Fontaine 2006, 20). Three-quarters of the existing French nuclear capacity was built in just ten years (1980-90). By the early 1980s, the French could proudly announce having fully Frenchified the American PWR technology. Block-ordering of reactors enabled standardisation and economies of scale, thereby laying the basis for the still largely prevailing image of nuclear as the guarantor of cheap electricity. Generous subsidies – mostly infrastructure investments – were offered to municipalities hosting nuclear installations.

Eighteen 900 MW PWR reactor construction sites launched between 1974 and 1979, and these reactors were connected to the grid between 1980 and 1985 (Bertel and Naudet 2004, 66). The Eurodif uranium enrichment plant was taken into use in 1976. In the same year, the construction of ten new 900 MW reactors at three sites was announced, while in 1977, a further eight reactor projects were decided – this time of significantly greater capacity at 1,300 MW each. Twelve more reactor orders of 1,300 MW at five sites were made in 1980 (Commission 2014).

[12] *Commission de sûreté des Installations Nucléaires* – Safety commission for nuclear installations.

[13] Commission interministérielle des installations nucléaires de base – Interministerial commission of basic nuclear installations.

Critics have often denounced the undemocratic nature of the announcement of the Messmer Plan, as decisions were made by a small circle of experts and politicians, without parliamentary scrutiny (Nelkin and Pollak 1981, 37-57; Bess 2003, 95; Dänzer-Kantof and Torres 2013, 28-29), in turn, they evoke the gradual build-up of the political will as a necessary precondition for the implementation of the plan: during the preceding 15 years, key actors had improved their skills and competences, while the “war of the systems” had settled the conflicts between the key players. The plan was therefore in preparation since the late 1960s and ready to be introduced once the time would be ripe. The Messmer Plan helped to consolidate French nuclear industry, and gave rise to three industrial groups

- Creusot-Loire – Framatome (since the bankruptcy of Creusot in 1985, Framatome): construction of equipment and boilers
- CGE – Alsthom-Atlantique (Alcatel Alsthom from 1991 onwards): electromechanics; and
- CEA-Cogema: fuel cycle

The launching of the “Messmer Plan” triggered a **wave of opposition against nuclear power** on planned reactor sites around the country. They culminated in 1977 in violent confrontation between the protesters and the policy at the planned site for an industrial prototype fast breeder reactor, Superphénix”, at Creys-Malville (see Event 3, section 3.4). EDF engaged in vigorous PR efforts in the name of “educating the public”. Through regular public opinion surveys, it sought to better understand the reasons for public opposition to nuclear, better govern this opposition, and build legitimacy for nuclear by demonstrating significant support for nuclear among the population. The results of the various surveys conducted by various organisms vary widely, depending on the survey methods. Dänzer-Kantof & Torres (2013, 12) report increasing approval ratings – from 35% to 65% between 1975 and 1980. Topçu (2010, 172-173) contends that growing support was mostly seen in regions seeking greater self-sufficiency in energy provision, whereas regions free of such pressures (e.g. Brittany and Languedoc-Roussillon) remained strongly opposed to nuclear.

Safety regulation advanced towards a clearer separation of responsibilities. In 1973, a nuclear safety unit, SCSIN,[14] was set up within the Ministry of the Industry, yet the unit suffered from scarcity of resources, and remained for a long time highly dependent on CEA’s safety department,

[14] Service central de la sûreté des installations nucléaires.

DSN,[15] for expertise and logistics (Topçu 2010, 53). A safety culture started to emerge from the collaboration between EDF and SCSIN on safety issues, which provided an attractive and challenging working environment for a great number of engineers. The gradually emerging French safety doctrine drew on the American model and legislation but sought to adapt it to French conditions.

Three Mile Island and the first openings of the nuclear technocracy (1979-1986)

In 1979, the Three Mile Island (TMI) accident in the USA occurred at the very moment when French nuclear safety officials and experts believed they had finally managed to bring accident risks under control. TMI contributed to **safety culture**: the prevailing practices of the nuclear industry were called into question, scenarios of a serious accident were for the first time integrated into safety planning, and safety experts gained a greater say within the industry (Foasso 2003, 10). The absence of a legislative framework governing nuclear power gave technical experts a decisive role in the case-by-case considerations concerning the location and safety of nuclear installations (Foasso 2003).[16] The government's communication strategy sought to reassure the public, rather than to foster transparency.[17]

By 1980, public support for nuclear had increased by about 20 percentage-points since the time of the massive contestation three years earlier. In a survey of about some 1,000 respondents, 59% considered French nuclear power stations as safe (Blanchard 2010, 150).[18] This greatly improved approval rating of nuclear could be partly attributed to the massive PR efforts undertaken especially by EDF.

Paradoxically, the **entry in power of the Socialist government of François Mitterrand in 1981** served to depoliticise choices concerning nuclear energy and led to a broad cross-party consensus on the need to pursue the "all-nuclear" policy launched in 1974. Mitterrand failed to respect his pre-electoral promise of reconsidering the nuclear programme, while the nuclear option suited the Socialist party's "scientist" convictions (Topçu 2006). The traditionally pro-nuclear and powerful

[15] Département de sûreté nucléaire.

[16] Foasso (2003) argues that this has, in fact, been beneficial to nuclear safety, as it has prevented decisions on technical safety matters from being excessively dictated by bureaucratic and legal considerations.

[17] The authorities indeed concealed a number of defects detected in the French nuclear installations in 1979 (Foasso 2003).

[18] According to a survey SOFRES-Le Pèlerin, 19th April 1980.

trade unions – the CGT in the first place – campaigned in favour of the continuation of the nuclear programme, whereas CFDT criticised the massive scale of the Messmer Plan.[19] Even the most contested elements of the nuclear programme remained in place, including the extension of the La Hague waste processing plant and the development of fast breeder reactors.

The Socialist government nevertheless made **concessions to the opponents**, including the abandonment of the reactor project in Plogoff, Brittany. Allegedly, this was done to please the electorate of the incipient Green party, whose candidate, Brice Lalonde, had obtained more than a million votes in the first round of the 1981 presidential elections.[20] From 1980 onwards, safety issues again almost disappeared from the media agenda, as economic problems attracted the bulk of the attention (Chateauraynaud and Torny 1999).

There were signs of the nuclear technocracy opening up and fostering transparency in the 1980s (Barthe 2006, 77-87). The nuclear proponents no longer saw anti-nuclear opposition as a manifestation of individual irrationality, but as part of larger political and social mobilisations. Public opinion surveys were conducted in order to explain the social origins of public opposition. Counter-expertise took its first steps towards institutionalisation, as the government set up – as a concession to nuclear critics within the socialist party – a pluralist expert commission (Commission Castaing, 1981-1984) to examine the options and research on radioactive waste management (Barthe 2006, 47-48). Its rather ambiguous recommendations were useful for both the nuclear 'establishment' and for the critics (Barthe 2006, 52-56). The **"Local Information Committees"** (CLIs – Commissions locales d'information) were established in 1981, to inform populations in the proximity of nuclear installations and to answer their questions.

In 1979, the **French national radioactive waste management agency, Andra**,[21] was created within the CEA. It was given a broad mandate, including the management of long-term waste disposal facilities, planning and construction of new disposal centres for low-level waste, and research on the methods and processes of long-term management of radioactive waste (Barthe 2006, 55-56). Deep geological disposal thus became the taken-for-granted option of high-level radioactive waste management (Barthe 2006, 57).

[19] http://alternatives-economiques.fr/blogs/bompard/archives/52

[20] http://seaus.free.fr/spip.php?article230

[21] Agence nationale pour la gestion des déchets radioactifs.

The beginning of mistrust and doubt: from Chernobyl to the closure of Superphénix (1986-1997)

The attempts by the government to cover up the true extent of the Chernobyl fallout in France inaugurated a period of mistrust towards the government and industry as sources of information especially on the risks of nuclear power (see Event 2, section 3.3). They also further strengthened "counter-expertise", with the creation of two key citizen-led expert organisations, ACRO and CRII-RAD, (see Showcase, section 2). EDF paid increasing attention to environmental issues.[22] The plants already under construction before Chernobyl were completed, and the construction of the Civaux plant launched in 1988. At the onset of the "nuclear winter" following Chernobyl, in 1987, the French Framatome and the German Siemens concluded an agreement to launch the preparation of a joint new reactor, at a time when both governments foresaw a future need for new nuclear capacity.[23] The work to design the new "third generation" European Pressurised Reactor (EPR) started in 1989.

Safety regulation advanced towards a further separation of roles and competences between actors. Technical experts lost some of their regulatory powers, the regulatory authorities gained greater independence in relation to the industry and became more sensitive to public opinion, while industrial and financial considerations took greater importance in EDF's decision-making. In 1991, DSIN[24] was set up, under the Ministries of the Environment and Industry. The safety authority, ASN, was then created, with both national and regional level offices – at the national level as part of DSIN and in the regions as part of the regional industry, research and environment offices, DREAL.[25]

European legislation (e.g. the EURATOM Directive 89/618 on public information concerning health protection measures in the event of a radiological emergency, and the Environmental Impact Assessment Directive) forced further opening and transparency within the French nuclear establishment. This was in line with the more general trend to strengthen citizen participation:

[22] For example through work within GRETS – a social science research unit of the EDF created in 1980 – which now largely reoriented its work towards environmental issues.

[23] "When Framatome and Siemens reached their agreement in 1987 it was the consensus at that time that we would need additional nuclear capacity in Germany and France", says Yves Cousin, head of engineering at EdF." (Financial Times, 14/11/1997).

[24] Direction de la sûreté des installations nucléaires.

[25] Directions régionales de l'industrie, de la recherche et de l'environnement. http://www.asn.fr/L-ASN

numerous laws were enacted at this time to foster local, participatory democracy (Gadbois et al. 2007; Blondiaux 2004, 2-3; Blondiaux 2008). For instance, ASN introduced in 1987 a system of measuring the level of seriousness of nuclear incidents, in order to better inform the public (ASN, 2007).

In the wake of Chernobyl, public support for nuclear declined from 67.4% in 1985 to 51.33% in May 1986, and further to 43.5% in 1988 (Dänzer-Kantof & Torres 2013, 459), to a level as low as following the launching of the Messmer Plan in the mid-1970s (Blanchard 2010, 133). The negative impact of Chernobyl on public opinion concerning nuclear power peaked about 2-3 years after the accident, and lasted at least a decade, during which the support for nuclear never reached anywhere near its pre-Chernobyl level (Blanchard 2010, 133).

Tensions accumulated between EDF and nuclear safety authorities. Safety authorities gained strength thanks to the efforts driven by the IAEA to develop a “safety culture” as an antidote against Chernobyl-like accidents. The numerous technical problems detected in French reactors in the late 1980s raised fears of a systemic design failure. The state authorities’ perception of their own role in safety control was transformed: the administration now began to see itself less as an advocate of state interests, and more as a guardian of the public interest. Yet, the ability of a government body to serve this interest by controlling industries was increasingly called into question (Foasso 2003). Counter-expertise gained more legitimacy and visibility in reaction to safety “alerts”, such as the discovery of higher frequency of leukaemia cases among children living in the neighbourhood of the La Hague site (the “affaire radio-contrôle”), and the subsequent setting up of a pluralist, multistakeholder body (Groupe radioécologie Nord-Cotentin – GRNC), in 1997, to examine the case (Gadbois, Heriard Dubreuil et al. 2007; Miserey 2007, 108). The sudden decision to close down the Superphénix fast breeder reactor, in 1997, was symbolically highly significant, made as a concession by the Socialist government to its Green Party ally in the government of Lionel Jospin (see Event 3, section 3.4).

Radioactive waste rose again on the agenda in the late 1980s and became a major driver of greater openness in French nuclear energy policy (for more details, see Event 4, section 3.5). Throughout the 1980s, authorities had sought a suitable solution for deep geological disposal, perceived by the majority of nuclear experts as the only practicable option. In 1987, ANDRA, at the time still part of the CEA, launched investigations designed to identify suitable disposal sites. The test drillings at four potential sites identified by ANDRA faced vehement opposition and protests, eventually leading the Socialist government of Michel Rocard to declare in February 1990 a one-year moratorium on the investigations.

Barthe (2006, 93-95) has described the moratorium as a beginning of “reversibilisation”, a logical conclusion in a situation when debates concerning technical solutions to waste management had reached a dead-end, and the problem was redefined as essentially political and societal rather than technical in nature. The country’s first law specific to nuclear energy, the Bataille law (1991), was a major milestone that introduced a new approach to radioactive waste management, opening the process to a broader range of participants and possible waste management options. In addition to deep geological disposal, long-term subsurface storage as well as transmutation and partitioning were to be examined over a 15-year period. ANDRA was turned into an independent public body with R&D, industrial and information functions, operating under the authority of the three ministries of industry, research, and the environment. This reform sought to separate responsibilities between different government actors, while retaining the essential of decision-making powers within the state.[26]

Electricity-market liberalisation, the resurgence of radical anti-nuclear protest and polarisation of the debate (1998-2003)

The end of the century was marked by the preparation for energy market liberalisation, stipulated by the EU, by reforms of safety regulation, radicalisation and polarisation of debate between the promoters and opponents of nuclear, and further institutionalisation of counter-expertise. The long-standing state-centredness of French energy policy came under increasing pressure, due mainly to two external drivers: the introduction of competition into the electricity and natural gas sectors, and the growing internationalisation of the energy sector in Europe with the consolidation of the single market (IEA 2004, 7). However, the French industry and government were able to slow down liberalisation and adapt EU regulation in such a way as to retain essential elements of the “French model" of the electricity market (e.g. Reverdy 2014). The gradual loosening of secrecy concerning the risks of nuclear, observed in the previous periods, was now followed by a similar opening up in

[26] Personal communication by an ANDRA official, 16 September 2008.

the area of nuclear economics. This opening was epitomised by the publication of a report prepared by three experts of varying backgrounds and partly contrasting visions concerning nuclear energy ("Charpin-Pellat-Dessus report") in autumn 2000, described at the time by the the Green Party environment minister, Dominique Voynet, as "possibly the first equitable report in the French nuclear history".[27]

The nuclear **industry underwent a process of reorganisation**. Partly pushed by electricity market liberalisation, in the context of saturation of the domestic market, the logic of energy independence began to give way to an approach emphasising economic competitiveness and export opportunities. Areva was created in 2000-2001 as a fusion between Cogema, CEA's nuclear arm, CEA-Industrie, and Framatome. France now had two industrial giants – EDF and Areva – each with its distinct industrial "logic". While EDF draw on its long experience in the control and management of the industrial supply chain, Areva operated as a supplier of fuel, procedures, equipment, turn-key reactor contracts, etc. The complementarity between EDF and Areva was to be a key asset especially in the export market. Initially, the reorganisation seemed to bring results, as an Areva-Siemens consortium won in 2003 the bid to build an EPR reactor in Finland, while a few years later, EDF won participation in two EPR projects in Taishan, China.

The period saw a return of the earlier **polarisation and radical contestation**, especially with the creation, in 1997, of an anti-nuclear NGO network, *Réseau sortir du nucléaire*, to carry forward the struggle that had led to the abandonment of the Superphénix fast breeder reactor (Topçu 2008). Today, the network has 918 member organisations.[28] Public support to nuclear declined, with about equal share (40-45%) of people supporting and opposing nuclear, and a significant proportion of citizens being undecided on the issue (e.g. Blanchard 2010, 132).

The **institutionalisation of counter-expertise** continued, as the GRNC, set up in 1997 (see the previous period), was given a permanent status in January 2003, and was mandated to assess and annually monitor the quality of AREVA's auto-evaluation of its radioactive releases (Sugier 2007, 112). Counter-expertise took a legal dimension in 2001, when a leading nuclear counter-expertise association, CRII-RAD, and the French association of sufferers of thyroid disease brought a

[27] Interview of Dominique Voynet, Les Echos, 31/10/2000.

[28] http://www.sortirdunucleaire.org/spip.php?page=rubrique-2&id_rubrique=2&type=&region=

complaint against person unknown, demanding the conviction of those responsible for having misled the French public about the nature and extent of the Chernobyl fallout in the country (Topçu 2006, 255).

Possibilities for **citizen engagement** were improved by the reinforcement of the independence of the CNDP (National Commission on Public Debate) in 2002, and the introduction of further new laws on local-level citizen participation.

Safety regulation was simplified in a reform between 1998 and 2002, following numerous incidents in the 1990s concerning notably radioprotection. The links between authorities responsible for nuclear safety and radiation protection were strengthened, and duties and responsibilities between actors clarified, the authority's sphere of competence was extended to cover radiation protection, and the organisation was subordinated to the three ministries of industry, health and the environment. The principal technical support organisation of the regulator was separated from CEA and an autonomous public organisation IRSN (*Institut de radioprotection et de sûreté nucléaire*) was created. (IEA 2004, 147).

Pushing for a French-led nuclear renaissance; public consultations on energy and nuclear policy (2003-2009)

As France sought to position itself as a leader of the industry's self-announced "nuclear renaissance" in the early and mid-2000s, the nuclear sector went through further organisational reforms. The EPR plant, commissioned in 2003 by the Finnish TVO from the Areva-Siemens consortium in 2003, was to become a showcase of the French-led nuclear renaissance. In 2005-2006, broad public consultations ("public debates") on nuclear power and waste management were for the first time organised by the National Commission on Public Debate (CNDP). The proponents of nuclear power used in climate change and energy security as among their key arguments. The two laws on nuclear waste management enacted in 2006 consolidated reversible geological disposal as the reference option for waste management, and made the safety authority, ASN, fully independent from both the government and the industry. The French site Cadarache won, in 2005, the race for hosting the ITER international experimental fusion reactor. However, clouds started to build on the French nuclear sector as early as 2006, the Finnish EPR soon turning in public discourse from a showcase to "Areva's Finnish debacle".

In 2003, nuclear electricity accounted for 77.6% of the total electricity generated in France (419.8 TWh of 540.7 TWh total), but the country also exported significant amounts of electricity to its neighbours (IEA 2004, 141). With a saturated domestic market, France now aimed to lead the international "nuclear renaissance", targeting reactor markets especially in Asia. However, the two first orders – aimed at flagship projects demonstrating the viability of Areva's EPR reactor – came from Europe: in 2003, the Finnish TVO ordered from Areva an EPR reactor to be constructed at Olkiluoto (municipality of Eurajoki), on a turn-key contract, and a year later, in October 2004, the French government decided on the construction of an EPR at Flamanville, Normandy. The plants had estimated budgets of 3-3.3 billion euros,[29] and were to be completed by 2009 (Olkiluoto) and 2012 (Flamanville).

The industry continued its strategy of **overseas investments**. In 2005, Areva joined forces with the North American Constellation Energy, which was planning to build the first nuclear reactor in the US since Chernobyl.[30] In a strategic move to guarantee its uranium supply, in 2007, Areva bought the Canadian uranium mining company, Uramin, operating in Nigeria, for EUR 1.8 billion. The following year, on 1st August, EDF announced the acquisition of the bankrupt British Energy. This generated concern in the UK, notably because of fears of electricity price increases and safety risks – in the wake of the radiation leaks in EDF reactors at Tricastin (France) earlier in the year.[31] Just over four months later, EDF announced its plan to buy 49.99% of the nuclear activities of Constellation Energy, in the US.

Further **liberalisation** of electricity markets generated discussion concerning the compatibility of nuclear energy within the new, liberalised framework, as the need for cost-consciousness created tensions within the nuclear establishment. Some argued that liberalisation had put an end to the long-standing French approach in which economic considerations remained secondary and subordinate to state security and political interests. This tradition had been evoked as an explanation, for instance, for the continued operation of the La Hague reprocessing plant, despite the continuous economic losses.[32]

[29] 3.3 bn for Flamanville, and between 3 and 3.3 bn for Olkiluoto (Thomas 2010).

[30] Financial Times, 16/09/2005.

[31] E.g. The Times, 24/09/2008.

[32] Personal communication by a French political scientist, March 17, 2008.

For Areva, problems began to mount already in 2005, almost immediately following the inauguration of works at the Olkiluoto EPR site in Finland. The project (as well as the EPR project led by EDF at Flamanville) has ever since been marred by delays, technical problems and cost overruns. By 2007-2008, the French press habitually referred to Olkiluoto 3 as Areva's "Finnish quagmire". The initial budgets for both Olkiluoto and Flamanville EPRs were soon exceeded. The construction of the Flamanville EPR started in 2007. By 2009, the overruns still remained reasonable: a delay of one year and 20% budget overrun were predicted.[33] This period also coincided with an increasing commitment of the UK government to a nuclear new-build programme, with EDF posing itself as the prime candidate for constructing an EPR at Hinkley Point (see UK Short Country Report). Problems surrounding the EPR reactor took a new turn in autumn 2009, when the Finnish, French and UK safety authorities issued a joint statement concerning the problems they had identified in the Control and Instrumentation (C&I) systems of the EPR. A year yearlier, TVO and Areva had already engaged in the long-drawn, and still continuing, dispute whereby both parties demand from the other significant compensations for the delays. The Finnish regulator, STUK, became a major player in the dispute, as the French repeatedly accused STUK for causing delays by its "unreasonable" demands on Areva – excessively detailed documentation in particular. In 2008, Siemens withdrew from the joint venture, leaving Areva alone to develop the EPR (see Finland Short Country Report). These problems notwithstanding, the UK government continued with its nuclear new-build plans, and EDF with its EPR reactor remained the prime candidate among the potential contractors. The agreement has since been signed, with additional Chinese funding, although cost estimates have already been increased (see UK Short Country Report).[34]

The first attempt to involve the public in decisions concerning nuclear energy in France was the debate organised by the Ministries of Energy and Industry, between March and May 2003, in preparation for the 'Energy Law', which would outline the country's energy strategy for the subsequent thirty years. The debate consisted of six public meetings held across the country, a

[33] http://www.lemonde.fr/planete/article/2015/04/21/epr-de-flamanville-de-plus-en-plus-en-retard-de-plus-en-plus-couteux_4618984_3244.html

[34] Suggested explanations to the continuous interest of the UK government and EDF in the Hinkley Point plant include the needs of the UK submarine warhead industry, and the desire of EDF and the UK government to maintain good relations with the Chinese government as a key investor in other reactor projects (esp. Taishan, China, and Bradwell, UK).

number of events at the local level and an information website. Government officials presented the issues and the public was free to comment (IEA 2004, 35-36). The process resulted in a 'three wise men's report', followed by a government decision subsequently submitted to Parliament for approval. Not only NGOs but also many independent observers condemned the debate as a poorly disguised attempt by the government to legitimise decisions it had already made (Mays 2004, 42; CG 2006, 70).[35] It was in this context of general scepticism that three debates were organised by the CNDP on nuclear policy in 2005-2006 – on radioactive waste management policy, on a planned new EPR reactor in Flamanville, and on the high-voltage transmission line designed to connect the Flamanville EPR to the national grid (see Event 4, section 3.5).[36]

After having won over a Spanish site in a bid for European candidacy, and then against Japan in the final competition, the French site Cadarache was chosen in June 2005 as the site for ITER, a collaborative project involving the EU, Russia, China, USA, Japan and Korea, aimed at experimenting with nuclear fusion. This multi-phase competition complicated the organisation of the mandatory public debate on ITER (Chateauraynaud et al. 2005).[37] The debate was finally held in parallel with the debates on EPR and nuclear waste, and concluded on 6th May 2006.[38]

Between 24th March and 24th July 2010, a public debate was organised on a planned second French EPR reactor in Penly, Seine-Maritime. The construction of Penly EPR was, however, put on hold soon after the Fukushima accident in 2011.

The public debate on radioactive waste management fed into a parliamentary discussion in preparation for a new law on nuclear waste. Two crucial new laws were enacted. The "Planning Act" established **reversible** geological disposal as the reference option, but stipulated that research should still continue on two other options: long-term near-surface storage, and partitioning and transmutation. The Act on nuclear transparency and security (the "TSN Act") transformed ASN into

[35] Daniel Boy, personal communication, 17 March 2008.

[36] The death of a young protester in November 2004 in demonstrations against nuclear waste transports between France and Germany considerably affected the public debate and led to further polarisation of views.

[37] To inform decision-making, the debate should have taken place in advance of the final location decision, but a debate on a project that might not go ahead after all – because rejected by the international selection committee – would have been difficult to justify (Chateauraynaud et al. 2005)

[38] http://cpdp.debatpublic.fr/cpdp-iter/docs/pdf/compte-rendu/cr-final.pdf

an independent safety regulation agency (the National Agency for Nuclear Safety – ASN).[39] The new ASN inherited the entire personnel, resources and tasks of its predecessors, DGSNR and DSNR.[40] The TSN Act vested ANDRA with the responsibility of preparing a public debate (under the auspices of CNDP) on the construction of a site for long-term disposal of high-level radioactive waste by 2015. Through this law, Parliament redefined the framework for the control of discharges from basic nuclear installations (BNIs). ASN became responsible for organising continuous radiation protection surveillance throughout the country and for disseminating information concerning surveillance. Private industry was subjected to same requirements as public authorities concerning the dissemination of information. The role of the local information commissions (CLIs) was strengthened. These legislative reforms spurred ANDRA to develop its capacities in the area of citizen participation and consultation. The agency now attributed a greater role to social science, and adopted a more participatory and conciliatory approach. Defining the meaning and the various technical, economic and societal implications of 'reversibility' became a key topic in ANDRA's research efforts (see event 5, section 3.6). Reflecting ANDRA's new philosophy, the term 'concertation'[41] made its appearance in the vocabulary of the agency. Previous texts on the matter had merely referred to 'consultation'. Despite this new, more open and participatory approach, long-term disposal of high-level radioactive waste in deep repositories remained the preferred option by the French nuclear industry – first implicitly and since the enactment of the 2006 Acts explicitly – as a logical and inevitable consequence of the choice of vitrification as the reprocessing option, which would render the retrieval of waste extremely difficult and costly (Gilbert and Bourdeaux 2006, 17-24).

Crisis and the end of the French-led renaissance (from 2010 onwards)

By 2010, the French-led nuclear renaissance was stalling. Since then, recurrent technical problems, delays and cost overruns have continued to plague both the Olkiluoto and Flamanville EPR construction sites, all the while French companies have suffered repeated setbacks in their

[39] Until then, nuclear safety was the responsibility of the Directorate-General for Nuclear Safety and Radiation Protection (Direction générale de la sûreté nucléaire et de la radioprotection, DGSNR), which was, somewhat confusingly, also called Autorité de sûreté nucléaire – ASN IEA (2004). Energy Policies of IEA Countries: France 2004 Review. Paris, IEA/OECD. The Divisions de la sûreté nucléaire et de la radioprotection (DSNR) were safety authorities at the regional level.

[40] http://www.asn.fr/L-ASN

[41] Concertation could be translated as dialogue, coordination and agreement (amongst the relevant participants).

attempts to set foot in Asian and American markets, and Areva has fallen deeper into trouble. Areva's problems stem not only from the continuing delays and cost overruns at Olkiluoto and Flamanville, but also from the resounding failure caused by the acquisition the Uramin mining company in 2007, at the very moment when uranium prices were at their highest, as major international players expected growing demand and a nuclear renaissance.[42] EDF has had to downsize its North-American activities, which it no longer considers of strategic importance.[43] The "Roussely report" (2010) recommended a suite of measures designed to mitigate the setbacks, including notably the need to offer a wider product range (with reactors of smaller capacity than that of the EPR), and improve project management (Szarka 2013). A year later, just before Fukushima, the French Council for Nuclear Policy, an inter-ministerial forum chaired by President Sarkozy, recommended consecrating EDF as the 'consortium leader' in French bids for turnkey reactor build, closer cooperation between Areva and EDF especially on EPR, and extending the life-time of existing reactors in France to 60 years (Présidence de la République 2011; Szarka 2013).

The Fukushima accident therefore occurred at a moment when the French-led nuclear renaissance had largely failed, for primarily economic and organisational reasons (Szarka 2013). The initial reactions were similar to those in many other European countries: "stress tests" on all French reactors; reassurance by the authorities and industry that a similar accident would be impossible in France – or that the EPR plant would resist in a similar situation;[44] freezing of the planned EPR

[42] The Uramin affair is currently being investigated, the then head of Areva, Anne Lauvergeon, being suspected of having manipulated her company's annual accounts in order to conceal the real value of Uramin. The mines – most of which in Nambibia, the Republic of Central Africa, and South Africa – have turned out to be either unprofitable or inoperable.

[43] http://www.lesechos.fr/30/07/2013/LesEchos/21489-063-ECH_edf-amorce-son-desengagement-du-nucleaire-aux-etats-unis.htm In March 2016, Corinne Lepage, Member of European Parliament, affirmed that EDF had made a loss of USD 6 billion in first investing with a view of constructing nuclear plants in the US, and then revoking its plans because of excessive American insurance costs. http://future.arte.tv/fr/corinne-lepage-le-contribuable-paye-pour-subventionner-une-filiere-nucleaire-de-plus-en-plus

[44] In an informal ministerial-level international seminar on nuclear safety, organised in Paris by the French government in early June 2011, the safety of the EPR reactor was at the heart of the debates: the industry and the government – the head of Areva, Anne Lauvergeon, in the first place – argued that had the Fukushima reactors been of the EPR type, a nuclear accident would have been avoided. Greenpeace – relying on analysis by an Austrian expert, Helmut Hirsch, called into question the safety of EPR, claiming the reactor could withstand at most a 24-hour blackout, highly insufficient in view of the eleven-day power cut in Fukushima ([44] Nucléaire: Greenpeace souligne une faille de l'EPR. Ouest France, 26 July 2011; L'EPR vulnérable selon Greenpeace, Le Figaro, 26 July 2011).

construction project at Penly in May 2011[45]; and debates concerning the prediction of the probability of a major accident.[46] The ASN called for a change in safety philosophy, and the need for the nuclear industry to "imagine the unimaginable", i.e. the possibility of a "beyond-design" accident. Fukushima did not fundamentally change French nuclear policy, yet for the first time even some mainstream politicians evoked the possibility of a nuclear phase-out. The energy scenarios for 2050 elaborated by a government commission for the first time included a phase-out scenario (Percebois and Mandil 2012). The German nuclear phase-out decision became a major topic in the French nuclear debate: the pro-nuclear side evoked Germany as a warning example, while those opposed to nuclear saw Germany as a frontrunner on a path towards sustainable energy policy (see Germany Short Country Report). Fukushima also triggered the publication of a multitude of books on nuclear energy, including those written by leading experts and politicians.[47]

In his election campaign, President François Hollande promised, if elected, to reduce the share of nuclear electricity from the current 75% to 50% by about 2025 and to shut down the oldest French reactor, at Fessenheim, by the end of 2016. The commitment was inscribed in the new law on energy transition on 17 August 2015. During his election campaign, Emmanuel Macron, elected President in May 2017, professed his commitment to this objective, yet only six months after taking office, the environment minister, Nicolas Hulot, announced that the target date would have to be postponed.

[45] Nucléaire: le projet de l'EPR de Penly en pause. Libération, 04/05/2011. http://www.liberation.fr/terre/01012335424-nucleaire-le-projet-de-l-epr-de-penly-en-pause However, at this time, the government still claimed, on 6 May 2011, that the construction of Penly would remain on the agenda, even though the timetable for the project was dropped.[45]

[46] Experts from an anti-nuclear NGO, Global Chance argued that in view of the actual accident record after Fukushima, the likelihood of a serious accident was 300 times higher than the theoretical likelihood estimated by the authorities. The director of the safety authority's expert arm, IRSN, Jacques Repussard, echoed the critics without nevertheless taking a position on the exact figures: the accident had clearly "reshuffled the cards", since the empirically observed accident frequency (measured as the number of accidents for the total number of reactor-years in the world) exceeded twenty-fold the estimates derived from probability calculations. The government held the line, as the energy minister, Eric Besson, considered the frequency of two accidents per half a century largely insufficient to enable reliable statistical analysis, and reminded that "zero risk does not exist" [46] ("Il n'y aura aucun moratoire sur les réacteurs EPR". Jean-Christophe Féraud. Libération, 31 May 2011).

[47] E.g. Chatelier, M., Criqui, P., Heuer, D. et Huet, S. 2012. Nucléaire : quels scénarios pour le futur ? Editions La Ville qui brûle; Allègre, C. 2011. Faut-il avoir peur du nucléaire? Éditions Plon; Lepage, C. 2011. La vérité sur le nucleaire. Albin Michel; Lévêque, F. 2013. Nucléaire on/off: Analyse économique d'un pari. Paris: Editions Dunod.

Economics gained an increasingly prominent position in nuclear debates, spurred in particular by critical reports by the Court of Auditors (CdC 2012; CdC 2014), a parliamentary commission inquiry into the costs of the French nuclear industry (2014), the publication by the safety expert organisation, IRSN, of estimated costs of a possible major accident in France, and EDF's estimates of the costly but reactor safety upgrades necessary for reactor lifetime extensions. The debates following the publication of the 2050 energy scenarios concentrated largely on the cost of a possible nuclear phase-out scenario – and on the costs of the necessary technical and safety upgrades of old reactors, it the current nuclear fleet were to be maintained.[48] Areva's financial problems aggravated to a point where the government in 2015 obliged EDF to bail out the company, yet also EDF finds itself in an increasingly fragile position.

Against the will of key EDF trade union representatives and following the resignation of EDF's finance director in March 2016, and of another board member just before the decision,[49] EDF nevertheless confirmed on 28 July 2016 its willingness to construct two EPR reactors at Hinkley Point, Somerset. After a last-minute cancellation by the new Prime Minister, Theresa May, of the planned signing of the contract between EDF and the UK government, the government declared, in late September 2016, that Hinkley Point C would indeed go ahead, despite the UK concerns that the Chinese participation in the project might threaten national security. Since 2010, and the official designation by the UK government of Hinkley Point as one of the future reactor sites, EDF (especially Vincent Rivaz, the head of EDF's UK subsidiary), had put increasing pressure on the UK government to move towards ordering the two EPRs from EDF.[50] The company submitted a planning application in October 2011, and started preparatory works on the site in February 2012. Negotiations between EDF and the UK government on a "strike price" – a guaranteed minimum price that EDF would receive for electricity supplied by Hinkley Point reactors – started in May 2012, and ended in October 2013 with the government's announcement of a provisional agreement. The deal would guarantee for EDF twice the current market price of electricity for each megawatt-

[48] The head of EDF, Henri Proglio, estimated that EDF would invest a total of €40-50 billion merely in the extension of reactor lifetimes – in addition to the needed grid and renewables investments ("L'Allemagne bouscule le dogme français de l'atome". Thibaut Madelin. Les Echos, 7 June 2011).

[49] https://www.ft.com/content/3209004a-54ca-11e6-befd-2fc0c26b3c60

[50] http://newsroom.edfenergy.com/News-Releases/Carbon-Price-Mechanism-a-first-step-in-the-year-of-delivery-for-secure-affordable-low-carbon-energ-20f.aspx

hour of power that the two Hinkley Point C reactors would generate over a 35-year period. In October 2014, the EU competition authorities approved the deal, thus rejecting the legal challenges raised by Austria and Germany.[51] By this time, the construction plans were already six years late, and the cost estimate had increased to a total of £24.5 billion, a more than 50% increase from the £16bn that EDF had announced only a year earlier.[52] In France, the project generates increasingly ambivalent sentiments: it constitutes a crucial flagship project for the country's nuclear industry, while at the same time causing a potentially fatal burden for EDF's already strained finances. While the general sentiment in the UK was, in 2012-2013, one of EDF having got an "incredibly favourable deal" and the UK taxpayer footing the bill, today's situation appears strikingly different. Even many nuclear-sector insiders see UK's nuclear plans as a threat to the finances of both EDF and the French state.

Both ASN and IRSN have expressed increasing concern about safety in the French nuclear industry. The mounting challenges associated with the ageing nuclear fleet and the technical problems encountered in the construction of the EPR reactors are obvious reasons, but especially ASN appears willing to demonstrate its independence,[53] in order to erase the image of secrecy within the French "nucleocracy". In October 2016, a third of the French reactors were out of operation, ten for regular maintenance works, four because of incidents, and eleven for detection of possible anomalies in their steam generators.[54]

[51] The EU authorities argued that the subsidies would indeed be necessary to correct a market failure – the only acceptable justification for state aid according to EU competition legislation http://www.ft.com/cms/s/0/372216e6-4ec0-11e4-b205-00144feab7de.html#axzz3NNtE3cUO

[52] https://www.ft.com/content/372216e6-4ec0-11e4-b205-00144feab7de ; http://www.ft.com/cms/s/0/372216e6-4ec0-11e4-b205-00144feab7de.html#axzz3NNtE3cUO

[53] For example, in April 2015 ASN announced that anomalies had been detected in composition of the steel in certain parts of the reactor vessel of the Flamanville EPR. Investigations led to the discovery of irregularities at the Creusot Forge – the supplier of vessels to numerous operating French reactors. ASN extended the investigations (conducted in collaboration with IRSN) to other reactors and components of EDF reactors. In its intermediary conclusions in September 2016, ASN noted that "regardless of their actual safety consequences, these irregularities reveal unacceptable practices; the reviews initiated by Areva NP must therefore be continued and are liable to bring further irregularities to light." http://www.french-nuclear-safety.fr/Inspections/Supervision-of-the-epr-reactor/Anomaly-affecting-the-Flamanville-EPR-reactor-vessel/Areva-NP-s-Creusot-Forge-Plant-ASN-publishes-the-list-of-irregularities-detected-so-far

[54] http://www.lemonde.fr/economie/article/2016/10/18/edf-va-mettre-a-l-arret-cinq-reacteurs-nucleaires-pour-reviser-leurs-cuves_5015903_3234.html

Plans in view of geological disposal of radioactive waste have continued to advance. The government approved in March 2010 ANDRA's application for a project it named "Cigéo", designed to dispose of all high-level and long-lived intermediate-level radioactive waste generated by the current French nuclear fleet during its entire lifetime, provided that reprocessing will continue.[55] The repository would be located in a "nuclear-free" area in a small village, Bure, in the east of the country. As stipulated in the 2006 Planning Act, this disposal must be reversible. In May 2013, the National Commission on Public Debate (CNDP) launched a mandatory public consultation process, which, however, had to be fundamentally revised because of obstruction by local opponents of Cigéo. The planned public hearings were cancelled, and the consultation took place only on the Internet, including debates between invited experts. Partly in order to rescue CNDP from humiliation and loss of credibility, a citizens' consensus conference was organised between December 2013 and February 2014. The experience was generally deemed a success and contributed to the decision to start the project by an industrial pilot phase. This would be followed by periodic reviews every five years, in consultation with key stakeholders. On 11th July 2016, Parliament adopted a law defining the precise meaning of reversibility. Andra is to submit its application for a construction licence in 2019.[56] Vigorous even if minoritarian citizen opposition against the project persists, led by activists of the citizens' movement against the "useless and imposed large projects" (grands projets inutiles et imposes").

1.3. Presentation of main actors

The French **government**, regardless of its political orientation, has invariably been a strong supporter of nuclear power. The only moment of doubt was with when the Socialist government of François Mitterrand entered power in 1981, yet the President paid only lip service to his electoral promises of putting the nuclear programme on hold, if elected. Dänzer-Kantof & Torres (2013, 27) see in a rather positive light this highly **government-centred approach,** calling it "enlightened dirigisme" – a mixed-economy model typical of the French policy and politics in general, entailing close but complex relationships between the state and the major industrial and business actors. In

[55] The facility is expected to host about 10,000 m3 of high-level waste (about 60,000 waste packages) and 70,000 m3 of intermediate-level waste (about 180,000 packages).

[56] https://www.andra.fr/download/site-principal/document/editions/368-28.pdf

the area of nuclear energy, key actors were the CEA and EDF, created in 1945 and 1946, respectively, as state enterprises to re-establish France's technological and military might. EDF and CEA leaders often held, at different stages of their career, important positions in the industry ministry, responsible for energy policy.

Commissariat à l'énergie atomique (CEA), since 2010 Commissariat à l'énergie atomique et aux énergies renouvelables[57] – Alternative Energies and Atomic Energy Commission – was founded in 1945, and became the incontestable leader in nuclear-related R&D, especially on fuel cycle issues. Until the early 1970s, CEA was also responsible for safety regulation. CEA enjoyed in the early decades of nuclear development remarkable independence from political steering, the military, and the research community (Larceneaux 2014). As the main developer of French gas-graphite reactor technology, CEA was a major promoter of a policy of "national champions", in the spirit of demonstrating the technological prowess of the nation. Together with its subsidiary, Cogema, it was responsible for the entire fuel cycle – for ensuring the long-term supply of uranium, management of the enrichment plants and spent nuclear fuel, for safety regulation, and R&D on fast breeder technology. Until the late 1960s, when CEA lost the "war of the systems" (see Event 1, section 3.2), CEA was responsible for all nuclear-related R&D in France. Today, CEA has ten research centres around the country: Saclay, Grenoble, Marcoule, Cadarache, Fontenay-aux-Roses, DAM Ile-de-France, Valduc, Cesta, Gramat, and Le Ripault.

Electricité de France, EDF, was founded in 1946, absorbing the approximately 1,300 firms producing or distributing electricity in the country. The state-owned company had a triple role as developer ("maître d'ouvrage"), general contractor, and operator of nuclear power stations. Throughout the years, EDF came to constitute the main counterpoint to CEA, prioritising economic efficiency and pursuing its public service mission of providing electricity to the greatest number at the least possible cost. EDF has the triple responsibility as developer, general contractor, and operator of nuclear power stations.

The state planning system was emblematic of the French dirigisme, with the **Commissariat général du plan** (1946-2006) in a central role. In this arrangement, the state established the

[57] LOI n° 2010-237 du 9 mars 2010 de finances rectificative pour 2010, article 9. https://www.legifrance.gouv.fr/affichTexte.do;jsessionid=DBA362E28437EE161E33C51ED0544B26.tpdila13v_2?cidTexte=JORFTEXT000021943745&dateTexte=&oldAction=rechJO&categorieLien=id&idJO=JORFCONT000021943742

general priorities for the successive nuclear programmes, while leaving to each public organisation under its control a great deal of freedom to organise their work at their own will.

The role of **"le Corps des Mines"**, polytechnics from the prestigious engineering schools, especially the Ecole des Mines, has been vital in the development of nuclear policy in France. These engineers have occupied leading positions at both key public and private organisations, and often have direct access to government and the president. More generally, "les Grands Corps" – engineers from leading polytechnics – have traditionally constituted a significant part of French elites in all sectors.

The **economic expert advisory committee, PEON** (La commission consultative française pour la production d'électricité d'origine nucléaire), established in 1955 and operational until the end of the 1970s under the Ministry of Industry, was a 31-member body providing the government with advice especially on the costs of nuclear energy. PEON decided on the details of each nuclear plan, in particular concerning the economics and the competiveness of nuclear, and on this basis, determined the scale of each programme. PEON played a key role in particular in the launching of the "Messmer Plan" in 1974. Most of the experts on the committee belonged to the "grands corps". These included representatives from ministries, Commissariat General du Plan, research (CEA), and industry. The Commission has repeatedly been criticised for the opacity of its decision-making (e.g. Dänzer-Kantof & Torres 2013, 23; Topçu 2010). The proposals of the commission relied heavily upon ccompetitiveness analysis conducted by EDF. The industry ministry's Direction du gaz, de l'électricité et du charbon (DIGEC) took over the tasks of producing economic advice once PEON ceased to exist. DIGEC produced eight reports between 1981 and 2004.[58]

Parliament has been a relatively minor actor in decision-making on nuclear. However, Dänzer-Kantof and Torres (2013, 25) argue that since the first parliamentary debate on nuclear in 1952, similar debates did indeed take place at regular intervals, yet they always resulted in a judgement in favour of nuclear. In recent years, parliamentary committees have produced influential reports for instance on economics of nuclear (e.g., Commission 2014). The parliamentary office for the evaluation of scientific and technological choices, OPECST, created in 1983 and composed of 20

[58] http://www.global-chance.org/IMG/pdf/GC25p71-72.pdf

parliamentarians, has been influential especially in the opening up of nuclear waste policy to a broader range of stakeholders and management options.

Trade unions (notably CGT[59], CFDT[60], FO[61]) have been major actors, for instance in defending the French gas-graphite technology during the “war of the systems” (see Event 1, section 3.2). CGT has been consistently pro-nuclear, whereas the CFDT was openly hostile to the Messmer Plan and played an important role in the anti-nuclear movement of the late 1970s (e.g. Topçu 2010, 98). In the on-going controversy over the planned Hinkley Point C power station in the UK, EDF’s trade unions have taken a position against the project, judging it too costly and risky in view of the present state of EDF finances.

According to Blanchard (2010), the French **media** constituted, from the early 1970s, a major forum for the anti-nuclear movement to spread its views. The left-wing newspaper, Libération, was a pioneer in opposing nuclear during its first years of existence in the 1970s. More generally, the Chernobyl ”cloud affair” (see Event 2, section 3.3) constituted a turning point in spurring journalists to take distance from official government communication. Foreign media gained greater visibility in the 1990s. Blanchard observed successive periods of varying intensity and polarisation in the media coverage on nuclear: polarisation and high media visibility in the mid-1970s, depolitisation and low visibility in the 1980s, then a new wave of mediatisation in the late 1990s, followed again by a declining interest and ”pacification” of the debate in the first decade of the 2000s.

Other industry actors

Cogema (Compagnie générale des matières nucléaires)

- subsidiary of CEA, founded in 1976
- supplier of uranium

Framatome

- created in 1958, as a merger of Schneider, Merlin-Gerin and Westinghouse
- main shareholder Creusot-Loire

[59] Confédération générale du travail.

[60] La Confédération française démocratique du travail.

[61] Force ouvrière.

- key player during the implementation of the Messmer Plan, responsible for the specifications, construction and assemblage of the various components, as well as production of fuel from the uranium supplied by Cogema

Areva

- created in 2002, as a merger of Framatome and Cogema, designed to become a national champion with activities covering all stages of the nuclear cycle.

Alsthom

- designer and supplier of turbines and alternators

Empain-Schneider (since 1994, Schneider Electrique)

- key subsidiaries Framatome and Creusot-Loire
- constructed almost all of the nuclear islands

GCE-Alsthom-Atlantique

- supplier of almost all of the “classical” or conventional nuclear islands

Péchiney-Ugine-Kuhlmann (Puk)

- operated on the entire fuel cycle

Empain-Schneider

- manufactured nuclear boilers

Compagnie générale d’électricité – CGE (1898-1991):

- large electro-mechanical components (e.g. turbines, alternators)

Saint-Gobain Pont-à-Mousson

Actors in the area of nuclear waste management

Andra: created in 1979 as part of the Ministry of Energy, with the specific task of designing an irreversible geological disposal system. Since the “Bataille Law” (1991), an industrial and commercial agency, independent of the waste producers. Also responsible for the publication of the national waste inventory; conception, exploitation, and surveillance of the waste storage sites;

coordination of R&D on geological disposal and interim storage; collection of waste from the producers; cleaning up abandoned contaminated sites; and providing public information.

CNE: National evaluation commission, responsible for annual assessment of the progress in R&D into radioactive waste management

CHN: Comité de Haut Niveau (the High-level committee), chaired by the Minister of Energy, responsible for the advancement and monitoring of the local economic support measures associated with the Underground Research Laboratory and Cigéo.

Anti-nuclear organisations

ACDR: Association Contre le Danger Radiologique (Association against radiological dangers), created in 1962 and transformed in 1966 into APRI (Association pour la protection contre les rayonnements ionisants), Association for the protection against ionising radiation.

MCAA: Mouvement Contre l'Arme Atomique (Movement against the atomic weapons). Since 1968 **MPDL** (Mouvement pour le Désarmement, la Paix et la Liberté).

Friends of the Earth, France, created in 1971

CRILAN, created in 1980 to oppose nuclear projects in La Manche area

Réseau sortir du nucléaire: an anti-nuclear NGO network today having more than 800 member associations.

CEDRA: Collectif contre l'enfouissement des déchets radioactifs

EODRA: Élus de Lorraine et Champagne opposés à l'enfouissement des déchets radioactifs (Elected representatives of the Regions of Lorraine and Champagne opposed to the geological disposal of radioactive waste).

Nuclear safety organisations

SCSIN: Service central de sûreté des installations nucléaires, created in 1973, and transformed in 1991 into Direction de la sûreté nucléaire (**DSCIN**).

DSIN: Direction de la sûreté des installations nucléaires

CSSN: Conseil supérieur de la sûreté nucléaire, created in 1973, and transformed in 1987 into **CSSIN** (Conseil supérieur de la sûreté et de l'information nucléaire)

IPSN: Institut de protection et de sûreté nucléaires, nuclear protection and safety organisation created within CEA in 1976

Groupe permanent d'experts sur les déchets radioactifs: Permanent radioactive waste expert group, created within DSIN in 1986

SCPRI: Service central de protection contre les rayons ionisants, transformed in 1994 into **OPRI** (Office de protection contre les rayonnements ionisants)

DGSNR: Governmental unit responsible for nuclear safety, Direction générale de la sûreté nucléaire et de la radioprotection, created in 2002

IRSN: Institut nucléaire de radioprotection et de sûreté nucléaire, independent nuclear safety and radioprotection expert organisation created in 2002

ASN: Agence de Sûreté Nucléaire, created in 2006 as a fully independent safety authority

Pro-nuclear organisations

SFEN: Société française pour l'énergie nucléaire (French society for nuclear energy), created in 1973.

Counter-expertise organisations

GSIEN: Groupement de Scientifiques pour l'Information sur l'Energie Nucléaire, created in 1975.

ACRO: Association pour le contrôle de la radioactivité à l'ouest, created after the Chernobyl accident in 1986

CRIIRAD: Commission de recherche et d'information indépendantes sur la radioactivité, created after the Chernobyl accident in 1986

WISE-Paris, a counter-expertise organisation created in 1983, with the aim to provide information and documentation on nuclear and energy issues.

Multistakeholder bodies

CSFN: Comité Sratégique de la Filière Nucléaire (Strategic committee for the nuclear sector), under the double-chairmanship by the Ministers of the Environment and Energy, and Economic Revival, includes a total of 80 members from the utilities, nuclear industry, trade unions, the state, and Andra. No civil society organisations are represented.

HCTISN: High Commission for Transparency and Information on Nuclear Security, organises periodic consultations and debates on the topic of radioactive waste management.

CNDP: Commission nationale du débat public (National Commission on Public Debate), created in 1995 and given the status of an independent administrative authority in 2002. At the request of the developer, CNDP organises four-month mandatory public consultations on major infrastructure projects and other topics considered of national interest. The CNDP does not have any decision-making power, nor does it make recommendations.

CLI: Commission locale d'information (Local Information and Monitoring Committee); a multistakeholder committee mandatory (since the Bataille Law 1991) in the neighbourhood of each nuclear installation. The commissions have the mission is to inform the public on nuclear activities and provide continuous monitoring of the impact of nuclear facilities.

CLIS: Comité local d'information et de suivi (Local Information and Oversight Committee). A multistakeholder body set up in Bure in 1999 to inform the public, to enable dialogue between stakeholders, and to monitor the activities of the underground research laboratory at Bure, and the Cigéo project.

ANCCLI: l'Association Nationale des Comités et Commissions Locales d'Information (National Association of Local Information Committees and Commissions) is a collection of CLIs. It hosts a selection of information on its website, publishes white papers and organises campaigns on various topics.

2. Showcase: Nuclear counter-expertise in France

The nuclear sector has been a forerunner in the development of institutions and organisations of 'counter-expertise' in France. Two periods were particularly crucial in the development of such 'countervailing power': the engagement of scientists in the anti-nuclear activism in the mid-1970s, with the creation of GSIEN (Groupement des scientifiques pour l'information sur l'énergie nucléaire) in November 1975, and the post-Chernobyl period, following the "Chernobyl cloud affair" (see Event 2, section 3.3).

Emergence of "scientist-driven" counter-expertise in the 1970s

In the mid-1960s, nuclear physics absorbed more than 20% of the entire budget allocated to fundamental research in France (Topçu 2006). The bulk of this research was conducted by the some 900 researchers within the Institut National de Physique Nucléaire et de Physique des Particules (IN2P3), created within the CNRS (Centre National de la Recherche Scientifique). A smaller numbers of scientists worked on nuclear physics within the CEA, and at the nuclear research centres of Saclay and Grenoble (ibid.).

A precursor to counter-expertise emerged from criticism within the scientist community, at the initiative of a handful mathematicians and biologists (Topçu 2006). These included some eminent biologists, notably Jean Rostand, Théodore Monod and Philippe Lebreton, the oceanographer Jacques-Yves Cousteau, and the mathematicians A. Grothendieck, C. Chevallet, P. Samuel and D. Guedj. These latter created in 1970 a group called Survivre (later Survivre et Vivre).[62] In April 1972, the group caused a scandal by revealing that a large number of barrels of radioactive waste stored at the Saclay research centre were cracked (ibid.).

In February 1975, a group of young scientists, most of whom nuclear physicists working for CEA and CNRS, signed a declaration criticising the massive Messmer Plan, which they considered as overambitious, and entailing a number of environmental and safety problems overlooked by the 'official' nuclear experts. However, these experts did not call into question nuclear energy as such. Within one week, the *"Appeal of the 400"* had been signed by 400 scientists, but three months later, the number of signatories had reached 4,000. Most were physicists, but a wide range of disciplines

[62] "Survive" and "Survive and Live".

was represented, from economics to zoology, from biology to psychiatry. Also about a hundred CEA physicists signed the Appeal, mostly those who profoundly disagreed with the abandonment of the national graphite-gas technology, which had provoked massive strikes at the end of 1969 (see Event 1, section 3.2) (Topçu 2006). This mobilisation revealed a generational conflict, the younger generation being unwilling to follow their senior colleagues in supporting the government's ambitious nuclear programme. The majority of the young scientists who engaged in this critique shared the anti-hierarchical or even libertarian spirit of the May-68 movement. The Appeal also reflected a deep cleavage between the institutional nuclear expertise on the one hand and the scientific community on the other (Soulié 2012).

The Appeal of the 400 led to the creation of GSIEN in December 1975. The organisation took upon itself to critically examine official documents, and systematically monitor health impacts of radioactivity from nuclear installations. Politically, the group was close to the moderate 'responsible left', and was inspired by the example of the American Union of Concerned Scientists (Topçu 2006, 252-254). GSIEN had the ambition to provide "objective" information on nuclear power, to counterbalance the official information they deemed biased (Topçu 2008, 230). It received significant support from many CEA and EDF researchers and engineers belonging to the CFDT trade union (Topçu 2008, 230-231). Since June 1976, GSIEN continues to publish four times a year *La Gazette Nucléaire*, a key outlet for anti-nuclear information in France. GSIEN was among the first in France to tell about the consequences of the Three Mile Island accident, in 1979.

Initially, GSIEN members refused to identify themselves as "specialists," "experts," or "counter-experts", considering in particular the notion of counter-expert as excessively ideological. Instead, they characterised themselves as citizens without specific competence on the nuclear programme, but who were able to interpret scientific and technical documents, thanks to their training and professional experience (Topçu 2008, 231). They sought to mediate between official and antinuclear discourses, while remaining true to their identity as providers of "objective" information, and neutral in relation to nuclear energy. GSIEN focused its critique against what they saw as the opacity, secrecy, lie, and propaganda surrounding nuclear. As such, its activity was part of a broader movement of the political left in the early 1970s, which denounced the lack of transparency of the French state on topics such as refugees, prisons, health, and immigrant workers (Topçu

2010, 115).

For the government and the promoters of nuclear, the *Appeal of the 400* constituted a shock, as it broke the hitherto prevailing scientific and institutional consensus concerning nuclear energy. It also received attention in national and international press. At the end of the 1970s, counter-expertise advanced with the creation of information bodies such as Local Information Commissions and the Information Council on Nuclear Energy, CIEE.[63] As part of its concessions to the anti-nuclear fraction of the political left, the new Socialist government that took power in 1981 helped to institutionalise counter-expertise by inviting critical scientists into expert committees and government advisory bodies. These included the Castaing Commission (1981-1984), set up to assess the radioactive waste management policy (Barthe 2006, 47-57; Topçu 2008, 232). Also the first openings towards **economic counter-expertise** occurred during this period: Dominique Finon, an economist critical of fast breeder reactors, was invited to give his views on reprocessing at a conference co-organised by UNESCO and the energy ministry (Barthe 2006, 51).

The institutionalisation of counter-expertise had ambiguous consequences. It fostered greater plurality of views and types of expertise within official institutions, but by integrating part of the criticism, it also helped to split up and weaken the anti-nuclear movement (Barthe 2006, 51-52). This arguably also accelerated the disintegration of the movement of physicists critical of nuclear power. Topçu (2006) mentions four reasons for the declining influence of GSIEN from the late 1970s onwards: the campaigns of delegitimisation by the established expert organisations; inability or unwillingness of critics within GSIEN to adopt a firm opinion against nuclear power; difficulty of combining the roles of scientist and dissenter; and the practice of the Mitterrand governments to 'domesticate' criticism by institutionalising it.

[63] CIEE was created by a presidential decree in November 1977. http://www.iaea.org/inis/collection/NCLCollectionStore/_Public/10/446/10446275.pdf

Chernobyl and the emergence of citizen-led counter-expertise

Immediately after the Chernobyl disaster in 1986 and following the criticism against the opacity surrounding government's communication on the accident, two associations were created in regions with a high number of nuclear installations. ACRO (Association pour le contrôle de la radioactivité à l'Ouest) in Normandy and CRIIRAD (Commission de recherche et d'information indépendantes sur la radioactivité) in Rhône-Alpes in the Southeast of the country set up their own independent laboratories for measuring radioactivity. This time, scientists were no longer in the driving seat, but instead provided advice to the movements led by activists. ACRO and CRIIRAD were not openly anti-nuclear, but sought to improve nuclear safety via continuous surveillance. Subsequently, the Ministry of Health accredited the laboratories of ACRO and CRIIRAD as organisations officially entitled to monitor radioactivity (Topçu 2006, 254-255).

Unlike the earlier "scientist-driven" counter-expertise represented by GSIEN (and to some extent by the CFDT trade union), ACRO and CRIIRAD were created and led by "laypeople" (e.g. teachers, nurses, doctors, pilots, farmers, and shopkeepers), while scientists (biologists and physicists) and technicians (e.g. CEA employees) merely provided expert advice to the laypeople (Topçu 2008, 235). The new organisations tried to bridge the gap between laypeople and experts by producing "independent" expertise on radioactivity and its impacts (ibid.). However, in the same way as GSIEN, both ACRO and CRIIRAD sought to safeguard their credibility and remain "apolitical", refusing to align themselves with any political party, activist group, government body or industry (Topçu 2008, 236). Today, CRIIRAD has 15 employees and more than 6,000 members.[64] In 2014, five employees and about thirty volunteers assured the daily operation of ACRO.[65]

CRIIRAD was important in keeping the Chernobyl controversy on the agenda during the first years following the disaster. During the first seven years it carried out analyses in 165 communes. Assisted by the geologist André Paris, it drew up a map showing the contamination from Chernobyl in France, as an alternative to the SCPRI map from 1986 (see Event 2, section 3.3), which still remained the reference in official communication (Topçu 2008, 238). The CRIIRAD map, published in 2001, showed levels of contamination by Caesium 137 vastly in excess of those announced by

[64] http://www.criirad.org/association/moyens.html

[65] http://www.acro.eu.org/wp-content/uploads/2012/10/rapport-activit%C3%A9s-ACRO-2014.pdf

the government in May 1986 – up to 800-fold in the Alsace-Lorraine region (ibid.). As a result, the French thyroid patient association lodged a complaint against the handling of the Chernobyl accident (see Event 2, section 3.3). CRIIRAD also contested the SCPRI methodologies and procedures of measuring, analysing and communicating radioactivity (ibid., 240).

Unlike its German counterparts (e.g. the Öko-Institut, Gruppe Ökologie: Institut für ökologische Forschung und Bildung, and Umwelt-Institut Munchen – all established during the same period from the late 1970s and late 1980s), ACRO and CRIIRAD have not embarked on the promoting alternative energy and participating in national nuclear debates, but have confined themselves to technical analysis of health and safety risks of nuclear (Jacquiot 2007; Topçu 2008, 241). Yet, CRIIRAD has expressed sharp criticism especially against what they characterise as a "vast conspiracy of silence" surrounding the nuclear sector in France (Rivasi and Crié 1998).

Nuclear waste management policy: a laboratory of experimentation in pluralist expertise

Since the stalemate and crisis in radioactive waste management policy in 1990, this policy area became site of experimentation in the development of "pluralist expertise" and more open, participatory, management approaches (see Event 5, section 3.6). The opening was underpinned by the Bataille Law of 1991, while the EU legislation on public participation and access to information, together with international cooperation (e.g. with the OECD Nuclear Energy Agency), opened greater opportunities for counter-expertise and pluralist expertise.

The "leukaemia affair" and GRNC

A further milestone was the setting up of an independent and pluralist expert group, Groupe de Radioécologie Nord Cotentin (GRNC), to examine the claims that child leukaemia had increased in the surroundings of the La Hague reprocessing and waste storage site. The "affair" started by two studies, published in 1995 and 1997, showing increased frequency of leukaemia among children living near the site between 1972 and 1996. The studies generated significant local concern and debate. The GRNC was entrusted with the task of assessing the risk from radioactive releases from the various nuclear installations in the Nord Cotentin area. The group was also to verify the findings of the 1997 study.

Establishment of the GRNC generated great hopes within the NGO community (Topçu 2010, 360), and was a remarkable event for a number of reasons. First, it was the first to bring together a variety of involved parties: the nuclear industry, institutionalised official expert organisations, ‘counter-experts’ from local and national NGOs (e.g. ACRO, CRIIRAD and GSIEN), and foreign experts (Gadbois et al. 2007; Miserey 2007, 108). Second, GRNC was an *ad hoc* group set up for a defined 10-year period, jointly governed by the ministries of health and the environment. Third, it had the double mandate of national-level cooperation and local-level analysis of the impacts of radioactivity (Sugier 2007, 115). GRNC may also have helped reduce the reluctance of powerful local actors towards increased transparency and sharing of decision-making power.

While a major step forward towards greater transparency and pluralist expertise, GRNC nevertheless had a mandate limited only to assessing the impact of nuclear installations, excluding questions concerning the orientations of nuclear policy. For instance, issues such as the extent of AREVA’s compliance with its commitment reduce waste generation, as stipulated under the OSPAR Convention, falls outside the remit of the GRNC (Sugier 2007).

Counter-expertise today

Other counter-expertise organisations today include NGOs such as Global Chance, WISE Paris, NégaWatt, Réseau Sortir du nucléaire, Greenpeace, and Friends of the Earth. Two observations about the history and the present of counter-expertise are in order. First, counter-expertise institutions have emerged in reaction to crises, and have had to struggle for public recognition. Second, the status of independent expert organisations in the French society in general, and in the nuclear sector in particular, is still unstable, and their independence from the state institutions is constantly called into question. Many NGOs, in turn, contest the legitimacy of ‘pluralist expertise’ itself (Topçu 2010, 396). Some have indeed raised concern because of the apparent reluctance of in particular younger academics to engage in this type of activity.[66] However, the demand for counter-expertise may also have declined simply because the safety authorities (ASN in particular) have gained independence and sharpened their critique towards the nuclear industry (e.g. concerning the EPR reactor, and the faults recently detected in the French nuclear reactors). The CNDP debates have highlighted the difficulties of creating in France a true space for democratic

[66] Personal communication, Marie-Angèle Hermitte, 18 June 2014.

discussion on energy choices. Topçu (2006, 255) argues that counter-expertise may risk becoming a "co-manager" of nuclear risks or remain completely marginalised. Access to public debate remains difficult for those without technical training in the nuclear area, as problem framings are dictated by the established players (Gilbert and Bourdeaux 2006, 55-56). Moreover, criticism from outsiders can meet with hostile attitudes from both elected officials and citizens in communities with nuclear installations.[67]

France is often considered, both within the country and abroad, as a latecomer in the domain of openness of decision-making and public access to information. Miserey (2007) argues that true freedom of information legislation still awaits being introduced in France, and that the existing information is often difficult for the public to understand. Despite advances (e.g. the 1978 Act on improving public access to information), the stipulations concerning "defence secrecy" still greatly limit free access to information (e.g., Cherief 2014). The law on transparency in nuclear matters (2006) helps local information bodies (e.g. ANCCLI and the CLIS at Bure) render information more accessible to the public, but these organisations have limited resources.

Counter-expertise first developed in the area of risk and safety, and gradually earned a more legitimate role in safety control, especially in response to the opacity revealed by the "Chernobyl cloud affair" (see event 2, section 3.3; and Foasso 2003). Since its creation as an independent safety authority in 2006, ASN has sought to safeguard its legitimacy and demonstrate its independence of industry and the government. The increasingly critical stand of ASN towards the nuclear industry may have reduced the power and the visibility of counter-expertise. Meanwhile, the National Court of Auditors (Cour des Comptes) has become a key actor conducting economic counter-expertise. With the persistent economic and financial problems faced by the French nuclear industry, and the increasing transparency in matters relating to safety, economics appears today as a new "frontier" for the development of counter-expertise in the French nuclear sector.

[67] This was experienced, for instance, by an ethnologist studying the public perceptions concerning nuclear power in the region of Nord-Cotentin. Her book and a TV documentary got a very hostile reception in Nord-Cotentin, and the researcher had to discontinue further research in the area. (Personal communication, Françoise Zonabend, 23 Oct 2008).

3. Events

3.1. Critical view to the selection process of the five events

The main criteria for the selection of the five events presented in this report were the importance of the event for the subsequent development of the French nuclear sector (priority given to events that have constituted turning points in French nuclear history), the public attention received by the event, and the availability of information – notably research conducted by social scientists. In temporal terms, the events cover the period from the phases that laid the basis for the launching of the massive nuclear power programme (from the mid-60s) to the present day. The post-war years were not addressed explicitly (except indirectly, as part of the history of the Superphénix fast breeder reactor), partly because this period is relatively well covered in the long historical narrative, and partly because of the exceptional size and societal importance of the nuclear programme launched in 1974. The events also describe the continuous efforts of the traditionally highly secretive and closed French nuclear sector to gradually move towards greater openness, and the reasons to such attempts.

The "war of the systems" in the late 1960s decisively shaped relationships between the key players – notably the CEA and the EDF – but also triggered the learning, capacity building, and reorganisation necessary for the launching of for the massive nuclear programme of the 1970s. The engagement of the society in this technology choice took place mainly through the influential labour unions and the media.

The "Chernobyl cloud affair" shook the public trust in the nuclear establishment in France and gave impetus to the development and institutionalisation of counter-expertise in the area of nuclear power in the country. As shown in the previous section (showcase, section 2), counter-expertise, which first developed in the 1970s, can indeed be seen as a defining feature in the subsequent interaction between the nuclear sector and the society. As such, the Chernobyl cloud affair triggered a counter-reaction to the exceptional strength and self-sufficiency of the French nuclear establishment. Finally, the societal repercussions of Chernobyl were greater in France than in many other European countries, and left permanent marks in the French self-perceptions.

The sudden decision by the Socialist-Green government in 1997 to definitely close down of the Superphénix industrial prototype fast breeder reactor was a traumatic experience for many engineers and other actors involved in the development of this technology, seen by many nuclear engineers until the late 1970s as the logical culmination point of any serious civilian nuclear programme, and a promise of an exhaustible source of affordable electricity. The closure of Superphénix marked the end of the 'fast breeder dream', but also brought down one more pillar of the French national nuclear technology development. The event furthermore highlights the close interaction between politics and the nuclear sector: the immediate reason for the shutdown was the entry of the Green party into the government, and the defenders of Superphénix frequently denounce the decision as "purely political".

The three national consultations concerning the construction of an EPR plant in Flamanville (Normandy) and the national radioactive waste management policy in 2005-2006 constituted a milestone in the opening up of the French nuclear policy to the civil society. The National Commission on Public Debate (CNDP), responsible for the organisation of these debates, is as such a characteristically French institution created to improve public engagement in planning and decision-making on significant technological projects. The nuclear debates were at the same time a "trial of strength" for CNDP, and a first-of-its kind attempt at true public involvement in nuclear policy.

As in many other countries, radioactive waste management has in France been a policy area at the forefront of developing more inclusive and dialogical processes of planning and decision-making. And as elsewhere, this openness has to a large extent emerged in response to local opposition against site investigations – conducted by the national radioactive waste management agency, Andra. In France, the concept of reversibility of the waste management solution – defined as both technical retrievability of waste and the reversibility of the decision-making processes – has constituted a key element in this evolution towards greater transparency and inclusiveness. However, such 'opening up' remains unavoidably incomplete. Despite the advancement of openness, the French waste management policy still remains very much an affair of the state, with highly unequal relationships between the citizens and the powerful public and semi-public actors.

Reversibility persists as a key element in disputes over the high-level radioactive waste management policy in France.

3.2. Event 1: The "war of the systems" in the 1960s (resulting in the choice of American PWR reactor technology)

Summary and context

The 1960s was marked by the so-called “war of the systems” – a competition between two technological solutions: the American pressurised-water reactors (PWRs), using enriched uranium, and the French gas-graphite reactors, which operated on natural uranium. The outcome of this “war” – and the process leading to it – had profound and lasting impacts on French nuclear sector, including a complete reorganisation of the landscape of key actors in the sector – CEA, EDF, the supplier industry, and public administration. At the end of the 1960s, France opted for the American PWRs, deemed as a tried-and-tested option, and therefore quicker and more economical response to the continuing growth in electricity demand.

Dänzer-Kantoff & Torres (2013, 85) have described the continuity in the French civil nuclear programme in the 1960s as result of a “surprising confluence of circumstances” at the beginning of the Fifth Republic inaugurated by de Gaulle in 1958. They highlight four factors: 1) an ambitious policy in favour of national sovereignty, 2) the desire to construct an independent “strike force”, i.e. atomic bomb, 3) the period of fast economic development fuelling growing energy needs, and 4) the ambition to foster the “greatness” of the country – both within and outside of France. In particular, the expectation of a continued rapid economic growth strengthened the importance of cost and economic efficiency as key criteria in technology choices, and thereby helped PWRs to win the “war of the systems”.

Key milestones

In **1960**, EDF obtained an authorisation to construct, together with the Belgians, a reactor (Chooz) close to the border with Belgium. EDF saw the reactor project (1962-67) as an alternative to the gas-graphite reactors, but also as an opportunity of learning-by-doing, as the first reactor of more than 300 MW it built without CEA (Dänzer-Kantof & Torres 2013, 130-138).

Active lobbying, since **1965**, by the American General Electric and Westinghouse, "based on extremely optimistic capital cost estimates" (Hecht 2009, 274), convinced EDF engineers of the virtues of the PWR technology. In **March 1966**, the director general of EDF, André Decelle, addressed a letter to the head of CEA, advocating the adoption of PWR technology under American licence (Dänzer-Kantof & Torres 2013, 147). The "war of the systems" was thus launched. Superficially a "war" between CEA and EDF, the dispute divided both organisations into opposing camps (ibid.).

In **May 1966**, a joint commission was set up to resolve the dispute, under the leadership of CEA's Jules Horowitz and EDF's Jean Cabanius. The commission was to compare the performance of two reactors of identical (over 500 MW) capacity: the gas-graphite reactor at Saint-Laurent-des-Eaux and the Oyster Creek boiling water reactor in New Jersey. The work proved highly conflictual, the two directors failed to arrive at a joint conclusion, and the conflicts were widely reported in the press (Dänzer-Kantof & Torres 2013, 148-150; Hecht 2009, 275).

In **1967**, the government authorised the construction of another French-Belgian PWR reactor, in Tilhange – the first entirely designed and built by a French-Belgian consortium (Framatome as the main French actor), under the American licence. The project laid the bases for a future French nuclear programme, for the Frenchification of the PWR technology (Dänzer-Kantof & Torres 2013, 169-174).

The entry into operation of a ***uranium enrichment plant in Pierrelatte, in 1967*** further favoured PWRs. Along the lines of the dominant post-war-of-the-systems discourse (Hecht 2009), Boiteux and Boulin (in Dänzer-Kantof & Torres 2013, 10), argue that the technology choice thus lost its political and military dimension, and became purely economic. In her 'technopolitical' analysis, Hecht (2009) rejects this interpretation as reductionist.

The unofficial decision in favour of the PWR came on **16 October 1969** from Marcel Boiteux, the then General Director of EDF. On visit at the Saint-Laurent-des-Eaux plant, Boiteux declared the gas-graphite reactor would be the last of its kind to be built in France. On the following day, the plant went to partial meltdown, in one of the most serious accidents of nuclear industry until then, and helped to foster positive opinions on the light-water reactors (Hecht 2009, 309). President Pompidou confirmed the choice of the PWR on **13 November 1969** in a limited interministerial meeting of the Council of State. EDF hence effectively replaced CEA as the uncontested leader of the French nuclear sector.[68] Partly to avoid being in complete contradiction with the policy of his prestigious predecessor, only five months after taking office Pompidou made concessions to the supporters of the "national" technology, e.g. allowing CEA to continue its R&D on natural-uranium reactors (Dänzer-Kantof & Torres 2013, 188-190).

In **November 1969, strikes broke out** at the sites of Marcoule and Saclay, while in Paris, workers, technicians, scientists, and engineers protested against the decision to end the gas-graphite programme. The demonstrators denounced the alleged loss of independence that the abandonment of gas-graphite technology would mean for the French nuclear sector, the claim that gas-graphite reactors would be uncompetitive, the use of economic profitability as the sole criterion, and the lack of adequate consultation of employee representatives (Hecht 2009, 301). They also warned against the threat of an American industrial take-over (ibid.). On November 14, CEA leadership conceded to reemploying the cleaning ladies whose laying-off had ultimately triggered protests, yet demonstrations continued across the country (ibid., 303-304).

Significance and (symbolic) meanings of the war of the systems – then and today

The war of the systems was already seen as highly significant in the 1960s. The choice was a traumatic experience for the CEA and EDF teams developing the gas-graphite technology, but also for those opposing "American imperialism" and dependence on American technology. This was especially reflected in the left-wing media reporting (e.g. Hecht 2009, 297-299). The trauma was gradually and in part overcome, as the memory of a failed French gas-graphite technology was turned into a story of a successful Frenchification of the PWR technology. This Frenchification was the result of a joint effort of technology adaptation and adoption by previously rival groups of actors.

[68] http://www.vie-publique.fr/politiques-publiques/politique-nucleaire/histoire-politique-nucleaire-civil/

In the words of Hecht (2009, 271-272), the war of the systems was “transformed over the years from the story of the demise of the gas-graphite program to that of the birth of the pressurized-water program”. In this success story, foreign technology was “nationalised”, and technological dependence was turned into independence. By the mid-1970s, EDF had become a major international player and technology exporter, largely thanks to the capacity building generated in the process (Dänzer-Kantof & Torres 2013, 12). The national narrative of ‘Frenchification’ resembles the Finnish nuclear engineers’ pride in their work to adapt the Russian technology and upgrading it to the Finnish standards. The development of PWRs gave a major stimulus for the development of R&D capacities at both CEA and EDF.

The victory of the light-water reactors profoundly rearranged industrial and institutional relationships, with major consequences for reactor designers, builders, and workers, who had to adapt to the new requirements (Hecht 2009, 319-320). Changes in work and safety guidelines also affected the gas-graphite reactors (ibid.). By settling the conflicts between the key players, the end of the “war” rendered possible the massive Messmer Plan in 1974.

In the communities hosting gas-graphite reactors, the war of the systems had diverse consequences. Hecht (2009, 306-309) mentions positive side effects. The mobilisation in 1969 against the abandonment of gas-graphite technology in the CEA-operated Marcoule site helped to identify a common enemy (abandonment of the gas-graphite technology) and thereby to reconcile two parts of the local community: the “original” inhabitants and the newcomers brought by the nuclear projects. In Chinon, where the plant was operated by EDF, no similar changes took place, since jobs were not in danger, thanks to the company’s labour statutes.[69] For the workers, engineers and managers at Saint-Laurent, the post-accident site clean-up following the accident in October 1969 was useful therapy, but also an occasion to demonstrate their skills and restore the reputation of the industry (Hecht 2009, 312-314).

[69] Furthermore, the Chinon gas-graphite reactors were expected to continue operating for some time into the future, and it was deemed likely that light-water reactors would be constructed at Chinon (Hecht 2009, 306-309).

Actors

Firms and companies

CEA: the developer and main promoter of the national gas-graphite technology. Yet, there were 'warring' fractions within CEA: Jules Horowitz and his team (at the "direction des Piles") vigorously advocated the gas-graphite reactors, whereas Claude Fréjacques and his team – responsible for the Pierrelatte enrichment plant – favoured the enriched-uranium route, because mastering the technology to a high degree of enrichment would make it easily possible to enrich to 3% - needed for PWR reactors (Dänzer-Kantof & Torres 2013, 147).

EDF: the main promoter of PWR technology in France. Also EDF was internally split. Some at the Direction de l'Equipment, and those who had constructed the gas-graphite reactors at Chinon (Jean-Pierre Roux and Georges Lamiral, in particular), and expecting to build the St-Laurent plant, favoured the national technology. The Director-General André Decelle and Director of Equipment, Jean Cabanius, defended PWRs, for technical, industrial and economic reasons, but also as a means for EDF to escape CEA's tutelage (Dänzer-Kantof & Torres 2013, 148).

Westinghouse and General Electric: the developer and the main promoter of the PWRs. Actively lobbied for PWRs especially towards the EDF engineers.

Belgian companies, EDF's partners in the Chooz and Tilhange light-water reactor projects. E.g. the Bureau d'Etudes Nucléaires, founded in 1956, sought French and Dutch collaborators to share the cost of technology transfer from the US (Dänzer-Kantof & Torres 2013, 82).

Sources vary in their judgement of the importance of **interpersonal relations and personal characteristics** of key protagonists. Georges Lamiral (1988), engineer at the EDF, rather favourable to the gas-graphite technology (Dänzer-Kantof & Torres 2013, 148), stresses such factors. Leadership change at EDF arguably had a major impact: The Director-General André Decelle resigned in 1967, having failed to persuade the government about the virtues of PWRs. His successor, Marcel Boiteux, was a keen defender of PWRs, and continued Decelle's efforts. Government reshuffle in July 1968 speeded up the adoption of PWRs (Foasso 2003, chapter 8).

Public institutions, political actors, interest groups and the media

The **French government** arbitrated between the various interests. Key actors included the

President (de Gaulle with his agenda of national independence, and his successor, Georges Pompidou, more open to international collaboration), and the ministers responsible for energy and research. The Commission PEON (Commission pour la Production d'Electricité d'Origine Nucléaire) gained an increasingly significant role in French nuclear policy during the war of the systems. Together with the Commissariat Général du Plan, it provided key advice for government decisions on nuclear energy. PEON largely relied on analysis conducted by EDF and the industry ministry's directorate for gas, electricity and coal (Foasso 2003, chapter 8).

One of the most influential **ministers** was Gaston Palewski – the first minister in charge of scientific research and spatial and atomic issues (Dec-62 to Feb-65). Palewski had a background in military nuclear, but became a major defender of gas-graphite technology and the founder of the PEON commission. He persuaded Franco to buy a gas-graphite reactor from France, built in Vandellós, Spain, and sought to convince the then Prime Minister, Georges Pompidou, of the virtues of gas-graphite reactors (Dänzer-Kantof & Torres 2013, 113). Maurice Schumann, minister responsible for research and nuclear in 1967-68, was a strong defender of gas-graphite technology. According to PWR supporters, he was ill-informed about the international market situation, but persuaded de Gaulle of the need retain the national technology (Hecht 2009, 286).

The President held the ultimate decision-making power. During the reign of de Gaulle, a choice of PWRs would have been difficult. It is unclear how much of de Gaulle's opposition stemmed from his overall policy of French independence: some authors claim that he was merely ill-advised, by key advisers that were staunch supporters of the national technology. Georges Pompidou's succession to the presidency facilitated the victory of the light-water reactor technology.

The **Belgian government** also had a role, as its collaboration was important in the setting up of the French-Belgian consortia to build the first PWR reactors (Chooz & Tilhange).

The war of the systems also opposed different sections of the "**grands corps**" – the polytechnics from different elite engineering schools, which have for decades dominated French energy policy. Pringle and Spigelman (1982, 234) evoke the "150 years of institutional rivalry" between the CEA and EDF engineers: the former came mostly from the "**corps des Mines"**, and the latter dominantly from the **corps des Ponts et Chaussées**.

Labour unions were vital players in the "war". Those closest to the Communist Party (esp. CGT) were highly critical of the PWR technology. The Communists denounced the lay-offs triggered by the abandonment of the national technology,[70] and the 'American imperialism' which the PWRs represented. In the aftermath of the 1968 student revolt, the abandonment of the national technology triggered strikes by CEA personnel in the latter half of 1969.[71] Advocates of the gas-graphite technology included labour unions and rank-and-file engineers at both CEA and EDF, who had devoted their entire professional life to this technology (Hecht 2009, 287).

The **political parties** were internally divided on the issue, but the left-wing parties (especially the communist PCF) were clearly in favour of the national gas-graphite technology.

The press was also divided. The first reactions to the rumours, in 1966, about the impending abandonment of the national technology, were characterised by dismay. The left-wing press (L'Humanité) decried it as a capitulation in the face of American imperialism (Dänzer-Kantof & Torres 2013, 167). Le Monde journalist Nicolas Vichney, who had been critical of gas-graphite technology throughout the "war", was "jubilant" (Hecht 2009, 298) at seeing his own predictions come true (Dänzer-Kantof & Torres 2013, 167). Dänzer-Kantoff & Torres (2013, 181-182) argue that **at the end of the 1960s**, the French nuclear policy was in disarray, as reflected in media reporting about a country without nuclear policy, having given up the national technology without identifying a substitute. Nuclear advocates, the public and the media widely perceived the abandonment of the national technology as great waste of resources (ibid.).

Discourses and behaviours

The conflict played out mostly in the politico-administrative decision-making structures and divided political groups from within. The two philosophies underpinning the national and American technology choices also divided the political leadership: de Gaulle defended the gas-graphite technology for reasons of national independence, whereas high echelons in financial and industrial administration adhered to an American-style modernity and considered CEA as uncontrollable and

[70] "La fin de la "guerre des filières": la leçon qu'il faut en tirer" dans Europe (19 novembre 1969). Europe. Agence internationale d'information pour la presse. dir. de publ. RICCARDI, Lodovico ; Réd. Chef GAZZO, Emanuele. 19.11.1969, n° 453. Bruxelles. http://www.cvce.eu/obj/la_fin_de_la_guerre_des_filieres_la_lecon_qu_il_faut_en_tirer_dans_europe_19_novembre_1969-fr-4dd2d82d-a361-4079-8ade-519398baaf95.html

[71] http://alternatives-economiques.fr/blogs/bompard/archives/52

excessively spendthrift (Foasso 2003, chapter 8).

Main arguments and their framing: technology, economics and politics

The “war of the systems” was ultimately also a choice between two paradigms. Choosing the gas-graphite technology would mean the continuation on an autonomous, “national” line of production, which would combine civilian and military objectives, whereas opting for PWRs would imply relying on imported, purely civilian technology, based on the most largely used, reliable and cost-competitive technology of the time. The dispute also juxtaposed arguments stressing national technological excellence and those prioritising inexpensive electricity generation for the greatest number of citizens (Foasso 2003; Hecht 2009).

Since 1966, EDF was increasingly attracted by the economic performance of the American PWR technology, and sought to separate technology from politics in its argumentation: for EDF, PWRs made “economic good sense” (Hecht 2009, 285). Poor operating experience from gas-graphite reactors in the UK and Germany – and the fact that these reactors had not been exported almost anywhere – added to the resolve of EDF in favour of PWRs (Dänzer-Kantof & Torres 2013). The gas-graphite advocates, by contrast, avoided a clear-cut separation between technology and politics. For them, economics alone should not decide; the national plutonium-production capacity should be retained, and France should capitalise on the time, money and knowledge already invested in the gas-graphite technology (Hecht 2009, 283).

Both sides referred to national interest: for the defenders of the gas-graphite technology, national interests meant technological independence, whereas the PWR camp framed the issue in terms of international interdependence: national interest would best be served by setting up national consortia to “Frenchify” and then export the PWR technology (Hecht 2009, 284).

In this context of warring systems, the **fast breeder technology provided a uniting theme**, as both sides defended the breeders as an incarnation of French greatness. As a technology that primarily only existed on paper (a prototype, CEA’s Rapsodie, existed) was flexible enough to cater to various technopolitical visions and scenarios (Hecht 2009, 291-294).

In 1969, in his famous speech marking the end of gas-graphite reactors, Marcel Boiteux justified his preference for PWRs by the demands of the international market: while light-water technology was not more proven and reliable than the gas-graphite reactors, about ten times more light-water than gas-graphite reactors were either under construction or ordered (80,000 MW and 8,000 MW, respectively). Continuing to develop a technology for which the rest of the world has no interest (except the UK, which was producing its own reactors) would hence not make sense. To survive and prosper, the French nuclear industry would need to master the technology dominant worldwide (Foasso 2003, chapter 8; Dänzer-Kantoff & Torres 2013, 167).

The arguments were therefore largely framed in terms of **economics**. The large uncertainty in the calculations (e.g. on the fluctuation of market prices, in the context of low fuel prices in the late 1960s) prevented clear-cut decisions on purely economic cost basis. Yet, the key dispute concerned the context for assessing economic viability: within the European Common Market, as argued by PWR advocates, or in terms of French economic independence in a national frame, as the gas-graphite camp wanted (Hecht 2009, 290). To salvage the gas-graphite technology, the labour unions prepared a report to counter the claims of government economic expertise, arguing that economics should not constitute the only basis for decisions, and that four reasons made the comparison between the American and French reactors irrelevant (Hecht 2009, 304-305):

- The amortisation period in the US was 30 years, but only 20 years in France
- The average capacity factor used for the US reactors was 7,500 hours per year per reactor, but only 6,800 in France
- The price comparisons between nuclear and conventional generation technologies were based on different parameters and principles in the two countries
- If France were to adopt similar pollution-prevention measures as the Americans, the price of kWh from conventional fuel would increase and make nuclear more profitable

They also denounced the government's lack of research policy and industrial policy, and called on the government to organise the national industry so as to prevent domination by Westinghouse (Hecht 2009, 294-296).

According to Hecht (2009, 293-294), the PWR advocates employed a combination of three "technopolitical strategies": managing technological and economic uncertainty, by quantifying them and pronouncing on their relevance and function; defining the context for future nuclear development, notably by renegotiating the meaning of 'national independence'; and constructing a new logic in which PWRs would contribute to French radiance.

Summing up, the war of the systems entailed confrontation between various framings of the key topics in the dispute: national independence vs. international interdependence; light-water reactors as an instrument of American imperialism or the path to French radiance through exports; or again, the gas-graphite technology as the eternal guarantee of national independence or as a route to technological and economic obsolescence (Hecht 2009, 320). Hecht summarises the strategies of the two sides of the dispute as follows:

- the relevant context for technology development: the nation or the international market?
- the significance of uncertainties in comparisons between the technologies: each side claimed that the uncertainties favoured their preferred option
- the relative weight of technological, economic and political factors in technology choice

Hecht (2009, 320-322) argues that the victory of the light-water technology was also a victory of argumentation that measured technological success in purely economic terms, and redefined EDF’s “public service” mission as “support of private industry efforts to become profitable in international markets”. Quantitative and economic reasoning gained prominence: the light-water reactor system came to be defined as the “economic” system, while gas-graphite was now described as the “political” system. The connection between gas-graphite reactors and French identity was broken, as the very “Frenchness” of this technology came under attack. Critics now pointed out that gas-graphite technology was partly copied from the British (Magnox reactors), contained imported elements, and entailed risks, as shown, e.g., by the Windscale fire in 1957.

Event 1	The war of the systems
Who was involved?	CEA, EDF, Government, Presidents de Gaulle & Pompidou, PEON Commission, Commissariat Général du Plan
When and where did it take place?	From early 1960s until 1969 (with repercussions lasting far longer)
What type of process was it? How did this change over time?	**Communication** in general; consultation among the involved “insiders” (industry, research and governamental actors). The “war” was an affair for the inner circle of French “nucleocracy”, rather than a question of relationships between industry, government and the public.

3.3. Event 2: The "Chernobyl cloud affair" and its impact on public trust in government and industry

Unlike in most other European countries, in France, the radioactive 'cloud' from the Chernobyl accident did not lead the government to undertake any protective measures. According to French nuclear experts, there was no reason to worry. The government stressed in their press releases the absurdity of the exaggerated measures undertaken in other countries (Kalmbach 2015). Time and again, from the first information bulletin released by the radiation safety authority, SCPRI (Service central de protection contre les rayonnements ionisants), on 29th April[72] until a milestone TV debate revealing the cover-up on 10th May 1986, the authorities sought to reassure the public, denying or belittling the extent of radioactive contamination in France. After the accident, France was the only European country not to transmit to the World Health Organisation (WHO) the detailed results of studies measuring the radioactivity levels observed in the country, but merely declared that the levels were low (Topçu 2013, 138). SCPRI was the first European expert organisation outside of Sweden to be informed about the fallout (Topçu 2013, 139), yet it did not release any quantitative information during the first week following the accident.

On the TV evening news on 30th April, the meteorologist Brigitte Simonetta made a statement that was to remain in the French collective memory. She explained that the weather conditions were predicted to remain favourable enough to block the eventual arrival of a radioactive cloud for the subsequent three days (until 2nd May). To illustrate this alleged protective shield, the meteorologist showed a map displaying a traffic sign "Stop!" on the French-German border. From 1st May onwards, the authorities repeatedly referred to this image of a cloud that stopped at the border by a weather front, "like a Resistance fighter defending France against the Nazi invasion" – an analogy evoked by a nuclear specialist at the time (Topçu 2013, 138). The situation was aggravated by the fact that the accident occurred just before a long weekend (1st May fell on a Thursday). The ministries and the media were understaffed, samples taken in various parts of the country to measure radioactivity took a long time to reach the capital, and to top it all, Prime Minister Chirac and President Mitterrand were in Tokyo, at a summit of Western heads of state.

[72] The first information bulletin released by SCPRI on the issue states: "no significant increase in radioactivity has been detected". SCPRI admitted that the fallout had reached France, but claimed that levels would need to be ten or a hundred thousand times higher to pose a significant threat to public health (Topçu 2013, 138).

On **9th May**, the first protection measures were taken: restrictions on food imports from Eastern Europe (Topçu 2013, 139). The true turning point came a day later, **10th May**, in a TV debate between Pierre Pellerin, then head of the SCPRI, and a GSIEN physicist, Monique Sené. Pellerin was unaware that Sené would be on the programme.[73] Direct on TV, Pellerin was compelled to display several maps with figures of air-borne radioactivity in France, showing elevated levels especially the South and the East of the country, while the equally affected Corsica was not shown. Pellerin had to admit that, at places, contamination reached 400 times the ordinary levels (Topçu 2013, 150-151).

Following this TV debate, the tone of press coverage changed completely, the media widely denouncing a "state lie", and referring – with irony – to the image of the "Chernobyl cloud". Despite the increasingly critical media reporting, the authorities continued their discourse designed to reassure the public. Pellerin, in turn, became the incarnation of the "state lie". The "Chernobyl cloud" quickly turned into a symbol of the alleged opacity and secrecy prevailing in the French nuclear sector. In reality, neither Pellerin nor the SCPRI explicitly claimed that the cloud had stopped at the border. However, the meteorological maps that the authorities used in order to reassure people left their mark in the public consciousness, but also in the minds of leading politicians, who used this image in their communication during the two weeks following the accident (Topçu 2013, 138). What Pellerin did affirm was that "the level of fallout in France does not require measures to protect public health"[74] – a message widely relayed by public authorities at the time (Dänzer-Kantof & Torres 2013, 459). Hesitations by the public authorities, contradictions between their successive declarations, lack of coherence between the measures undertaken in France and abroad, lack of transparency, and the denial falsely attributed to Pellerin triggered in the public opinion a feeling of lie and deceit (Dänzer-Kantof and Torres (2013, 459).

By coincidence, two events came to accentuate the feeling of mistrust. On **21st May**, the satiric weekly newspaper, "*Le Canard enchaîné*", revealed, thanks to a leaked IPSN[75] report, that a grave incident at the Bugey plant two years earlier had been concealed. Also in May 1986, the media widely reported on events leading to the exposure of five workers to radiation at the La Hague

[73] The programme series titled "Droit de réponse" ("The right of response").

[74] 'Le niveau des retombées sur la France ne nécessite pas de contre-mesures sanitaires."

[75] Institut de protection et de sûreté nucléaires – a nuclear protection and safety organisation within CEA.

facility. Intense controversy also followed media speculations on catastrophe scenarios at the Nogent-sur-Seine plant near Paris, then at the final stages of construction (Topçu 2013, 152-153).

Actors and behaviours: Communication on Chernobyl during the weeks following the catastrophe

As the leading state radioprotection service at the time, **SCPRI (the Service central de protection contre les rayonnements ionisants**), and especially its long-time director, Professor **Pierre Pellerin**, came to hold a nearly monopoly position in communicating on the consequences of the catastrophe in France. SCPRI also undertook the vast majority of the measurements at its 130 measuring stations. SCPRI in general and Pierre Pellerin in particular became a scapegoat and the incarnation of the state's failure.

From 28th April onwards, measurements were also conducted at the different sites owned by **CEA**, **EDF**, and around **Cogema's** reprocessing plant at La Hague. The personnel at these sites were aware of the greatly elevated radiation levels, yet neither CEA nor EDF released any of the measurement results (Topçu 2013, 143-144).

The politico-administrative sphere, from ministerial spokespersons to local and regional officials, remained equally quiet about the Chernobyl cloud, and delegated the issue to **SCPRI**. The responsible **ministers** gave their first press conferences on the subject almost ten days after the event, and their message was invariably reassuring. On 6th May, the **health minister, Michèle Barzach**, stated that Chernobyl had no public health impacts in France, whereas the **Minister of Agriculture, François Guillaume**, declared that France had been "totally saved from radionuclide fallout". Still after the Pellerin-Sené TV debate, on 11th May, the Minister contended that in the light of the present knowledge, "agricultural products from our territory present no danger". On 12th May, the **industry minister, Alain Madelin**, admitted that authorities had been late in informing the public. Madelin banned the sale of spinach in Alsace and announced the creation of an interministerial body on information about nuclear energy. **Prime Minister Chirac**, as well as the Interior Minister Charles Pasqua acquiesced on the issue over the entire duration of the crisis (Topçu 2013, 145). In all regions but Alsace, the **prefects** followed to the letter the instructions from SCPRI. Fearing reactions from **farmers**, the departmental services in charge of agriculture, health and social affairs merely sent samples to SCPRI, without doing their own analysis (ibid.).[76]

Most of the plentiful evidence of contamination collected by **scientists** was not communicated to the public, partly because the government had reminded leading public sector scientists of their "duty of reserve" as civil servants.[77] As early as 29th April, several **independent research laboratories** (Paris, Orsay, Lyon, Strasbourg, Bordeaux, and Caen) detected the arrival of the cloud in France, but not until the second week in May did a handful of scientists release some results (Topçu 2013, 147).

Media was highly uncritical in the days following the accident, mostly just reproducing the official message of 'no reason to worry'. On 2nd May, the journalists signalled that the fallout had finally reached France, but that it still was without danger.[78] The tone of media reporting changed rapidly and fundamentally after the TV debate on 10 May 1986 between Pellerin and **Monique Sené**. Media reporting denouncing a "state lie" began to flourish, and many reporters felt betrayed by the state. Journalists who had observed the measures adopted in other Western European countries were also critical (Bauer et al. 2017). The decline of trust in government communication following the "cloud affair" may have contributed to the greater visibility of **foreign media** reporting on nuclear observed in the 1990s (Blanchard 2010, 105).

The **anti-nuclear movement** in France was weak at the time of Chernobyl. Only about 3,000 people participated in a demonstration on 9th May in Paris, while similar events elsewhere in Europe gathered tens of thousands of demonstrators (Topçu 2013, 153). Greenpeace was seriously handicapped by the affair of the Rainbow Warrior, the Greenpeace ship sunk by the French secret services in July 1985. The government accused Greenpeace of collaborating with the KGB, whereas Friends of the Earth was blamed for "catastrophism" (ibid., 154).

The creation of the two **counter-expertise organisations** – **ACRO** and **CRIIRAD** – was one of the main concrete and immediate consequences of Chernobyl in France (see showcase, section 2). They became major critics of nuclear in general, and of the lack of access to reliable information in

[76] For instance, on 4th May 1986, the food safety laboratory of the Ministry of Agriculture declared in Le Monde newspaper that animal foods were safe, and that hence limitations on the consumption of specific food items would not be warranted.
[77] The government addressed a letter to the directors of all research laboratories and institutes (CNRS and universities), reminding them of their "duty of reserve" as civil servants (Topçu 2013, 148-149).
[78] "En France, une marge de sécurité considerable", Libération, 2nd May 1986.

particular. From mid-May 1986 onwards, CRIIRAD became the driving force in calling into question the official ‘narrative’. ACRO and CRIIRAD directed their attacks primarily at the head of SCPRI, Pierre Pellerin (Kalmbach 2015).

Political and societal fallout – the importance of Chernobyl anniversaries

After the initial media row over the “cloud affair”, the issue of Chernobyl faded to the background, partly because the French nuclear establishment no longer announced the source of electricity in France, and partly because antinuclear protest targeted the Superphénix fast breeder reactor (Kalmbach 2015). The topic was only ‘re-discovered’ on the 10th anniversary of Chernobyl, in April **1996**, as the IPSN published an information brochure primarily addressed to journalists, reinstating the message from 1986: there was still no evidence of mistakes made by the French government or scientific elite on the matter of Chernobyl. Journalists seized the opportunity to revive the Chernobyl cloud affair, and to demonstrate the persistence of the official story of a ‘cloud that stopped at the border’ (Kalmbach 2015).

In late 1996, a random veterinary analysis of a wild boar shot by a hunter in the Vosges revealed significant levels[79] of contamination by Caesium-137 (Chateauraynaud & Torny 1999, 443). Further research by ISPN found greatly elevated levels of radioactivity also in mushrooms and berries. The subsequent search led – as CRIIRAD and other critics had predicted in 1986 – to the discovery of further ‘hot spots’ in the mountains near the Italian border, and in Corsica.

The annual Chernobyl commemorations are highly mediatised events in France, shown also as the peak in the number of nuclear-related texts in the French press every 26th April (Kalmbach 2015; Chateauraynaud et al. 2005). The use of Chernobyl commemorations for communication is almost exclusively limited to the anti-nuclear camp. While EDF keeps a low profile, and Areva (as its predecessors, Cogema and Framatome) completely abstains from this debate, the CEA is the only exception to this pattern. During the 20th anniversary it set up a comprehensive website with information on Chernobyl, aimed at politicians. In a position paper, Bernard Bigot, the then High-Commissioner for nuclear energy, praised the excellent work done by French nuclear institutions and experts, and argued that there was no reason to call their work into question – neither in 1986 nor in 2006 (Bigot 2005; Kalmbach 2015).

[79] 1687 bq/kg.

Discourses and behaviours: Interpretations of the political and societal consequences of Chernobyl in France

The “Chernobyl cloud affair” is in France seen as a demonstration of what some consider pervasive secrecy around a risky yet economically and politically vital technology. More fundamentally, the “affair” has become a symbol of the elitism, technocracy, secrecy, and lack of transparency considered by critics as endemic in French policymaking. Various interpretations followed the ‘cloud affair’. As in most other Western countries, the catastrophe was largely framed as a “Soviet” accident, which would be impossible in France.[80] Others denied the image of a ‘safe’ Western nuclear power and denounced a ‘state lie’ (Chateauraynaud and Torny 1999, 216-217). More nuanced interpretations emerged over time (e.g. Strazzulla & Zerbib 1991). The affair also gave rise to the production of future prophecies. Regardless of the specific interpretations of “what actually happened”, in France, the “Chernobyl cloud affair” brought to the centre of the debate the two interrelated questions of 1) transparency of information, and 2) independence of expertise. In doing so, it fostered the emergence of a new type of “**whistleblower**” (Chateauraynaud & Torny 1999, 217) that combines denouncement and alarm – appeals for help and prophecies of doom (ibid., 14).[81] Dänzer-Kantof & Torres (2013, 460) note that after Chernobyl, the “tongues were loosened” – it became possible to talk about nuclear safety, with practical evidence at hand.

Kalmbach (2015) notes a remarkable resemblance between the meanings given to the metaphor of ‘Chernobyl’ in the eastern European and the French discourses: in “both cases, ‘Chernobyl’ stands for ‘disinformation’ and for ‘betrayal by the government of their own people’”. The “cloud affair” brought to the fore questions concerning “the responsibilities of the political and scientific elites” and the desirable degree of openness in a democracy. And yet, while frequently in the media, Chernobyl is “a 'taboo subject' that nobody knows anything about” (Kalmbach 2015). Topçu (2013, 138) takes side in favour of the critics, arguing that Chernobyl indeed illustrates a particular way of “governing by secret” in the world’s most nuclearised country – a mode of governing she considers

[80] On 8th May, the press release of SCPRI explained that the Chernobyl reactor is of technology completely different from the Western one. Hence, even the worst-case scenario of a partial core meltdown in a Western reactor would have far less serious consequences.

[81] In this conception, whistleblowers can also warn about the menace of impending health or environmental risks. The idea hence goes beyond the usual notion of whistleblowing as mere post hoc denouncement of illegal or immoral acts (Chateauraynaud 2013).

as a defining feature of French nuclear sector.

Two books were particularly influential in the French debate on Chernobyl. The book of Swetlana Alexijewitsch, “La supplication: Tchernobyl, chroniques du monde après l’Apocalypse”, published in 1998, became an incarnation of a counter-narrative to the ‘official story’. An edited volume published in 2004 by sociologists Guillaume Grandazzi and Frédérick Lemarchand, “Les silences de Tchernobyl”, brought to the fore researchers from the Caen University research group, especially during the 20th Chernobyl anniversary. The book was the first to look at Chernobyl exclusively from the perspective of human and social sciences (ibid.).

Bauer et al. (2014) examine the **context-related national specificities** that determined the repercussions of Chernobyl: the formation, role and status of nuclear experts and counter-experts; the change and direction of national nuclear polities, politics and policies; the shape, political role, and protest culture of the antinuclear movement; the national nuclear fleet; and the importance of charities. Unlike in the UK, the French critical voices trusted neither the state experts nor the politicians, seeing both as part of “the French nuclear techno-political regime” (Bauer et al. 2014). In the UK, the nuclear “establishment” had already lost a lot of its power by the time of Chernobyl. In contrast with Britain, many of the French antinuclear activists had their personal histories linked to Chernobyl; for example, Michèle Rivasi, the founder of CRIIRAD, has since then become a renowned antinuclear activists and Green party politician. Moreover, many journalists in France felt personally betrayed by the public authorities, and helped to keep the memory of the “cloud affair” alive. Finally, the French anti-nuclear movement attacked civilian nuclear, whereas its UK counterpart concentrated on anti-weapons activism (see the UK Short Country Report).

There were obvious economic and political reasons to conceal the impact of Chernobyl: the economic interests of the powerful French nuclear sector aligned with the interests of the likewise influential and strike-prone farming lobby. Admitting nuclear safety problems would have weakened the former, whereas restrictions on the consumption of agricultural products would have generated vehement protests from the farmers. Topçu (2013, 140-141) considers various further explanations for the communication and management failures. Since 1966, SCPRI held the exclusive right to inform and protect the public in case of an accident,[82] and its officials were bound by confidentiality

[82] A monopoly position accorded to SCPRI by the Decree 66-450 of the Ministry of Health.

requirements, until the end of their career; and the personal characteristics of Pierre Pellerin, director of SCPRI from its creation in 1956 until his retirement in 1996: authoritarianism, thirst for power, attachment to the nuclear sector, and "taste for secret". Defenders of Pellerin, point at the scarcity of SCRPI's communication resources. EDF had the necessary resources, but was legally not entitled to communicate on questions relating to the fallout (ibid.). Poor interministerial coordination, and the long-lasting tendency of French politicians to delegate complex and technical nuclear issues to the technical experts – in this case SCPRI – made things worse (ibid.). Topçu (2013, 142) considers these explanations insufficient, and argues that "normalisation of secret" had over time become dominant in the state institutions in question (see also Larceneaux and Leprince Olivier 2014).

Public perception

In the wake of Chernobyl, public support for nuclear declined from 67.4% in 1985 to 51.33% in May 1986, and further to 43.5% in 1988 (Dänzer-Kantof and Torres 2013, 459). Blanchard (2010, 133) observes that the negative impact of Chernobyl on public opinion peaked about 2-3 years after the accident, and lasted at least a decade, during which the support for nuclear stayed far below its pre-Chernobyl level. Blanchard (2010, 134) links this time lag with the uncertainties concerning the concrete health impacts of Chernobyl, but the "cloud affair" certainly was a contributing factor. The post-Chernobyl era also saw the emergence of a number of other health-related public fears and "scandals" – such as those on asbestos, "contaminated blood", pesticides, and GMOs – which undermined trust in government (see e.g. Chateauraynaud and Torny 1999).

Ways of managing public opinion

Chernobyl marked the beginning of a new era in French nuclear policy, with transparency as the keyword. Authorities and industry now admitted that the possibility of a serious accident in France was possible[83] although highly unlikely – and despite the controversy that this change in argumentation generated inside the nuclear "establishment", notably within the EDF.[84] Provision of

[83] See e.g. a presentation by Pierre Tanguy, nuclear safety inspector at the EDF: "La catastrophe de Tchernobyl: Les leçons à en tirer pour les programmes nucléaires d'Électricité de France", 11th March 1987. http://documents.irevues.inist.fr/bitstream/handle/2042/8177/MURS_1988_11_79.pdf?sequence=1

[84] Pierre Tanguy estimated, in the magazine "Science et Vie" (1990), aimed at the general public, that the likelihood of a serious accident in the French nuclear power stations over the ten upcoming years would be of the order of a few per

safety information was added to the prerogatives of the industry ministry's nuclear safety commission, CSSN, whose name was correspondingly transformed to CSSIN (by a governmental Decree from 2nd March 1987). The parliamentary science and technology office, OPECST sought to impose itself as a key organisation in safety regulation and stressed the importance of transparency and continuous safety improvement as pillars of public confidence (OPECST 1987). Numerous local authorities (regional, departmental and municipal) set up their own radioactivity monitoring systems, to avoid dependence on SCPRI alone (Topçu 2013, 231). The safety authority, SCSIN, took a somewhat more critical stance towards EDF and CEA.

EDF adopted a more proactive communication strategy to improve its image. From now on, it informed the public early and even about minor incidents, in order to show that it had nothing to hide.[85] It launched a massive communication and PR effort, targeted in particular at schoolteachers, doctors, and local politicians.[86] The company's social science research unit, GRETS, created in 1980, now sought to better understand questions relating to the environment and public opposition (Dänzer-Kantof and Torres 2013). The experimental system of classification and information on nuclear incidents and accidents, introduced by EDF in 1988 (Dänzer-Kantof and Torres 2013, 461-462), served as inspiration for IAEA, which in the following year adopted the currently used INES (International Nuclear Event Scale) system (Topçu 2013, 232). This more proactive attitude was not limited to EDF – for instance, DSIN (predecessor of ASN) used Minitel – a sort of French version of the Internet, since then practically abandoned – to inform the press about even small incidents (Barthe 2006).

These efforts at greater transparency laid the bases for more dialogical and participatory governance from the mid-1990s onwards. General legislative and institutional innovations included the creation of CNDP in 1995, the adoption of the Arhus Convention in 1988, and the Environmental Impact Assessment Directive (1985), which all strengthened the involvement and

hundred. The statement was relayed by the Canard enchaîné, and subsenquently denied by the EDF, yet Tanguy kept to his own estimate (Le Canard enchaîné, 21/02/1990). http://saint.aroman.marc.free.fr/Nucleaire/Erreurs%20nucleaires/SG%2026%2011%2099%20L'accident%20nucl%C3%A9aire%20grave.doc

[85] Interview of a former communications director of EDF by Topçu (2013, 233-234).

[86] Between 1988 and 1989, EDF information events targeted at such groups were attended by about ten thousand persons (Dänzer-Kantof & Torres 2013, 461).

information of public in planning and decision-making processes (Gadbois et al. 2007). In the nuclear sector, international pressures came from the EURATOM Directive 89/618 on the duties of authorities to inform the public about health protection measures in the event of an accident, and the OECD Nuclear Energy Agency (OECD-NEA)[87] work on public engagement. The 1990s saw a wave of legislative reforms designed to strengthen citizen participation, in urban and regional planning as well as environmental policy, for instance.[88]

The "legalistic turn" of counter-expertise

Counter-expertise' earned a more legitimate role in safety control, and the capacity of a government body to control industries and defend public interest was increasingly called into question (Foasso 2003). In the wake of the search for hotspots triggered by the discovery of elevated levels of radioactivity in the lone wild boar killed in 1996, a search for the French ***"victims" of Chernobyl*** gathered speed. Counter-expertise took a "legalistic turn" in March 2001, as the **French association of thyroid patients (AFMT)** lodged – together with **CRIIRAD** and **51 thyroid patients** – a complaint "against person unknown", accusing the Chirac government of having misled the public and failed to undertake appropriate health protection measures after Chernobyl. About 200 claims were brought to justice in April 2006, to mark the 20th anniversary of the catastrophe. In September 2011, the **Paris Court of Appeal** rejected the claims – a decision confirmed in November 2012 by the **Court of Cassation,** thereby releasing Professor Pellerin of charges. A year later, also the last appeal instance – the **European Court of Human Rights** – rejected the claim lodged by 650 claimants.[89] This did not end the controversy, however. Many experts and expert organisations refuted the claims by **AFMT:** these included the **Institut de veille sanitaire (INVS)** – responsible for public health monitoring (Rogel et al. 2010), the state nuclear safety expert organisation, **IRSN**,[90] and a **group of 52 medical doctors**, in a letter published in 2005 by the left-

[87] For example through the OECD-NEA Forum of Stakeholder Confidence.

[88] For example, the "Loi d'orientation sur la Ville 1991"; "Loi sur l'administration territoriale 1992"; and "Loi Barnier 1992" (Blondiaux 2004, 2-3).

[89] http://www.slate.fr/story/116719/tchernobyl-nuage-bd-autorites-menti-sciemment

[90] http://www.irsn.fr/FR/connaissances/Installations_nucleaires/Les-accidents-nucleaires/accident-tchernobyl-1986/consequences-homme-environnement/Pages/8-Les_consequences_sanitaires.aspx#.V45l5K55Ahs

wing daily **newspaper, Libération.**[91] Unsurprisingly, also the **French Society for Nuclear Energy (SFEN)** denied the claims.[92]

The controversy took speed again a few weeks after the publication of the INVS report, as **Sophie Fauconnier** (Fauconnier 2006), in her doctoral thesis in medicine established a link between the catastrophe and the diagnosed cancer cases. Her father, **Denis Fauconnier,** a medical doctor working in Corsica during the Chernobyl accident, claimed on the *France Culture* radio channel in January 2015 that political interests steered and controlled scientific research.[93] Fauconnier has also denounced the lack of transparency in the treatment of the issue of thyroid cancers, accusing the authorities (IRSN in particular) of having withheld vital information.[94] The dividing lines in the dispute are blurred, as the work of **Jean-Michel Jacquemin**, the pioneer defender of the rights of the thyroid sufferers, is contested even within the counter-expertise community. CRIIRAD has distanced itself from Jacquemin's statements, in particular those that place France on par with the most affected regions in Eastern Europe.

[91] The authors of the letter claimed that the self-declared "victims of Chernobyl" in France were simply "prisoners of an anti-nuclear and legal-medical lobby". http://www.sfmag.net/spip.php?article3513

[92] https://www.dissident-media.org/infonucleaire/mensonge_et_desinfo.html

[93] https://www.franceculture.fr/emissions/terre-terre/le-blues-des-experts-3-les-suites-de-tchernobyl-en-corse

[94] http://www.nuage-radioactif.com/

Event 2	The Chernobyl cloud affair
Who was involved?	Authorities and industry: SCPRI (Pierre Pellerin), CEA, EDF, Cogema, ministers (relatively limited, low-profile role), IPSN, IRSN, Institut de veille sanitaire, ASN, Société française d'énergie nucléaire (SFEN) Scientists at state research laboratories and universities Counter-expertise organisations: GSIEN (Monique Sené), CRIIRAD, ACRO Media: TV meteorologists, press and TV at large Thyroid cancer patients (and their representatives/defenders: Jean-Michel Jacquemin) French and European courts of justice
When and where did it take place?	Venue: the media and public sphere The most intensive period 29 April 1986 – mid-May 1986. Lasting repercussions until today, with peaks of attention at each Chernobyl anniversary (26 April)
What type of process was it? How did this change over time?	**Communication** in general No true consultation or participation; the public was at first (mis)informed, which then gave rise to counter-expertise (bottom-up, uninvited participation), controversies, and court cases Establishment of an atmosphere of deep mistrust in authorities and "official" expertise as the main consequence of the "affair" Efforts at greater transparency by the authorities and the industry, in order to gain the lost public confidence.

3.4. Event 3: The closure of the Superphénix fast breeder reactor in 1997 (and the process leading to the closure)

The event

Like in many other countries, in France the development of fast breeder nuclear reactors (FBRs) took place in the general context of post-War nuclear policies and international competition for national technological achievement (Goldschmidt 1967). FBRs were both a driver and a consequence of technology development. It was seen as a strategic technology, embodying the vision of a future abundant in energy and free from fuel supply concerns. In 1953, in an attempt to catch up with the British and the Americans, France launched its first studies on FBRs, with CEA in the lead (Vendryès 1997). The FBRs were an integral element in the "nationalist" technopolitical regime (Hecht 2009), built on the strategy of "national champions". The FBR programme hence was also important in the "war of the systems" (see Event 1, section 3.2), and was closely associated with the French military nuclear programme.

The construction of an experimental reactor, Rapsodie, began in 1961 in Cadarache, south of France. The US provided the necessary enriched uranium, whereas plutonium was purchased from the UK. The 24 MW (thermal) reactor reached criticality four years behind the schedule, in 1967, but attained full power in just three months (Vendryès 1997). The capacity was then ramped up to 40 MW, and Rapsodie was generally considered as a "technical success" (Finon 1989, 159). Encouraged by the experience, engineers from CEA/EDF/GAAA (Groupement Atomique Atlantique Alsacienne) embarked on the construction of a 250 MW prototype reactor, Phénix, although Rapsodie had still not even reached full output. Reaching criticality in 1973, and nominal power on March 15, 1974, Phénix was acclaimed as a technical success: France had caught up the leaders in FBR technology (Jobert & Le Renard 2014; Sauvage 2009).

By this time, the wounds of the "war of the systems" still open, FBRs had become a privileged area of cooperation between CEA and EDF – a source of new consensus and a shared vision for the French national nuclear endeavour, as the only remaining national technology (Hecht 2009, 291). Finon (1989, 169) saw FBRs as an incarnation of the "irresistible logics of an EDF-CEA alliance". Building on the experience on national prototypes would allow the pursuit of national technological excellence, whereas the American light-water reactor technology provide a short-term solution, to be later followed by the "logic of a breeder future" (Hecht 2009, 293). Prototype FBRs were developed as part of a long-term national nuclear project including reprocessing and a fleet of industrial 1,000 MW breeder reactors (Finon 1989, 182).

The move from the Phénix prototype to the industrial prototype, Superphénix, in Creys-Malville, Southeast of France, was characterised by accelerated planning and decision-making fuelled by optimism. To reconcile the interests of CEA and EDF – and, more broadly, the nationalist and nationalised regimes (Hecht 2009) – the engineering services of EDF would coordinate the Superphénix worksite, while CEA would hold the license of the prototype reactor.

Superphénix had a significant **transnational dimension**. Euratom had tried, in vain, to launch the development of a 300 MW European reactor already in the 1960s (Giesen 1989). In the early 1970s, several European countries (e.g. the UK and Germany) envisaged the construction of industrial 1,000-megawatt FBRs. Now, deliberations between three national electricity utilities – EDF, the Italian ENEL and the German RWE – together with CEA and the French government, resulted in two joint projects: the 1,200 MW Superphénix, and its German counterpart, "SNR 2" (Marth 1993). Superphénix would mark a shift from experimental to industrial FBRs, thereby also shifting the lead from CEA to private industries. Superphénix was owned by a joint-equity limited company NERSA, with shares divided between EDF (51%), ENEL (33%), and RWE (16%). CEA sold the technology patent to Novatome, an *ad hoc* subsidiary, which could respond to international FBR orders. The estimated investment costs of FBRs exceeding those of light-water reactors (Finon 1989, 31), a European consortium was a means of sharing the risks, advancing towards a commercially viable technology, and promoting industrial cooperation in Europe.[95] International competition had also fostered the circulation of ideas and creation of a common mindset among the involved scientists and engineers.

Prime Minister Chirac took the official decision to approve the construction of Superphénix in 1976 – quickly, and without significant public consultation.[96] Massive demonstrations erupted, entailing violent confrontations between the police and the demonstrators, and leading to the death of one demonstrator in July 1977. The construction of the first-of-its kind reactor took almost a decade (1976-1985). Numerous technical and safety problems, interruptions, and intense debates focused on safety punctuated the twelve-year period of operation. Opponents also contested the fundamental rationale, and the economic and technical viability of Superphénix. The whole endeavour came to an abrupt end on 19th June 1997, as Lionel Jospin, the Prime Minister of the newly-elected Socialist-Green government, declared in his inaugural speech to the Parliament that Superphénix would be abandoned. The decision was generally considered as a concession from the Socialists to the Greens that had posed the closure of Superphénix as a precondition for their entry in the government. The reactor was shut down in 1998 and is in the process of decommissioning ever since.

While a significant symbolic victory to the anti-nuclear movement, many nuclear-sector insiders qualified the decision as "purely political". The defenders of Superphénix considered the shutdown

[95] The solution hence resembled the "Airbus model" (Muller 1989), designed to respond to the increasing competition with the large (especially American) multinational enterprises.

[96] http://itese.cea.fr/_files/LettreItese12/LI12Printemps2011SPXv27.pdf

as enormous waste of human and technological resources invested over the years into developing the technology. For Dänzer-Kantof and Torres (2013, 559) the closure of Superphénix marked a symbol and an end of an era, the death of the idea of “historical-technological progress”, and a victory for the “presentism” characterising our age.

French experts continue to play a prominent role in European fast reactor collaboration and the international “Generation IV” initiative, still seeing the technology as promising in the face of the long-term prospects of fuel depletion. A 600 MW experimental sodium-cooled fast reactor, Astrid, is being planned for Marcoule, south of France.

Discourses and actions: The gradual decline of support to Superphénix

Jobert & Le Renard (2014) divide the evolution of fast breeders in France into three periods. The first, (1954-1975) entailed efforts to demonstrate the feasibility of the technology. At the second phase (1975-1986), an “industrial prototype” was to be constructed, and the project was evaluated against technological, economic, and safety criteria. The final, operating stage (1986-1997), entailed demonstrating the safety of the plant, but also revising its objectives in the new context. It was this last stage that saw a gradual erosion of trust in Superphénix.

As the the economic recession following the first oil crisis in the mid-1970s suddenly brought down the fundamental rationale behind FBRs, i.e. the rapid and continued growth of electricity demand, French critics of FBRs called upon the government to abandon its plans. To support their claims, they referred to work by commissions of inquiry in countries such as the UK and USA, which had concluded that developing FBR prototypes should no longer a priority (e.g. Flowers 1976; Keeny 1977). The government remained steadfastly in favour of the FBRs, considering them of key strategic importance.[97] However, the more immediate priority of launching the massive nuclear programme gradually relegated FBRs to a long-term ‘insurance’ option. Plans for industrial FBR fleets were hence repeatedly postponed, the Three Mile Island accident further brought down forecasts of nuclear development, and worries about uranium depletion faded. The abandonment of Superphénix was part of the campaign promises by François Mitterrand, but once elected, the President did not hold his promise (Røren 2013, 84).

[97] President Giscard d'Estaing declared that, the French uranium used in FBRs would make France comparable to Saudi Arabia in terms of energy resources (Bériot & Villeneuve 1980).

New methods of economic modelling increasingly informed debates on FBRs. Assumptions concerning the breeding gains, capital costs and the importance of doubling times had been fundamentally revised in the UK (Sweet 1982, 18). Finon (1982; 1989) and Keck (1980) drew similar conclusions for France and Germany. The ever-stricter safety requirements further eroded the economic viability of Superphénix.

In 1986, Superphénix started operation as a part of EDF's industrial fleet, but the absence of near-term plans for industrialisation had made it an isolated prototype. The Chernobyl accident eroded trust in nuclear technology, and led to the withdrawal of Italian ENEL from the European consortium. A sodium fire in a solar power plant in Almeria (Spain) cast a doubt on the safety of the EPR sodium-based cooling system, and the rapidly declining energy prices reduced the weight of energy security and sufficiency in policymaking (Jobert & Le Renard 2014). The operation of the plant itself was plagued by numerous technical problems.[98]

A major question turned out to be the denomination of the reactor as "industrial prototype". If considered "industrial", the plant would be assessed against commercial electricity generation criteria, while a prototype reactor would be evaluated more as a research project. Defenders of FBRs evoked idealistic and highly optimistic prospects of abundant energy to the entire humankind (Sauvage 2004, 12), and qualified the FBRs' problems as "childhood illnesses" or "inevitable teething troubles" (Judd and Ainsworth 1998, 609); as valuable feedback necessary for the development of the technology. With time, FBR technology was framed ever more as a long-term R&D effort, rather than a solution to short-term energy needs.

Discourses: Critiques and controversies

Three general strands of criticism against Superphénix can be identified, two of which could be qualified as "moderate" and the third as "radical". The first strand of moderate criticism was expressed by trade unions and a part of the political opposition (esp. the Communists), who feared that the entry of private foreign interests would lead to an outcome similar to the choice of the "American" PWR technology. In 1972, Parliament nevertheless approved a change in legislation

[98] In March 1987, a sodium leak occurred in the fuel storage "cylinder" tank. Only a year after the reactor had finally restarted after this incident, a new incident occurred in July 1990, as pollution or oxidation of the primary sodium was detected and the operation of the plant was stopped for four years.

allowing the establishment, on French soil, of "electricity-sector activities of European interest" – the FBR project was now seen as a "continuation of France through other means" (Jobert & Le Renard 2014). The second version of moderate criticism drew on technological and increasingly also economic argumentation: while not opposed to the project as such, many nuclear-sector insiders considered the technology as immature (e.g. Parti Socialiste 1978, 35), still economically unviable, and unnecessary in the prevailing energy situation. The radical critics opposed the principle of FBRs itself, seeing the it as a part of the massive nuclear endeavour underway, including a huge fleet of PWRs, FBRs and fuel reprocessing plants, thus resulting in major safety and proliferation risks (Jobert & Le Renard 2014). The early counter-expertise organisations, in which scientists played a central role, adopted this radical stance.[99]

Pluralist expertise and public engagement

The decisions to launch the French FBR programme were made, in the 1950s, under the largely unconstested moral authority of "savants".[100] From 1976 onwards, public contestation led to a gradual opening of spaces of discussion between the promoters and opponents of FBRs. Consultation on technological risks was at this time limited to the written "public inquiry" process (Turpin 1983), but Anglo-Saxon examples were used to justify calls for more open debate, alongside demands for decentralisation, transparency, and pluralism. Two informal consultation processes on Superphénix are worth mentioning as precursors to later participatory processes: a conference organised in 1976 by the departmental council of Isère, and a deliberative experiment organised as part of a TV programme "Public auditions on the fast breeder". Both explicitly referred to the Anglo-Saxon model of public hearings (Conseil Général de l'Isère 1977: 5; Bériot and Villeneuve 1980), and involved debates between renowned scientists with contrasting views on the project,[101] CEA and EDF representatives, and politicians (Jobert & Le Renard 2014).

The problems encountered and the new economic context in the mid-1970s led to a broadening of the debate and reassessment of the role of Superphénix. Its viability was considered now also in a

[99] For instance, the "Gazette Nucléaire", the communication bulletin of GSIEN, claimed in the end of 1976 that an accident in Superphénix might affect more than a million people (Topçu 2006).

[100] "Savants" was the term in French applied in this debate.

[101] For example, in the Isère debate, two high-level physicists, Professor Lew Kowarski (against Superphénix) and Nobel Prize winner Dr. Louis Néel (in favour).

broader context of safety, reliability and cost, and its “raison d’être” examined also in the light of the broadening out of nuclear waste management options (Barthe 2009; see also the Showcase, section 2). Between 1991 and 1998, as many as fourteen official reports – and the associated public hearings – examined the safety, underlying rationale, costs and research contribution of Superphénix.[102] Safety experts of IPSN and ASN examined the sodium-based cooling system, while OPECST was active in debates on Superphénix. OPECST played in the 1990s a role similar to that of the RCEP in the UK during the preparation of the “Flowers report” (1976), as a source of ‘pluralist’ expertise on FBRs. Yet, especially the anti-nuclear movement has criticised OPECST for merely serving the nuclear lobby (e.g. Constanty & Nouzille 2006).

Opponents took also legal action, and included some high-level politicians. When environment minister at the right-wing Juppé government (1995-1997), Corinne Lepage led an intense battle with the industry minister Franck Borotra. Denouncing legal irregularities, Lepage refused to sign the decree authorising Superphénix to start operating, after a period of closure. A lawyer by training, Lepage also advised the Canton of Geneva in its battle against Superphénix.

Demonstrations against Superphénix: Creys-Malville as a symbol and a turning point in anti-nuclear action

During the 1970s, Superphénix became the symbol and key target of anti-nuclear opposition, and generated the most massive anti-nuclear protests. The plans to construct Superphénix advanced quickly in the early 1970s. Legally mandatory local “public inquiries”[103] designed to obtain a construction licence were to begin in 1974, but the opponents obtained postponement of the inquiry to 1975, on legal grounds. The inquiry revealed mounting opposition against the project, primarily among academics from the large cities close to the site in Creys-Malville (Lyon, Grenoble, and

[102] For example, in May 1992, a public debate within the OPECST examined the possibility of converting the plant into a research facility contributing to this superior aim (Le Renard and Jobert 2014).

[103] In contrast with their British counterparts, the public inquiries in France are of short duration, limited to the municipalities close to the site, and designed to collect written or oral comments from the citizens. One of their major objectives is to ensure that due compensations are paid to the individuals and private sector entities potentially affected by a project of general interest.

Geneva), with GSIEN in a key position. As many as 1,300 researchers from CERN[104] demonstrated against Superphénix. This led the General Councils of Isère and Savoie to request the closure of the plant (Topçu 2006).

In summer 1976, the first large demonstration attracted 15,000 – 20,000 participants, including farmers from the nearby regions, and ended in violent confrontation with the police. About a hundred “Malville committees” were created. Nation-wide NGOs (Greenpeace, Friends of the Earth, and FRAPNA) participated in most demonstrations. Superphénix became a symbol of antinuclear movement in Europe (Topçu 2013). In November 1976, 1,400 engineers, physicians, and technicians from the Geneva region signed an open letter to the French, Italian and West-German governments calling for the cancellation of the project, democratic debate, information to the local and concerned population, and independent expertise (Røren 2013, 7).

The second major demonstration, in Creys-Malville in July 1977, gathered between 20,000 and 60,000 opponents, including hundreds of foreigners, notably 800-1500 West-Germans (Tompkins 2011; 2016). Organised by the coordination of the “Malville committees”, the demonstration was supported by activists from the extreme left: Unified Socialist Party (PSU), the Communist Workers’ Organisation (OCT) and the Communist Revolutionary League (LCR). The prefect of Isère, René Jannin, had mobilised massive police and army forces to prevent the demonstrators entering the site. The clash with the police led to the death of one demonstrator,[105] while about a hundred demonstrators and five policemen were injured (Topçu 2010, 96-97). This dramatic confrontation left enduring marks on society, not least in the anti-nuclear movement, as many potential sympathisers now turned away from anti-nuclear action (Aykut 2012, 357-358). The dispersion and decline of the anti-nuclear movement following Creys-Malville also weakened public concern for the environment in the 1980s (Touraine et al. 1983, 4; Aykut 2012, 314).

Over ten years later, in 1988, environmentalists and consumer organisations launched a “Grenoble petition” demanding the closure of Superphénix. The traditionally moderate CFDT trade union did not sign the petition, but did not approve the restarting of the fast breeder either (Bompard 2011). In

[104] CERN, Centre Européen de Recherche Nucléaire / European Organization for Nuclear Research

[105] Vital Michalon, a 31-year-old physics teacher.

1989, the European Committee against Superphénix[106] was created, consisting of associations and organisations especially from France, Switzerland and Italy. In 1990, on the fourth anniversary of Chernobyl, several demonstrations were organised in these three countries, under the slogan “Four years after Chernobyl, Malville today”.

Interpretations and consequences of the closure of Superphénix

The early termination of Superphénix, after a year of fully satisfactory operation, shocked those involved in the project, which in their view had denied the time to demonstrate its true potential. Opponents of Superphénix saw the decision as the “natural” end-point to an overambitious plan of moving quickly from R&D to commercially viable industrial operation. The trade union CGT organised demonstrations in defence of jobs and local economy (Blanchard 2010, 357).

Jobert & Le Renard (2014, 22) consider that the technology had come to a point in which it no longer could hold together all of the contradictions involved in the project (Latour 1996, 232), including in particular those between the commercial and scientific-demonstration objectives. The project was abandoned, because it no longer offered the needed “technopolitical flexibility” as the reactor was reframed as an industrial endeavour; the technology escaped the control of its inventors – CEA and EDF engineers – and the programme could no longer be renegotiated with the freedom necessary for a research programme.

[106] *Comité européen contre Superphénix.*

Event 3	Superphénix fast breeder – and its closure
Who was involved?	CEA, as the main developer of FBRs EDF, collaborating with CEA in the development and operation of FBRs Government ministries (industry, environment) Safety authorities and expertise organisations (IPSN, ASN) OPECST: a parliamentary forum for pluralist expertise and debate (academics are given an opportunity to participate) Anti-nuclear movement in France, Italy and West Germany (Superphénix as a symbol of anti-nuclear opposition) Local farmers Local authorities of the state (prefects) Labour Unions
When and where did it take place?	From 1954 to 1998; in the Southeast of France (Creys-Malville)
What type of process was it? How did this change over time?	Initially, nothing – not even communication. From 1970s onwards, bottom-up action (demonstrations, petitions) During the early 1990s, consultation: several expert committees and commissions, with more pluralist composition (notably within OPECST, Parliament)
What rationale was given by the party that implemented the engagement?	To examine the viability of the technology, in a new context (from economic, technical and safety perspective)

3.5. Event 4: The two "nuclear debates" organised by CNDP in 2005-2006

As part of the attempts to increase the transparency and openness in French energy policy, three national consultations – "national debates" – on nuclear energy were organised in 2005–2006 by the National Commission on Public Debate (CNDP). The debate radioactive waste management policy was to inform the parliamentary discussion in preparation of the "Planning Act" of 2006, which retained reversible geological disposal as the reference option for nuclear waste management (Andra 2010, 38). The Act also recommended the continuation of research on three management options – long-term geological disposal, transmutation, and interim storage (CNDP 2006a). The second debate concerned the construction of a new European Pressurised Reactor (EPR) in Flamanville, while the third was held on the construction of the high-voltage transmission line that would connect the EPR to the national electricity grid. In the following, the debates on the

EPR and radioactive waste will be described.

CNDP is an independent public organisation created in 1995, since 2002 an independent administrative authority, whose mandate is to organise public debates and ensure public participation in infrastructure projects of national interest, and significant socioeconomic, environmental or land use planning implications. A group of six independent experts from various backgrounds, a “Commission particulière du débat public” (CPDP), is set up to organise the debate. Interested parties are invited to submit position papers, which the CPDP uses to compile a summary of views. CPDP often specifically requests counter-expertise. Within three months following the end of the four-month debate, the developer must explain how it will take the debate into account in its decisions and actions. CNDP’s operating principles are close to the Habermasian preconditions of an ideal speech situation: “equivalence” (anyone wishing to express her view may do so), argumentation (each opinion must be justified), and transparency. CNDP does not make decisions, nor does it give recommendations, but produces merely a summary of the points raised, and chairman’s conclusions.[107]

EPR debate

The starting point for the debate on the EPR was difficult not only because of the general scepticism generated by the poorly organised national debate on energy in 2003,[108] but also because the industry minister Nicole Fontaine had already declared her support for the reactor on 8 October 2003. Her declaration was considered precipitous and undemocratic by a number of actors.[109] Prime Minister Jean-Pierre Raffarin distanced himself on the following day, noting that no decision has been taken yet. However, following a parliamentary debate in April 2004, Flamanville was chosen as the site for the new reactor in October 2004. EDF began site preparations in April 2005. The CNDP declared in June 2005 that the debate would start on 19th October. The scene was set for a highly explosive and controversial debate.

[107] http://www.vie-publique.fr/forums/rub1308/cndp-debat-public.html

[108] Deemed also by independent observers as ‘‘seriously flawed’’, a poorly disguised attempt by the government to legitimise the decisions it had already made (e.g. Mays 2004, 42; CG 2006, 70).

[109] For instance, Greenpeace, the Greens, many associations and prominent individuals such as the former environment minister from the Juppé government, Corinne Lepage, a widely respected environmentalist Nicolas Hulot, as well as the “counter-expert” and economist Benjamin Dessus.

The CPDP nominated to lead the debate included persons that could be considered as “counter-experts”, notably the physicist Annie Sugier,[110] and Françoise Zonabend, anthropologist, author of a seminal book, describing the life of the populations around the La Hague installations (Zonabend 1989; 2014). CNDP decided that the debate would have a national dimension, covering not only questions relating to the siting of the proprosed plant, but also the entire EPR programme (Chateauraynaud et al. 2005).

In September 2005, CNDP declared that a few lines in the submission by the anti-nuclear network, Réseau sortir du nucléaire, would have to be deleted from the CPDP’s summary report, because they referred to a document classified as defence secrecy. As the attempt by CNDP to mediate between EDF and the NGOs proved unsuccessful, the NGOs opposing the EPR withdrew less than a week before the debate was due to begin. The debate was nevertheless launched on the 3rd November 2005, and lasted until early March 2006.

Chateauraynaud et al. (2005) consider that, in view of the difficult circumstances, the CPDP succeeded relatively well, partly thanks to improvisation and creativity, designed to ensure the participants adhered to the procedural rules. This was difficult, because EDF tended to see the process as a public information campaign, while the other participants were more interested in the final outcome than procedural justice (ibid.). The nation-wide generalist press highlighted the fact that the decision to build an EPR had already been done, whereas the specialised economic press hardly reported on the debate at all (ibid.).

The main concrete outcome of the debate was the commitment of EDF to give certain civil society organisations greater access to its nuclear safety reports, and release to selected academics information considered of national security interest. Any discussion about the future of nuclear power in France was postponed until 2015-2020 – when the need to replace the existing nuclear capacity was estimated to arise (Ballan et al. 2007).

The debate on radioactive waste policy

The debate on the management of medium and high-level radioactive waste took place partly in parallel with the EPR debate. OPECST strongly opposed the organisation of a debate, calling into

[110] Chairwoman of the pluralist commission, “*Groupe Radioécologie Nord Cotentin*” (GRNC), set up in 1997 to examine the controversies over the prevalence of leaukemia among children around the La Hague nuclear installations.

question the mandate of the CNDP in this domain. The debate started in September 2005, on the same day that construction of the new EPR reactor started in Finland. Anticipating sharp conflicts, the CPDP strongly restricted the scope of the interventions by participants. National anti-nuclear NGOs again boycotted the process, but debate was lively at the local level. Activist groups undertook high-profile actions outside the meeting venues.

An **American consultancy firm, IEER** (Institute for Energy and and Environmental Research) intervened in the debate at the request of the local information committee, CLIS, of the host community of Bure. The polemic between IEER and Andra occupied a highly visible role in the debate. International aspects were evoked, given that the La Hague reprocessing plant handles spent nuclear fuel from abroad (Chateauraynaud et al. 2005).

Assessment of engagement: consequences and "success" of CNDP debates

Chateauraynaud et al. (2005) highlighted three main differences between debates on radioactive waste and the EPR. First, debates on radioactive waste already had a long history in France, whereas the construction of a new nuclear reactor had never before been a subject of nationwide discussion. Second, the waste debate was to prepare a parliamentary debate on waste policy, whereas the EPR project concerned the construction of a new plant and its place in the national electricity network. Third, the forms of criticism and the participants in the debates were different.

In both debates, the first meetings within the CPDP in September 2005 revealed the key arguments of the NGOs: the debate comes too late; the decision had already been made (waste disposal research 'laboratory' was seen as a disposal facility in disguise); four months is not enough for a true debate; and the scope of the debate should be national, not local. Greenpeace argued that the decision on an EPR had made the debate on radioactive waste pointless, and called for an end for the generation of waste in the first place. The NGOs would have wished to address parliamentarians, who were in their view insufficiently informed about the topics on the agenda (Chateauraynaud et al. 2005).

Anti-nuclear NGOs criticised the waste debate for having served to legitimise the prevailing policy of deep geological disposal as "inevitable". Stéphane Lhomme, then the head of the anti-nuclear NGO network, Réseau sortir du nucléaire, deemed the debate as "bogus" and devoid of any impact on decision-making (Lhomme 2006). Some observers considered that the debate had forced discussions into an excessively formal framework of rules, which limited spontaneity and true dialogue (Ballan et al. 2007), while some accused the anti-nuclear groups of misleading propaganda (Nifenecker 2006). Ballan et al. (2007) concluded that none of the three CNDP debates (EPR, waste, THT line), but in particular the one on the EPR, went beyond mere provision of information to citizens and reinforcement of the existing power relations. Further problems included lack of clarity on the 'rules of the game' and on the objectives of the debate, difficulties to define the right geographical scope and tone of a debate on a highly technical topic (Zonabend 2007), imbalance of resources between participants, budgetary constraints, and problems of access to information – manifested in particular by the "defence secret affair" (Lehtonen 2010). Yet even the critics recognised that, in view of the difficult starting point, the CNDP had managed to resist pressures from vested interests, protect its own integrity, introduce new perspectives, and change the rhetoric in waste management policy (GC 2006, 64). One sign of CNDP's strengthened legitimacy was that the NGOs shifted, during the process, their criticism from CNDP towards the government (Chateauraynaud et al. 2005). Yet, the creation of CNDP has probably also pushed the nuclear industry to sharpen and refine its marketing strategies, helping it to pursue purely instrumental objectives (cf. Fiorino 1990).

A virtue of CNDP is its explicit mandate to guarantee the pluralism of perspectives, and its freedom to determine the form of the debate. It deliberately brought to the nuclear debates independent – and often international – "counter-expertise'', which sometimes stirred controversy, but whose value was broadly recognised (GC 2006, 71). The waste debate illustrated the capacity of CNDP to generate surprise (Mermet 2007) and facilitate the crystallisation of new points of view (Chateauraynaud et al. 2005), as permanent near-surface storage emerged as a serious option (CNDP 2006, 15). Since CPDP members are often academics or retired people, they tend to hold views different from those of the developers.[111] The openness of the chairman of the CPDP, Georges Mercadal, was considered as elemental for the quality of the waste debate.[112] The chairman started the debate from a 'clean slate' and produced a rather iconoclastic report, which

[111] Personal communication, a French social scientist specialised in citizen participation and deliberative democracy, September 16, 2008.

[112] Personal communication by a French political scientist, March 17, 2008.

rejected geological disposal as the only alternative, and suggested near-surface storage as a solution that would ensure ‘reversibility’. However, although the three nuclear-related debates were organised in parallel in order to ensure proper articulation between the interrelated topics, for many citizens the rationale behind this separation of the debates remained unclear (CNDP 2006 7). This arrangement was said to prevent broader discussions on French nuclear policy, which anti-nuclear groups posed as a primary condition for their participation (Lhomme 2006).

Broader impacts of the debates on deliberative democracy

CNDP debates do not provide advice or recommendations to policymakers. While this may seem to contradict the principles of deliberative democracy, it on the other hand reduces the risks of manipulation and strategic action. Furthermore, the debates influence policies indirectly: developers anticipate the issues likely to appear in the debates, and seek to justify their decisions with reference to the various views expressed during the CNDP debates.[113] The lack of direct policy influence can obviously also fuel cynicism and diminish citizens’ motivation to participate. The government’s declaration, prior to the CNDP debate, to launch the construction of an EPR in Flamanville, also undermined the waste debate (GC 2006, 61).

The French nuclear technocracy has been notorious for its lack of transparency (e.g. Gilbert and Bourdeaux 2006; Schneider 2008). Gradually, over the years, transparency has increased, thanks to the institutionalisation of “counter-expertise”; establishment of ‘‘Local Information Commissions’’ (CLIs) around nuclear installations; activities of ‘‘whistleblowers’’; and organisations such as OPECST and CNDP (Chateauraynaud and Torny 1999; Topçu 2006; 2008; Gadbois et al. 2007; Miserey 2007). CNDP constantly sought to even out the inherent asymmetries of power between participants. The “nuclear debates” may indeed have been more crucial for the status and credibility of CNDP than for nuclear sector policies: CNDP managed to gradually carve out for itself a niche amongst the state institutions, as a norm-setter and guardian of the principles of deliberative democracy (e.g. Chateauraynaud et al. 2005).

The overall judgement of the CNDP debates remains ambiguous. Despite their virtues, the debates demonstrated the constant difficulty of introducing in France true spaces for democratic discussion

[113] Personal communication, a French social scientist specialised in citizen participation and deliberative democracy, September 16, 2008.

on energy choices.

Event 4	The CNDP "nuclear debates" 2005-2006
Who was involved?	CNDP, the organiser of the debates EDF and Andra, as the developers Government ministries and ministers (industry, environment) Safety authorities and expertise organisations (IPSN, ASN) Anti-nuclear NGOs (national and local) Local authorities Citizens
When and where did it take place?	From September 2005 to March 2006, with meetings at various locations, but primarily at the planned sites of the installations (Flamanville and Meuse/Haute-Marne)
What type of process was it? How did this change over time?	Communication and consultation. CNDP debates offer to the developer the possibility to explain the project, but also for the public to express their views. Prior to the debate, CNDP collects written contributions from groups and individuals, following a strictly formalised four-page format, and publishes these at the beginning of the debate, together with the documentation produced by the developer. Chairman's conclusions and a summary of the debates are published at the end of the debate. Within three months following the debate, the developer must explain how the debate has been / will be taken into account in further decisions.
What rationale was given by the party that implemented the engagement?	CNDP debate is legally mandatory for projects exceeding a certain scale, and which are expected to have significant national/regional impacts.

3.6. Event 5: Reversibility and the opening up of high-level radioactive waste management (RWM) policy in France

Introduction and summary

France is one of the countries with the most advanced plans for deep geological disposal of high-level radioactive waste, and according to the current plans, the repository, situated in a remote village in the eastern part of the country is to become operational in 2025. Reversibility has been a cornerstone of France's radioactive waste management (RWM) policy since the 1990s.

The search for a suitable disposal site has been ongoing since the late 1970s, when – following a similar declaration by the OECD – the government announced deep geological disposal as the preferred option for RWM. However, like in many other countries, the site investigations conducted in the late 1980s generated vehement opposition, and citizens asked why their community should be chosen as “France’s nuclear wastebasket” (Barthe et al. 2010). This prompted the government to declare a one-year moratorium on the search of a site in 1990. In order to give the discussions on RWM a new start and to open up the debate to various stakeholders and options, the government entrusted a parliamentary commission[114], led by Christian Bataille, with the task of conducting extensive stakeholder consultations. Barthe (2006, 93-95) has described the moratorium and the subsequent opening up towards a more deliberative mode of governance as a logical conclusion in a situation in which debates on the technical RWM solutions had reached a dead end: as nothing remained to be decided at the technical level, social acceptance became the key issue. Within only a few months the problem was redefined as essentially political and societal rather than merely technical in nature (ibid). Parliament adopted a law on the management of radioactive waste in 1991 – the country’s first law on nuclear power. The “Bataille Law”[115] reopened the search for solutions by stipulating a 15-year period of R&D on three options: a) geological disposal – until then been seen as the only option, b) long-term near-surface storage, and c) partitioning and transmutation. The law inaugurated a more dialogical and participatory approach to RWM policy, and introduced the principle of **reversible** disposal. An Act on nuclear transparency and security was also enacted in 2006, notably creating an independent safety regulation agency (the National Agency for Nuclear Safety – ASN). Since 1998, reversibility has been the cornerstone of French RWM policy. It was confirmed in the 2006 “Planning Act”, enacted after a public consultation organised by CNDP in 2005-2006 (Event 4, section 3.5). The Act established reversible geological disposal as the reference option, but stipulated that, in parallel, research should continue on two other options. A new law adopted in July 2016 inscribed the definition and

[114] Office d’évaluation des choix scientifiques et technologiques, OPECST, composed of 20 parliamentarians, was created in 1983 to inform Parliament on scientific and technological choices. Another sign of attempts by the government to open up the hitherto highly closed and non-transparent decision making, especially in the area of nuclear energy, was the setting up of the College for the Prevention of Technological Risks in February 1989 (Barthe 2006, 101-102; Journé 2010).

[115] The law was named after the parliamentarian Christian Bataille, appointed to lead the extensive stakeholder consultations in preparation of the law.

conditions of reversibility in French legislation. An Act on nuclear transparency and security was also enacted in 2006, notably creating an independent safety regulation agency (the National Agency for Nuclear Safety – ASN).

Site selection

After the failure of the site investigations conducted in the late 1980s and the subsequent "reopening" of the RWM policy as stipulated in the Bataille Law, the government reintroduced an initiative in 1993 that searched for volunteer hosts for an underground research laboratory (URL). The following year, site investigations were launched in four of the thirty departments that expressed interest: Gard (clay formations), Vienne (granite), Meuse (clay), and Haute-Marne (clay). Local opposition movements emerged quickly, although most local politicians were in favour of the projects. In 1996, the sites of Meuse and Haute-Marne were merged to constitute the current site at Bure, a small village in the northeast of the country. In 1997, public inquiries on the creation of an URL were conducted on the three sites. For both scientific and political (local opposition) reasons, Gard and Vienne were eliminated, leaving Bure in 1998 as the only candidate. The construction of the URL started in 2000.

Gradually, over the course of the 2000s, Bure became the preferred location for the construction of a deep geological repository. The absence of alternatives and competing sites has been a central criticism from local citizens and politicians in and around Bure. The transformation from an URL to a repository site was further consolidated in 2005, when Andra concluded that Bure was "perfectly appropriate" to host such a facility, and chose an area of 250 km^2 for the construction.[116]

In 2009, Andra submitted its proposal to create a geological disposal facility, *Cigéo* (Centre industriel de stockage géologique). The initial area of 250 km^2 was then scaled down to about 100 km^2 in informal discussions with geologists,[117] and further down to 30 km^2 – after consultations with local stakeholders.[118] In March 2010, the government approved the proposal, subsequent to its examination by ASN, the National Assessment Board (CNE), and international experts. In May 2013, CNDP launched a mandatory public consultation on the Bure site, which, however, had to be

[116] This area is known as "zone de transposition".

[117] Thibaud Labalette, Andra, personal communication, 18 November 2013.

[118] "Zone d'intérêt pour la reconnaissance approfondie" (ZIRA).

fundamentally restructured because of obstruction by local opponents of Cigéo. The planned public hearings were cancelled and replaced by on-line expert debates, whereas a citizens' consensus conference was organised to "save the face" of the CNDP.

According to the timetable established in 2006, the construction of the repository was to begin in 2017 and be completed by 2025, when the installation would become operational. However, as one of the largest industrial projects ever to be undertaken in Europe, Cigéo faces considerable challenges, partly because it is located in a sparsely populated area without a tradition of nuclear power. Following the public consultations in 2013-14, the timetable was revised, and a decision was made to start the disposal with a five-year industrial pilot phase. Andra now plans to submit a construction licence in mid-2019, and to start construction work in 2022.

Local socioeconomic challenges

The fact that a nuclear "megaproject" of such a dimension should be carried out in a sparsely populated and economically declining region without a tradition of nuclear energy created specific socio-economic challenges (Lehtonen 2015). The disposal site is situated on the border between the departments of Meuse and Haute-Marne, each belonging to a different region – Meuse to Lorraine and Haute-Marne to Champagne-Ardenne. The underground and surface installations are situated on different sides of the border, largely for political reasons – to ensure that Cigéo benefits both departments equally. To help the local and departmental authorities prepare for the possible arrival of the project, economic support has been granted and an interdepartmental scheme for the development of the region prepared in consultation with the local stakeholders (SIDT 2013).

At the local level, Cigéo is expected to generate 1,300-2,300 direct jobs during the approximately seven-year construction period, and 600-1,000 over the 100 years of operation (SIDT 2013). In a region with a declining industry and a sparse, ageing, and relatively poorly trained population, such perspectives trigger great expectations. At the same time, various local stakeholders, citizens, and politicians evoke fears and concerns, such as excessive dependence on a single industry, rising living costs, loss of rural traditions and ways of life (e.g. hunting opportunities), insufficient ability of local businesses to harness the benefits from Cigéo, the risk of the region becoming seen as France's nuclear waste-basket, radiation risks, as well as disturbance and pollution caused by increasing transport volumes.

Year	Milestones in French high-level radioactive waste management (Source: Lehtonen 2015).
1978	Decision in favour of reprocessing: the planned sequence of RWM: vitrification – interim storage at La Hague – deep geological disposal.
1979	With the creation of Andra, geological disposal becomes institutionalised as the reference option.
1987-1990	Site investigations meet strong local opposition, and prompt the government to declare a one-year moratorium on site investigations.
1991	The country's first law on nuclear policy stipulates a 15-year period of research on three options: geological disposal, long-term near-surface storage, and transmutation and partitioning.
1994-1997	Site investigations initially at four sites.
1998	The government chooses Bure as the site for the Underground Research Laboratory. Government adopts *reversible* geological disposal as the reference option.
2005	Andra concludes on the suitability of Bure as a site for the repository.
2005-06	Public debate on the general options and orientations of the French radioactive waste management policy.
2006	A new law on radioactive waste management, the so-called Planning Act, mandates Andra to develop reversible geological disposal as the solution to HLW management.
2009	Proposal by Andra for the creation of a geological disposal facility at Bure, between two Departements (Meuse and Haute-Marne) and two regions (Lorraine and Champagne-Ardenne).
March 2010	Government validates the proposal, after consultation with the safety authority, the National Assessment Board, and local stakeholders.
May-Dec. 2013	Mandatory consultation, "public debate", on Cigéo. Opponents prevent two first public meetings from going ahead, and meetings are replaced by debate on the internet. Conclusions of the debate released on 15th February 2014.
Dec.2013 - February 2014	Organisation of a consensus conference on the Cigéo project, in response to the problems encountered in the public debate.
May 2014	Andra publishes the actions it intends to undertake in reaction to the public debate. These include an "industrial pilot phase" and a slight adjustment of the timetable, with the planned date for construction licence in 2020.
July 2016	An Act defining the conditions of reversibility is adopted.

Reversibility

Reversibility has played an increasingly central role in debates concerning nuclear waste management in France since the late 1980s. Until then, the country's "nuclear elite" considered irreversible disposal in deep geological repositories as the best and, de facto, the only option of waste management, an option institutionalised by the creation of a waste management agency, Andra,[119] in 1979 (Barthe 2006, 55-56). The proposed final disposal solution remained largely unchallenged, and the relevant authorities and industry experts saw it as a way to depoliticise waste management decision-making, turning RWM into a purely technical and scientific matter (Barthe 2009). Even some critics of nuclear power considered geological disposal as the most reasonable and rational solution. However, irreversibility – described as the impossibility to recover the waste packages – was a central component in the argumentation by environmental NGOs and local politicians opposed to geological disposal in the late 1980s (Cézanne-Bert and Chateauraynaud 2009, 61-63). They advocated instead interim near-surface storage on the nuclear sites. Apart from NIMBY[120] concerns, the opposition against disposal was framed much in terms of alternative notions of rationality, appropriateness of decisions in the context of uncertainty, and responsibility towards future generations. Opponents called into question the rationality of "burying something that is not completely dead" (Barthe 2006, 108) or evoked the argument of technical progress: future generations should not be deprived of the opportunities of more rational and economic manner that the likely future technological development would generate (Cézanne-Bert and Chateauraynaud 2009, 63). Burying wastes irreversibly would hence be simply "anti-scientific" (Barthe et al. 2010).

Institutionalisation of reversibility

In January 1990, a Socialist parliamentarian called for geological disposal to be made reversible (ibid.). The Bataille Law (1991) made reversibility into an element of the country's nuclear waste legislation, but only as a possibility, without clearly defining the term. In particular, the distinction

[119] Agence nationale pour la gestion des déchets radioactifs (Andra) was created within the Commissariat à l'énergie atomique (CEA).

[120] "Not-in-my-backyard."

between the technical retrievability and the reversibility of decisions remained unclear.[121] In rhetoric, "irreversible burial" gradually gave way in the 1990s to "reversible geological disposal,"[122] and reversibility gradually became a major theme in French RWM policy (Hoorelbeke 2008, 9). Yet, irreversible final disposal remained the reference option (Barthe 2006; Barthe et al. 2010). In December 1998, the government heeded the demands from civil society actors, confirming that the final disposal solution indeed must be reversible. It saw reversibility as a precondition for the public acceptability of the waste management option (Hoorelbeke 2008, 9-10; Barthe 2009), and stressed that importance of allowing future generations to benefit from future technological development, instead of being bound by decisions taken in the past (Gilbert and Bourdeaux 2006, 33-34).

Reversibility and retrievability

The French approach differs from the majority of the other OECD countries in that reversibility, instead of retrievability, is the central concept (e.g., OECD-NEA 2009a, 21). While the Bataille Law made reversibility a central concern for Andra (e.g., Andra 2010; Cézanne-Bert and Chateauraynaud 2009; 2010), the Planning Act of 2006[123] further distinguished between recoverability ("récupérabilité") and reversibility, the former denoting to the technical ability to recover waste, and the latter referring to the possibility of reversing decisions. Reversibility remains the umbrella term, covering both the technical and decision-making aspects.

Experts in RWM were all but enthusiastic about the requirement of reversibility, which they perceived as contrary to the logic of final disposal, and as such merely a "social and political constraint" to rational technical solutions (Gilbert and Bourdeaux 2006, 39-40). Like in many other countries, the proposed solution was the adoption of a phased disposal concept, consisting of progressive steps towards final irreversible geological disposal (Andra 2010, 36). Critics were quick

[121] Furthermore, the Law did not define clearly whether reversibility obliged the waste management authority to examine two altogether alternative disposal concepts or to consider reversibility as an early step in a process ultimately leading to irreversible disposal (Andra 2010, 35).

[122] "Reversible geological disposal" ("stockage géologique réversible") was introduced in the Law 1991, in parallel with irreversible disposal.

[123] Loi n°2006-739 du 28 juin 2006 de programme relative à la gestion durable des matières et déchets radioactifs: http://legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000000240700. Planning Act No. 2006-739 of 28 June 2006 Concerning the Sustainable Management of Radioactive Materials and Waste: http://www.andra.fr/download/andra-international-en/document/editions/305va.pdf

to point out that such a solution presented a number of weaknesses. In particular, it would progressively diminish the degree of reversibility, and would in fact impose on future generations a sudden shift from reversibility to irreversibility: once the last stage of the process would be reached, a one-off decision to close the site would be unavoidable (Barthe 2009; Cézanne-Bert and Chateauraynaud 2009). An alternative notion was formulated by a sociologist Yannick Barthe, in 2001, at a conference organised by the CLIS of Bure. Interim storage would become the reference option, which would require continuous exploration of alternative waste management options, given that the confinement of the waste packages would in any case need to be periodically checked approximately every 100 years (Cézanne-Bert and Chateauraynaud 2009, 84; Gilbert and Bourdereaux 2006, 37-38).

The "Planning Act" of 2006 further clarified the terms of reversibility, but did not fully satisfy critics, since long-term near-surface storage was relegated to a secondary position. The new Act consolidated the position of reversibility as a central concern in the national RWM policy, distinguished between the technical and decision-making versions of the concept, and gave Parliament a key role in decision-making. In their analysis of the debates on reversibility, Cézanne-Bert and Chateauraynaud (2009, 44) observed that in practice, the debate on R&R still attracted little media attention, and remained predominantly a technical issue, kept on the agenda essentially by Andra's engineers and local members of the CLIS of Bure. Both CLIS and the elected General Councils of the two host regions have set reversibility as a primary condition for a repository, but accept reversibility only as a temporary solution (OECD-NEA 2009b). While the demand for reversibility came from the civil society, the opponents to geological disposal and nuclear energy now saw the topic essentially as an attempt by the nuclear lobby to gain "social acceptance" for geological disposal and for the continued reliance on nuclear energy (Cézanne-Bert and Chateauraynaud 2009, 4). The Planning Act of 2006 nevertheless made reversibility into a key theme of the CNDP debate in 2013.

Reversibility post-CNDP 2013

The Planning Act of 2006 stipulated that a new parliamentary debate concerning the principle of reversibility should be conducted in 2015. However, several attempts were made to bypass this requirement and legislate on reversibility in an accelerated process. The government and certain parliamentarians sought to insert an article concerning reversibility in two legislative Acts in 2014-2015 – one on energy transition and another on relaunching of economic growth and activity (the "Macron Law"). A Senate representative from the Department of Meuse, Gérard Longuet, indeed managed to slip in an article on reversibility in the latter law, at a session held at 5 am on 28 April, in the presence of only about thirty parliamentarians (Chauveau 2015). The Constitutional Court finally invalidated this amendment, judging that it had nothing to do with the general objectives of the Macron Law. Together with his colleague from Haute-Marne, Christian Namy, Longuet managed to get their Bill on reversibility accepted, which was adopted by Parliament on July 11th 2016, and then enacted as a law on 26 July.[124] It defines reversibility as the ability, for the future generations, to either construct and then operate a disposal facility through successive phases, or to review earlier choices and modify the management solutions.[125] It also includes the possibility to retrieve the waste packages according to the dispositions and during a period that are in line with the strategy of operation and closure of the facility. The law also foresees periodic reassessment of the project every five years. Disposal must remain reversible for at least 100 years, but a new law – in association with the construction licence process – will be needed to define the length of the reversibility period.

Reversibility as a means of 'opening up' or 'closing up'?

By reopening the research of alternatives to long-term geological disposal of long-term radioactive material, the Bataille Law triggered a process of opening up, with far-reaching consequences for nuclear policy and decision-making in France. Reversibility has since then been a key element of this opening up, and constituted a part of the response to the crisis encountered in 1980s. The Bataille Law introduced new participants into the debate, increased the complexity and

[124] https://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000032932790&dateTexte=&categorieLien=id

[125] "La réversibilité est la capacité, pour les générations successives, soit de poursuivre la construction puis l'exploitation des tranches successives d'un stockage, soit de réévaluer les choix définis antérieurement et de faire évoluer les solutions de gestion."

unpredictability of decision-making, and changed the role of expertise in the process (e.g. by bringing in academic social scientists from CNRS). The role of the expert became one of providing information for further exploration of different possibilities rather than for a pre-defined policy decision (Barthe 2006). Instead of 'hard decisions having to be made on the basis of soft facts' (Funtowicz and Ravetz 1994), the challenge in many cases seems to be how to render a decision 'softer' through active 'non-decision making' (Barthe 2006, 214).

While reversibility was elemental in this opening up, its consequences reached further: the CNDP debate in 2005-2006 helped the organisation to gain credibility and independent image notably among the NGOs (e.g., Chateauraynaud et al. 2005),[126] while the opening up of RWM policy also allowed OPECST to reinforce its authority in parliamentary scrutiny on science and technology choices (Parotte 2016). Both CNDP and OPECST have been central in the French RWM policy, characterised by successive and mandatory public consultations and expert reviews, conducted by actors independent of the waste management organisation, Andra.

However, as the recent attempts by local politicians to push through decisions on reversibility through the backdoor illustrate, the "reversibilisation" and opening up always remains temporary and vulnerable to strategic and instrumental action, as dominant groups seek closure around their preferred option. Furthermore, both the opponents and defenders of geological disposal frequently claim that reversibility is merely a way to justify geological disposal (for an example of such views by an advocate of geological disposal, see Gibb 2004, 15). The expert-led and technocratic tradition of French nuclear policymaking has certainly not disappeared, yet in the light of this technocratic tradition the recent changes in both legislation and the relationships between the state and civil society in France (e.g., McCauley 2007; Saurugger 2007) appear as significant signs of "opening up." At regular intervals, decisions need to be taken, alternative options closed down, and some participants excluded from decision-making. Such individual moments of closure can either lead to progressive narrowing down of options and convergence towards an ineluctable final decision, or they can instead be precursors to subsequent and periodic moments of "opening up" and reappraisal. Seen in this light, the current situation in the French RWM policy is probably closest to an intermediate model of "technical reversibility" (Barthe et al. 2010): a staged process whereby

[126] Personal communication, a French social scientist specialised in citizen participation and deliberative democracy, September 16, 2008.

political decisions progressively lead towards final geological disposal, with reversibility as an interim solution on the path towards such irreversibilisation (e.g. Andra 2008, 20; MEEDM/ASN 2010). While significant opening up has taken place since the late 1980s, Parotte (2016) underlines its limits, and suggests the notion of “closing up” to describe a process whereby geological disposal remains the reference option, but only provided that the condition of reversibility is complied with. The specific conditions for reversibility have the double function of legitimising the reduction of the range of options on the agenda, while at the same time ensuring that a negotiation space is maintained concerning future phases of implementation. While this reduction of the possibilities remains partial, it nevertheless does not fully define which elements in the political commitments already made still remain open for negotiation. Finally, if CNDP and OPECST have indeed played a prominent role in the opening up of the RWM policy debate, both have seen their influence decline as the project has advanced towards implementation and techno-economic considerations have taken precedence. The largely failed public debate in 2013 has served to marginalise CNDP, but also provided an opportunity for innovation and renewal.

Event 5	Radioactive waste management policy and reversibility
Who was involved?	Andra (responsible for implementing the disposal project); Directorate General for Energy and Climate – DGEC –the Ministry responsible for energy (responsible for RWM policy); EDF, Areva, CEA (waste producers); OPECST (parliamentary scrutiny); CNDP (organisation of public consultations); CLIS and ANCCLI (mediators between local stakeholders); CNE – National Assessment Board, ASN, IRSN, CHN, independent experts, National Court of Auditors, (evaluators and monitoring bodies); HCTISN (facilitator of stakeholder consultation); the pilot group of the interdepartmental land use development plan; GIP Meuse & GIP Haute-Marne (multistakeholder bodies established to manage the use of economic support funding at the municipal and departmental levels); local politicians; NGOs opposed to the disposal project (EODRA, StopBure!, Villesurterre, Réseau Sortir du nucléaire,...)
When and where did it take place?	From the opening up and enhanced dialogue in RWM policy since 1990 until today.
What type of process was it? How did this change over time?	From mere communication prevailing until 1990, to an increasing degree of consultation and pluralist expertise (the various commissions and OPECST in the 1990s), and to some extent more genuine participation (CNDP debates, citizens’ consensus conference 2014)

4. Facts & Figures

The purpose of this section is to give an overview of nuclear power in France. This section contains such data as number of reactors, reactors' locations, technical and chronological details of reactors' construction as well as statistics on electricity production, periodization and social connections to nuclear constructions. This data can be used as a supportive material to the following sections of the country report and in order to understand the overall country's situation. Key dates and abbreviations used in this report are presented in the beginning of this section.

4.1. Data summary

- There are 19 nuclear power sites in France (in total 24);
- About 75% of electricity production in France comes from nuclear energy;
- Nuclear electricity is generated at low cost, given that practically all investment costs have been amortised, yet the life-extensions and back-end costs (decommissioning, waste management) are pushing costs up;
- France is the largest electricity exporter in the world (more than €3 billion annual revenue), and a significant exporter of nuclear technology and know-how;
- France is building a new generation nuclear power reactor (generation **III**);
- There are plans to reduce the share of nuclear energy from the current 75% to 50% to 2025;
- Estimates vary widely concerning the share of spent fuel that is recycled. Part of the plutonium – which constitutes about 1% of spent fuel – is reprocessed into MOX fuel, yet only a third of French reactors can use MOX. Of the 95% of spent fuel consisting of uranium, about 10% is in principle recoverable, but France does not possess the technology needed to do so.

4.2. Periodization

French nuclear developments can be divided into ten periods:

1. 1945-1951 – Post-war nuclear technocracy
2. 1952-1959 – Launching of the civilian nuclear programme
3. 1959-1965 – The second nuclear programme
4. 1966-1973 – “War of the systems”, and the adoption of the PWR technology
5. 1974-1979 – Launching of the “all-nuclear” policy (the Messmer Plan)
6. 1979-1986 – Three Mile Island and the first openings of the nuclear technocracy
7. 1986-1997 – The beginning of mistrust and doubt: from Chernobyl to the closure of Superphénix fast breeder industrial prototype reactor
8. 1998-2003 – Electricity-market liberalisation and the resurgence of radical anti-nuclear protest
9. 2003-2009 – Pushing for a French-led nuclear renaissance; attempts to democratise energy and nuclear policy
10. 2010 – Crisis and the end of the French-led nuclear renaissance

4.3. Key dates and abbreviations

Key dates are highlighted in bold:

1945	**Creation of CEA** (Commissariat à l’énergie atomique), 18 October
1946	**Creation of EDF** (Electricité de la France et Gaz de France), on 8 April, by a law on nationalisation, which unites private companies within one and a single electricity and gas company.
1948	The first French uranium deposits discovered at Crouzille, Limousin. **Entry into operation of the first French reactor, Zoé**.
1949	Creation of the first large national nuclear research centre managed by CEA.
1950	Conception of gas-graphite reactors capable of providing plutonium for the construction of an atomic bomb. The “Mouvement pour la paix” (movement for peace) launches the “Stockholm Appeal” against the use of nuclear weapons, with the then High-Commissioner of CEA, Frédéric Joliot-Curie, as its first signatory. Joliot-Curie is removed from office a few months later.
1952	**The first plan for the development of nuclear power (1952-1957)**
1954	**The launching of the French military nuclear programme**.
1955	**Creation of the Commission consultative pour la production d’électricité d’origine nucléaire – PEON (Consultative commission for the production of nuclear electricity).** Creation of the centre for plutonium production at Marcoule

1958	Creation of the Framatome company, as a merger of the companies Schneider, Merlin-Gerin and Westinghouse.
1959	The first plutonium ingots produced in France.
1960	Limitation on the civil responsibility of nuclear operators in case of an accident. CEA experiments on the immersion of radioactive waste in sea.
1962	Creation of the Association Contre le Danger Radiologique – ACDR (Association against radiological dangers).
1963	**Creation of the Mouvement Contre l'Arme Atomique – MCAA (Movement against the atomic weapons).**
1964	On the recommendation of PEON commission, a Council of ministers prepares for the construction of one 500 MW graphite-gas reactor per year.
1965	The second five-year nuclear plan is launched.
1966	L'ACDR is transformed into the Association pour la protection contre les rayonnements ionisants – APRI (Association for the protection against ionising radiation).
1968	Student revolts in May. The MCAA becomes the Mouvement pour le Désarmement, la Paix et la Liberté (MPDL) Accident at the Chooz power plant.
1969	Accident at the Saint-Laurent-des-Eaux plant. Georges Pompidou becomes president of the Republic, and nominates Jacques Chaban-Delmas as Prime Minister. **The choice in favour of Westinghouse PWR technology, and the abandonment of the national gas-graphite technology.** Creation of the interim waste storage site, CSM, at La Hague. Development of the technology for vitrification of radioactive waste at Marcoule.
1971	**First mass demonstrations against nuclear power:** 1,500 people protest against the reactor in Fessenheim (Alsace) and 15,000 at Bugey (Ain). Creation of Friends of the Earth (Amis de la Terre) in France. The "Menton message": 2,200 scientists from several countries – primarily biologists and economists – sign a petition in Menton, France, warning about the dangers of nuclear.
1972	**Restructuration and consolidation of French nuclear industry: private capital, public-private partnerships, consortia between French and foreign enterprises**. Creation of the international uranium enrichment company, EURODIF.
1973	The first oil shock. **Creation of safety organisations: Service central de sûreté des installations nucléaires (SCSIN) and Conseil supérieur de la sûreté nucléaire (CSSN)** Creation of the French society for nuclear energy (Société française pour l'énergie nucléaire – SFEN).
1974	**Launching of the massive nuclear programme, named after the then Premier Minister, Pierre Messmer. The Messmer Plan foresees the construction of thirteen 1,000 MW reactors.**

The death of the President Pompidou on 3rd March; Valéry Giscard d'Estaing becomes President on 2nd April.
Transfer to France of the Westinghouse licence for the construction of PWRs in France marks the beginning of the "Frenchification" of the technology.
Creation of a working group responsible for exploring the technical options for nuclear waste (OGD), to work on two research orientations: deep geological disposal and transmutation.

1975 **Eighteen nuclear steam-generating systems ordered from the national constructor Framatome.**
Brief debate on the nuclear programme in Parliament.
Controversies over the siting of reactors.
Creation of the Conseil de la politique nucléaire extérieure.
Giscard d'Estaing decides to continue the execution of Messmer Plan, with the intention to construct some 50 reactors of 900-1,300 MW – a total capacity of 50,000 MW – by 1985.
At Fessenheim, 15,000 demonstrators rally against nuclear power.
In August, a demonstration against the plant in Blayais.
The "Appeal of the 400" and the creation of the counter-expertise organisation Groupement de Scientifiques pour l'Information sur l'Energie Nucléaire (GSIEN).

1976 Creation of COGEMA (Compagnie générale des matières nucléaires).
Mass demonstrations against the planned Superphénix fast breeder industrial demonstration reactor at Creys-Malville.
Creation of the nuclear protection and safety organisation, IPSN (Institut de protection et de sûreté nucléaires) within CEA.

1977 Four demonstrations against planned nuclear power stations at Nogent, Gravelines, Paluel, and Golfech.
Mass demonstrations against Superphénix fast breeder reactor at Creys-Malville lead to violent confrontations between the police and the demonstrations, and to the death of one demonstrator.
The socialist party calls for a moratorium on the nuclear programme.
Creation (by President Giscard d'Estaing) of the Conseil de l'information nucléaire, chaired by Simone Veil.
CFDT labour union organises a conference for the confrontation of views on the programme.
Organisation in Paris of a conference on the "psycho-sociological implications of the development of a nuclear industry", by the French society for radioprotection and INSERM.

1978 Petition against the construction of a nuclear power plant at Golfech gets 3,000 signatures.
The "Geneva appeal", on 2nd October, is signed by 50,000 signatories across Europe.
The formation "Ecologie 78" presents candidates across the country in parliamentary elections.
The waste vitrification unit becomes operational at Marcoule.
Decision in favour of reprocessing, with the planned sequence for handling of

	the waste: vitrification – interim storage at La Hague – deep geological disposal.
1979	Three Mile Island accident in the USA, 28th March, rated at INES level 5. The interministerial committee on nuclear electricity authorises EDF to construct six 1,300 MW reactors and three 900 MW reactors in 1980-1981. In its first report, the nuclear information council (Conseil de l'information nucléaire) criticises the nuclear programme. **A nuclear waste management agency, Andra, is created within CEA; geological disposal hence becomes institutionalised as the reference option.**
1980	The government accelerates the nuclear programme: twelve new reactors are ordered. Accident at the Saint-Laurent-des-Eaux reactor. National petition calling for democratic debate on energy policy is signed by more than 500,000 persons. Failure to create a surface storage waste storage facility at the Bois-Noirs site, in Loire. Creation of the anti-nuclear organisation, **CRILAN,** in reaction to the construction of two reactors in Flamanville (Manche), development of the La Hague reprocessing plant, the Manche waste storage site (Centre de Stockage Manche) and the military nuclear installation "Arsenal de Cherbourg".
1981	Entry in power of the socialist government of François Mitterrand. Parliamentary debate on energy policy. **The plan to construct a reactor at Plogoff, Brittany, is abandoned**. Slight deceleration of the programme of reactor orders. Accident at the La Hague reprocessing plant. Demonstration organised by the Friends of the Earth calls for the closure of La Hague reprocessing plant, and opposes the construction of a reactor at Braud-et-Saint-Louis. **Establishment of the multi-stakeholder Castaing commission to examine nuclear waste policy options.** **Beginning of a gradual dispersion and weakening of the anti-nuclear movement**.
1983	International protest demonstration at La Hague. Creation of WISE-Paris, a counter-expertise organisation with the aim to provide information and documentation on nuclear and energy issues. Creation, at CEA, of a unit for R&D on nuclear waste management – Département de recherche et de développement sur les déchets (DRDD). Site investigations in view of deep geological disposal of waste.
1984-1985	**The last phase of Generation II reactor orders (except for Civaux, 1988-1991). The end of orders within the national borders.**
1985	Creation at the Ministry of Industry of a working group (Commission Coguel) to establish criteria for the choice of a deep geological disposal site.
1986	**The revealed attempts to cover-up of the consequences of the Chernobyl accident in France lead to a rapid erosion of trust in governmental information on nuclear risks and safety.** Creation of a Groupe permanent d'experts sur les déchets radioactifs within DSIN (Direction de la sûreté des installations nucléaires)

	Creation of the counter-expertise organisations, ACRO and CRIIRAD.
1987	Pierre Delaporte replaces Marcel Boiteux, the director of EDF since 1967 (until 1979, Director General; then President). CSSN is transformed into the Conseil supérieur de la sûreté et de l'information nucléaire (CSSIN).
1987	Andra begins site investigations for the installation of an underground research laboratory for deep geological disposal.
1987-1990	**Waste disposal site investigations meet strong local opposition, and prompt the government to declare a one-year moratorium on site investigations.**
1988	François Mitterrand is elected for a second term as President of the Republic. The share of nuclear in the production and consumption of electricity in France reaches its peak at 88%.
1989	Accident at the Gravelines plant.
1990	Site investigations for deep geological disposal face vehement local opposition. Government declares a moratorium on nuclear waste management research. OPECST organises public consultations on the topic. First "Bataille report" is published at the end of the year.
1991	**The Bataille Law on nuclear waste management** stipulates a 15-year period of R&D on three management options: 1) deep geological disposal, 2) long-term near-surface storage, and 3) partitioning and transmutation. The Law also strengthens the status of Andra, making it a state agency independent of waste producers. Creation of CNE (Commission nationale d'évaluation), an organisation charged to annually assess the progress in R&D into radioactive waste management. SCSIN becomes Direction de la sûreté nucléaire (DSCIN).
1992	Creation of a mediation group, led by the parliamentarian, Christian Bataille, to investigate the options for establishing an underground waste research facility. Inauguration, at Soulaines (Aube), of a low-level radioactive waste storage site.
1993	France signs the London Convention banning the dumping of radioactive waste in sea.
1994	The Service central de protection contre les rayons ionisants (SCPRI) becomes the Office de protection contre les rayonnements ionisants (OPRI). The mediation group releases its report on waste disposal research sites, proposing four sites: Gard, Vienne, Haute-Marne, and Meuse.
1994-1997	Site investigations for high-level nuclear waste initially at four sites – the Meuse and Haute-Marne sites are soon merged to form but one site in Bure, a village at the border of the two departments.
1996	Publication of the "Bataille Report" on the advancement of research into the country's radioactive waste management options.
1997	Entry in the power of the left-green government of Lionel Jospin. Soon after taking office, Jospin announces the **closure of the Superphénix fast breeder reactor.** **Creation of the anti-nuclear NGO network, Réseau sortir du nucléaire**. The "affair" of radioactive leaks at La Hague.

	Creation, within CNRS, of a research programme on the back-end of the nuclear cycle. Public inquiries conducted at the three candidate sites for hosting a waste research laboratory.
1998	**The government chooses Bure (Meuse & Haute-Marne) as the site for the Underground Research Laboratory**. Government adopts *reversible* geological disposal as the reference option. Closure of Superphénix. CNE publishes a report on the question of reversibility of nuclear waste disposal. OPECST publishes the "Rapport Le Déaut" on transparency in the nuclear sector.
1999	**Incident at the Blayais station, 27-28 December, classified at level 2 on the INES scale.** A parliamentary debate on nuclear confirms the support to the continuation of French nuclear policy. Authorisation for the construction of an URL at Bure.
2000	**Charpin-Pellat-Dessus report: the first comprehensive and public analysis of the economics of the nuclear sector in France**.
2001	**The government creates the AREVA group**.
2002	**Creation of the safety unit within the government (Direction générale de la sûreté nucléaire et de la radioprotection – DGSNR) and an independent nuclear safety and radioprotection expert organisation (Institut nucléaire de radioprotection et de sûreté nucléaire – IRSN).**
2003	Public debate on the French energy strategy results in the publication of the "Besson report", leading to a White Paper on energy. The industry minister, Nicole Fontaine, declares her support in favour of the construction of an EPR. T**he Finnish company, TVO, orders an EPR from Areva-Siemens**.
2004	Parliamentary debate on the EPR in April. Flamanville chosen as the site in October.
2005	**Andra concludes on the suitability of Bure as a site for the waste repository**. **International decision to site the ITER experimental fusion reactor in Cadarache, France.** Areva begins the construction of the Olkiluoto 3 EPR in Finland. EDF orders an EPR reactor to be built in Flamanville, La Manche.
2005-06	**Thee "nuclear debates" (public consultations organised by CNDP**) on: 1) the construction of an EPR reactor at Flamanville, 2) the general options and orientations of the French radioactive waste management policy; and 3) construction of a high-voltage transmission line to connect Flamanville EPR to the national grid.
2006	**A new law on radioactive waste management, the so-called Planning Act**, mandates Andra to develop reversible geological disposal as the solution to HLW management. **The law on transparency and safety in the nuclear sector creates ASN as a fully independent safety authority**.

2007 **EDF starts the construction of the Flamanville EPR** in December.

2008 Accidents at the Chinon and Tricastin plants.

2009 Proposal by Andra for the creation of a geological disposal facility at Bure, between two Departments (Meuse and Haute-Marne) and two regions (Lorraine and Champagne-Ardenne).
The French "national" consortium (Areva, EDF, GDF Suez, Vinci, Alstom) loses to the South-Korean Kepco the bid to construct a reactor in Abu-Dhabi.

2010 **Government validates Andra's proposal to construct a deep geological repository at Bure, project Cigéo**, after consultation with the safety authority, the National Assessment Board, and local stakeholders.
"Roussely report" on the reorganisation of the French nuclear industry.

2011 Fukushima accident, 11 March.
Accident at the nuclear installation Centraco, near the Marcoule site.
Additional evaluation report (September), prepared by EDF, on the safety of Blayais and Saint-Laurent-des-Eaux, in response to the Fukushima accident.

2012 ASN releases, on 3rd January, its report on the safety evaluations conducted in reaction to the Fukushima accident. In June, ASN publishes 36 additional decisions concerning the installations of EDF, CEA and AREVA.
Report of the National Court of Auditors (Cour des Comptes) on the costs of the nuclear sector.
President Hollande takes office and confirms his electoral promise of reducing the share of nuclear in French electricity supply from the present 75% to 50% by around 2025. Hollande also reaffirms his intention to shut down the Fessenheim plant (Alsace) by the end of 2016.

2013 May-December: **mandatory consultation, "public debate", on Cigéo, the nuclear waste repository project. Opponents prevent two first public meetings from going ahead, and meetings are replaced by debate on the internet.**
To "save the face" of CNDP after the failed public debate, a consensus conference on the Cigéo project is launched in December.

2014 **The consensus conference on Cigéo** proves relatively successful, and ends in February.
Conclusions of the CNDP public debate on Cigéo released on 15th February 2014.
Andra publishes the actions it intends to undertake in reaction to the public debate. These include an "industrial pilot phase" and a slight adjustment of the timetable, with the planned date for construction licence in 2020.
Parliamentary commission discusses the costs of the nuclear sector.

2015 Law on energy transition confirms the objective to reduce the share of nuclear in electricity supply to 50% by 2025

2017 Environment minister Nicolas Hulot announces, on 7th November, that the target date for reducing the share of nuclear in electricity supply will have to be postponed.

Abbreviations:

ACDR	Association Contre le Danger Radiologique (until 1966)
ACRO	Association pour le contrôle de la radioactivité à l'ouest
AFMT	Association française des maladies de la thyroïde
ANDRA	Agence nationale pour la gestion des déchets radioactifs
APRI	Association pour la protection contre les rayonnements ionisants (Association for the protection against ionising radiation); until 1966 ACDR.
ASN	Agence de sûreté nucléaire
ASTRID	Advanced sodium technological reactors for industrial demonstration
BWR	Boiling Water Reactor
CEA	Commissariat à l'énergie atomique et aux énergies alternatives (French Alternative Energies and Atomic Energy Commission)
CCPAH	Comité contre la pollution atomique dans La Hague
CENS	Centre d'études nucléaires de Saclay
CEPN	Centre d'études sur l'évaluation de la protection dans le domaine nucléaire
CFDT	Confédération française démocratique du travail
CGC	Confédération générale des cadres
CGT	Confédération générale du travail
CIEE	Conseil de l'information sur l'énergie électronucléaire
Cigéo	Centre industriel de stockage géologique (Project for the construction of a deep geological repository for high- and medium-level waste at Bure)
CLI	Commission locale d'information
CNE	Commission nationale d'évaluation, an organisation charged to annually assess the progress in R&D into radioactive waste management
CNDP	Commission nationale du débat public
CNRS	Centre national de recherche scientifique
CODIRPA	Comité directeur pour la gestion de la phase post-accidentelle d'un accident nucléaire ou d'une situation d'urgence cardiologique
COGEMA	Compagnie générale des matières nucléaires
CPDP	Commission particulière du débat public
CRILAN	Comité de réflexion indépendante et de lutte antinucléaire ; an anti-nuclear organisation in the Nord-Cotentin region, established in 1980
CRIIRAD	Commission de recherche et d'information indépendantes sur la radioactivité
CRIN	Comité régional d'information nucléaire
CRN	Centre de recherches nucléaires
CSM	Centre de stockage de la Manche
CSPI	Commission spéciale permanente d'information près de l'établissement de La Hague
CSSN	Conseil supérieur de la sûreté nucléaire
CSSIN	Conseil supérieur de la sûreté et de l'information nucléaires
DSIN	Direction de la sûreté des installations nucléaires
DRDD	Département de recherche et de développement sur les déchets
EDF	Électricité de France S.A.
EPR	European Pressurised Reactor

EURODIF	European Gaseous Diffusion Uranium Enrichment Consortium
FBR	Fast breeder reactor
FO	Force ouvrière (labour union)
GDF Suez	Engie since 2015, multinational electric company from France
GRNC	Groupe Radioécologie Nord Cotentin
GSIEN	Groupement de Scientifiques pour l'Information sur l'Energie Nucléaire
IPN	Institut de physique nucléaire
IPSN	Institut de protection et de sûreté nucléaire
IRSN	Institut de radioprotection et de sûreté nucléaire
IN2P3	Institut national de physique nucléaire et de physique des particules
INSERM	Institut national de la santé et de la recherche médicale
ITER	International Thermonuclear Experimental Reactor
MCAA	Mouvement contre l'armement atomique (Movement against atomic weapons)
MOX	Mix of oxides of uranium and plutonium, designed for the fabrication of nuclear fuel
OGD	Groupe de travail sur les options techniques relatives à la gestion des déchets nucléaires
OPECST	Office parlementaire d'évaluation des choix scientifiques et technologiques
OPRI	Office de protection contre les rayonnements ionisants
PC	Parti communiste
PEON	Commission consultative pour la production d'électricité d'origine nucléaire (Consultative commission for the production of nuclear electricity)
PSU	Parti socialiste unifié
PWR	Pressurised Water Reactor
SCSIN	Service central de sûreté des installations nucléaires
SCPRI	Service central de protection contre les rayonnements ionisants
SFEN	Société française pour l'énergie nucléaire (French society for nuclear energy)
URL	Underground Research Laboratory (for deep geological disposal of radioactive waste)

4.4. Map of nuclear power plants

Figures below present locations of nuclear power plants in France.

Figure 1 – Nuclear power plants in France. Source: WNA 2016.

The following figure represents reactors in more details with their current state.

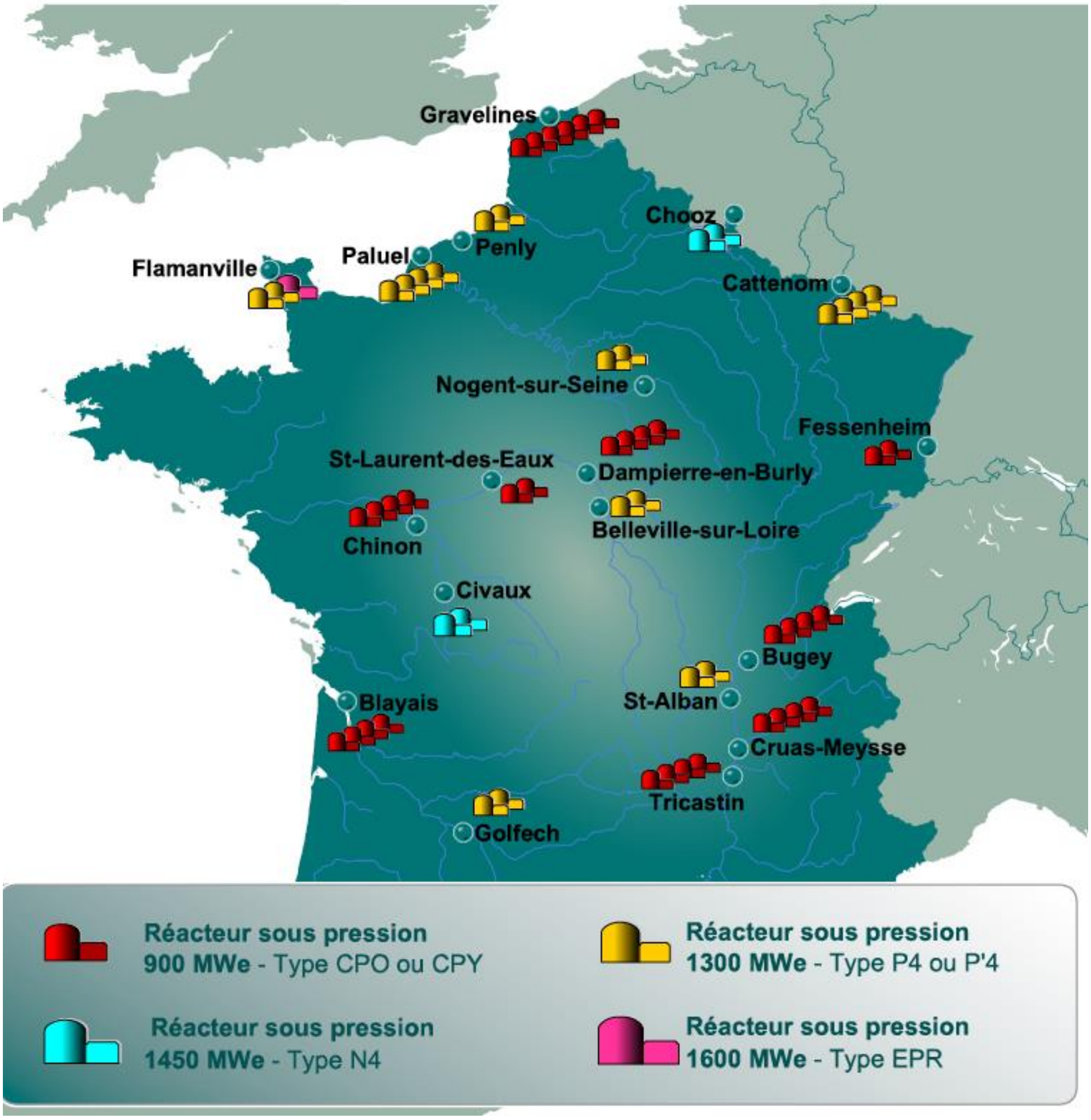

Figure 2 – Reactors in operation and under construction in France. Source: ASN 2016

Different colours of reactors represent reactors’ maximum capacities.

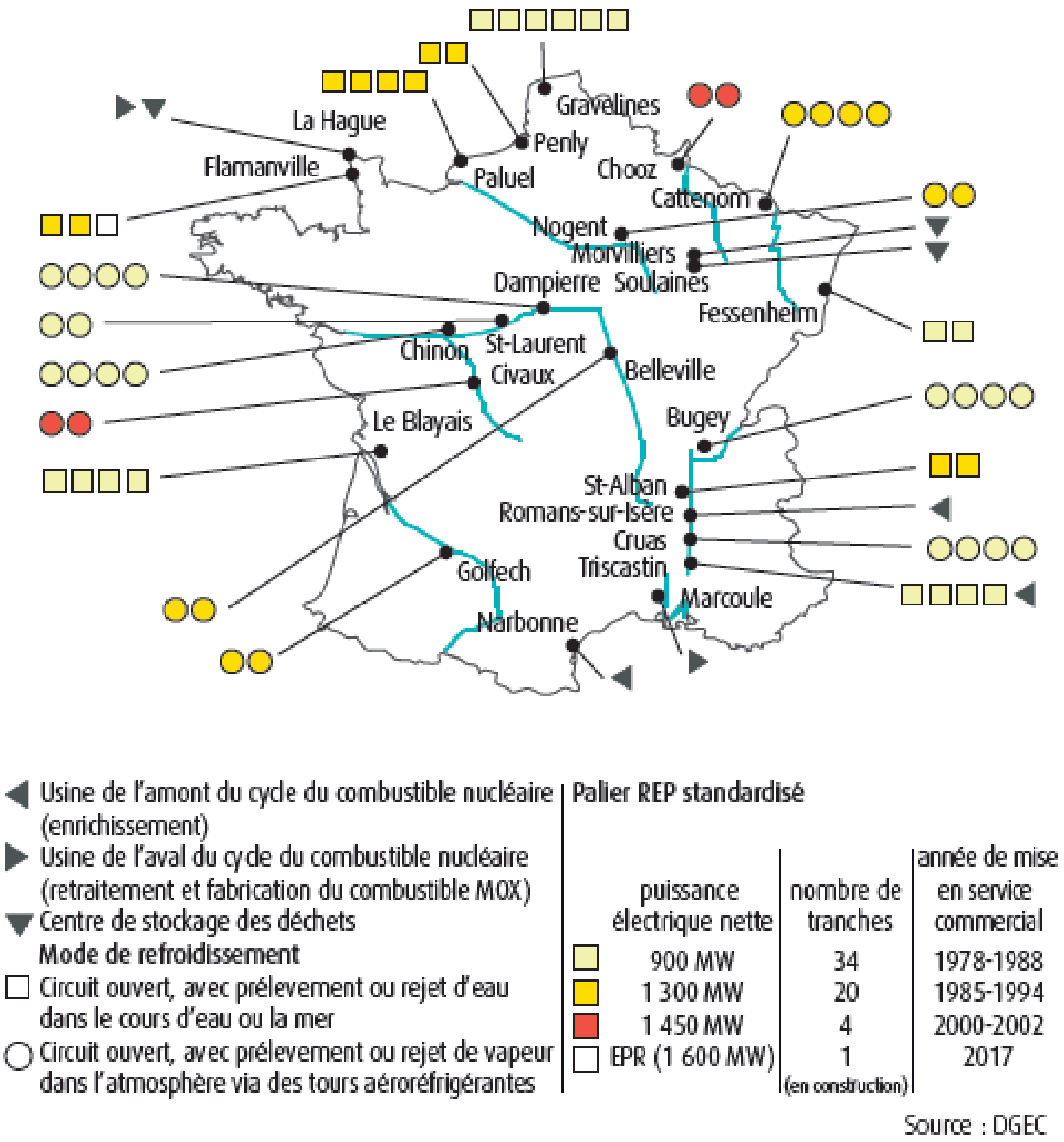

Figure 3 – French nuclear sites, 30 June 2015. Source: Ministry of the Environment. Chiffres clés de l’énergie, Edition 2015. P. 28.
http://www.developpement-durable.gouv.fr/Les-chiffres-cles-de-l-energie-en.html

4.5. List of reactors and technical and chronological details

Tables below represent summaries of nuclear reactors in France.

Table 1 – List of operating reactors in France. Sources: WNA 2016, IAEA 2016.

No	Name	Operator	Reactor supplier, generator supplier	Type	MWe net	Construction began	Operations started	Planned shutdown
1	**Belleville-1**	EDF	Framatome, Alstom	PWR	1310	1980	Jun-88	
2	**Belleville-2**	EDF	Framatome, Alstom	PWR	1310		Jan-89	
3	**Blayais-1**	EDF	Framatome, Alstom	PWR	910	1976	Dec-81	
4	**Blayais-2**	EDF	Framatome, Alstom	PWR	910		Feb-83	
5	**Blayais-3**	EDF	Framatome, Alstom	PWR	910		Nov-83	
6	**Blayais-4**	EDF	Framatome, Alstom	PWR	910		Oct-83	
7	**Bugey-2**	EDF	Framatome, Alstom	PWR	910	1972	Mar-79	2019
8	**Bugey-3**	EDF	Framatome, Alstom	PWR	910	1973	Mar-79	2019
9	**Bugey-4**	EDF	Framatome, Alstom	PWR	880	1974	Jul-79-Jan-80	2019
10	**Bugey-5**	EDF	Framatome, Alstom	PWR	880	1974	Jul-79-Jan-80	2020
11	**Cattenom-1**	EDF	Framatome, Alstom	PWR	1300	1979	Apr-87	
12	**Cattenom-2**	EDF	Framatome, Alstom	PWR	1300		Feb-88	
13	**Cattenom-3**	EDF	Framatome, Alstom	PWR	1300		Feb-91	
14	**Cattenom-4**	EDF	Framatome, Alstom	PWR	1300		Jan-92	

15	**Chinon-B1**	EDF	Framatome, Alstom	PWR	905	1977	Feb-84	2024
16	**Chinon-B2**	EDF	Framatome, Alstom	PWR	905	1977	Aug-84	2024
17	**Chinon-B3**	EDF	Framatome, Alstom	PWR	905	1980	Mar-1987	2027
18	**Chinon-B4**	EDF	Framatome, Alstom	PWR	905	1981	Apr-1988	2028
19	**Chooz-B1**	EDF	Framatome, Alstom	PWR	1500	1984	Dec-96	
20	**Chooz-B2**	EDF	Framatome, Alstom	PWR	1500	1985	1999	
21	**Civaux-1**	EDF	Framatome, Alstom	PWR	1495	1988	1999	
22	**Civaux-2**	EDF	Framatome, Alstom	PWR	1495		2000	
23	**Cruas-1**	EDF	Framatome, Alstom	PWR	915	1978	Apr-84	
24	**Cruas-2**	EDF	Framatome, Alstom	PWR	915		Apr-85	
25	**Cruas-3**	EDF	Framatome, Alstom	PWR	915		Sep-84	
26	**Cruas-4**	EDF	Framatome, Alstom	PWR	915		Feb-85	
27	**Dampierre-1**	EDF	Framatome, Alstom	PWR	890	1974	Sep-80	
28	**Dampierre-2**	EDF	Framatome, Alstom	PWR	890		Feb-81	
29	**Dampierre-3**	EDF	Framatome, Alstom	PWR	890		May-81	
30	**Dampierre-4**	EDF	Framatome, Alstom	PWR	890		Nov-81	
31	**Fessenheim-1**	EDF	Framatome, Alstom	PWR	880	1970	Dec-77	2016
32	**Fessenheim-2**	EDF	Framatome, Alstom	PWR	880		Mar-78	2016

33	**Flamanville-1**	EDF	Framatome, Alstom	EPR (PWR3)	1330	1979	Dec-86	
34	**Flamanville-2**	EDF	Framatome, Alstom	PWR	1330		Mar-87	
35	**Golfech-1**	EDF	Framatome, Alstom	PWR	1310	1982	Feb-91	
36	**Golfech-2**	EDF	Framatome, Alstom	PWR	1310		Mar-94	
37	**Gravelines-B1**	EDF	Framatome, Alstom	PWR	910	1974	Nov-80	
38	**Gravelines-B2**	EDF	Framatome, Alstom	PWR	910		Dec-80	
39	**Gravelines-B3**	EDF	Framatome, Alstom	PWR	910		Jun-81	
40	**Gravelines-B4**	EDF	Framatome, Alstom	PWR	910		Oct-81	
41	**Gravelines-C5**	EDF	Framatome, Alstom	PWR	910		Jan-85	
42	**Gravelines-C6**	EDF	Framatome, Alstom	PWR	910		Oct-85	
43	**Nogent s/Seine-1**	EDF	Framatome, Alstom	PWR	1310	1981	Feb-88	
44	**Nogent s/Seine-2**		Framatome, Alstom	PWR	1310		May-89	
45	**Paluel-1**	EDF	Framatome, Alstom	PWR	1330	1977	Dec-85	2025
46	**Paluel-2**		Framatome, Alstom	PWR	1330	1978	Dec-85	2025
47	**Paluel-3**		Framatome, Alstom	PWR	1330	1979	Feb-86	2026
48	**Paluel-4**		Framatome, Alstom	PWR	1330	1980	Jun-86	2026
49	**Penly-1**	EDF	Framatome, Alstom	PWR	1330	1982	Dec-90	
50	**Penly-2**		Framatome, Alstom	PWR	1330		Nov-92	

51	**Saint-Alban-1**	EDF	Framatome, Alstom	PWR	1335	1979	May-86
52	**Saint-Alban-2**		Framatome, Alstom	PWR	1335	1979	Mar-87
53	**Saint-Laurent-B1**		Framatome, Alstom	PWR	915		Aug-83
54	**Saint-Laurent-B2**		Framatome, Alstom	PWR	915		Aug-83
55	**Tricastin-1**	**EDF**	Framatome, Alstom	PWR	915	1974	Dec-80
56	**Tricastin-2**		Framatome, Alstom	PWR	915		Dec-80
57	**Tricastin-3**		Framatome, Alstom	PWR	915		May-81
58	**Tricastin-4**		Framatome, Alstom	PWR	915		Nov-81

The next table shows reactors that are no longer in operation.

Table 2 – List of shut down reactors. Sources: WNA 2016, IAEA 2016

No	Site name	Use	Operator	Reactor supplier, generator supplier	Type	MWe net	Construction began	Operations started	Shutdown
1	**Brennilis**	Experimental heavy water	CEA, EDF		GCHWR	70	1967	1967	1985
2	**Bugey-1**		EDF	many, Rateau, Jeumont-Schneider	UNGG/ GCR	540	1965	1972	1994
3	**Celestin 1**	Tritium breeder				130		1967	2009
4	**Celestin 2**	Tritium breeder						1968	2009
5	**Chinon-A1**		EDF	Framatome, Alstom	UNGG/ GCR	70	1957	1963	1973

6	**Chinon-A2**		EDF	Framatome, Alstom	UNGG/GCR	200	1959	1965	1985
7	**Chinon-A3**		EDF	Framatome, Alstom	UNGG/GCR	480	1961	1966	1990
8	**Chooz-A**		EDF, SENA (Belgium)	Westinghouse	PWR	300	1962	1967	1991
9	**Marcoule-G1**	Plutonium production		SACM, Rateau	UNGG/GCR	2	1955	1956	1968
10	**Marcoule-G2***	Plutonium production			UNGG/GCR	40	1955	1959	1980
11	**Marcoule-G3**	Plutonium production			UNGG/GCR	40	1956	1960	1984
12	**Phénix**		CEA, EDF	CEM	FBR	233	1968	1973	2009
13	**Saint-Laurent-A1**		EDF	Framatome, Alstom	UNGG/GCR	480	1963	1969	1990
14	**Saint-Laurent-A2**			Framatome, Alstom	UNGG/GCR	515		1971	1992
15	**Superphénix (Creys-Malville)**		NERSA, EDF, ENEL, SBK	Novatome, Ansaldo	FBR	1240	1976	1986	1997

*Marcoule G2 reactor was fully dismantled from its place.

One nuclear reactor is under construction – Flamanville-3 EPR. The advanced plans to build another EPR were put on hold soon after the Fukushima accident (Table 3).

Table 3 – Planned reactors in France

Name	Use	Operator	Reactor supplier, generator supplier	Type	MWe net	Construction began	Operations started
Flamanville-3	Commercial	EDF	Areva (former Framatome), Alstom	EPR	1750	July 2007	2018-19
Penly-3		EDF, GDF	Framatome, Alstom	EPR	1750	cancelled	

A mandatory public consultation on the construction of an EPR reactor at Penly was conducted in 2010. However, the plans were put on hold soon after the Fukushima accident, and the statutory public inquiry was postponed until further notice. In 2012, the government announced about construction and connection to the grid in 2017. However, GDF Suez, a major proponent of the project, withdrew its participation and EDF cancelled the construction.

4.6. Data on electricity production, consumption and demand forecast

Basic data on the French electricity sector, at the end of 2015 (IAEA 2016, 10):

- Total nuclear capacity: 63 130 MW(e);
- Nuclear electricity supplied: 419.0 TWh;
- Share of nuclear in total electricity supply: 76.3%;
- Total accumulated number of years of operational experience: 2048 years (the second-highest in the world, after the USA, and before Japan).

Source: IAAEA (2016,10).

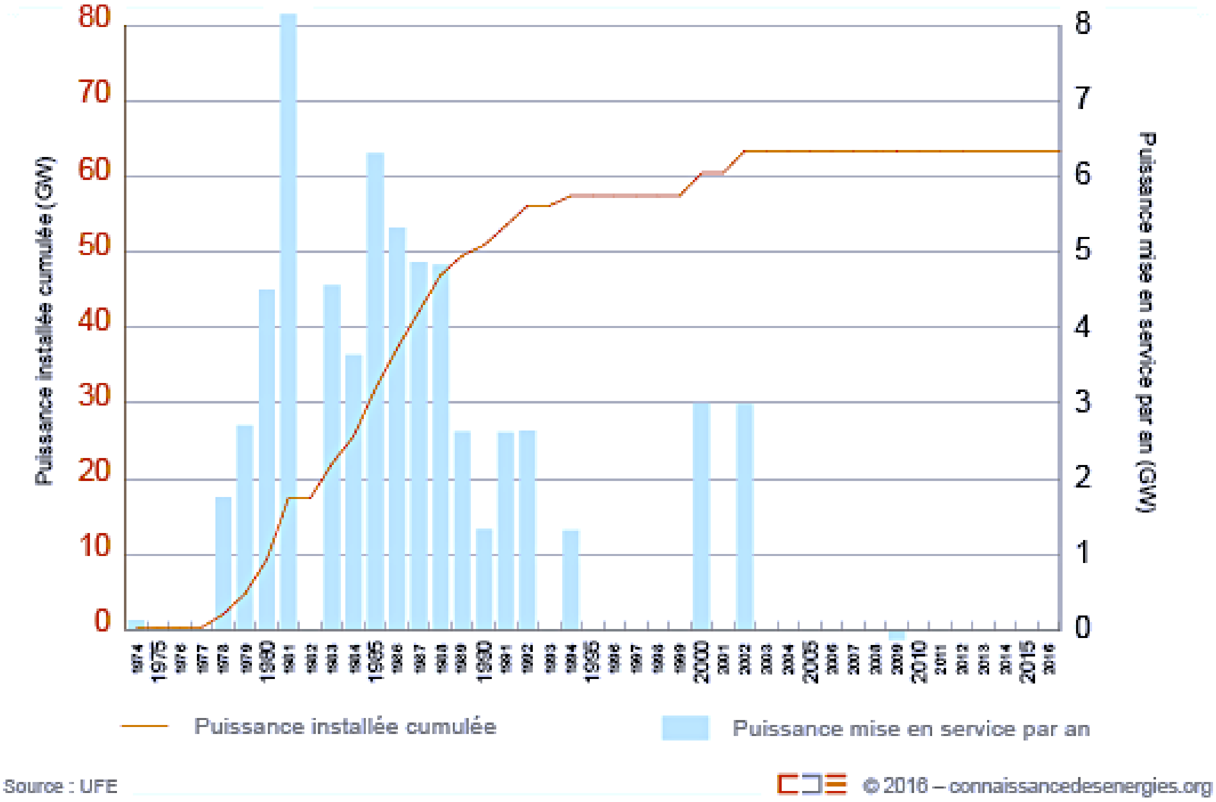

Figure 4 – Installed nuclear capacity in 1974-2016: cumulated (the discontinuous line, in GW on the last-hand y-axis), and installed capacity per year (the blue bars, in GW on the right-hand y-axis),

Energy production

While nuclear represents about 75% of total electricity generation in France, its share of the total primary energy supply is “only” just over 40% - still among the highest in the world.

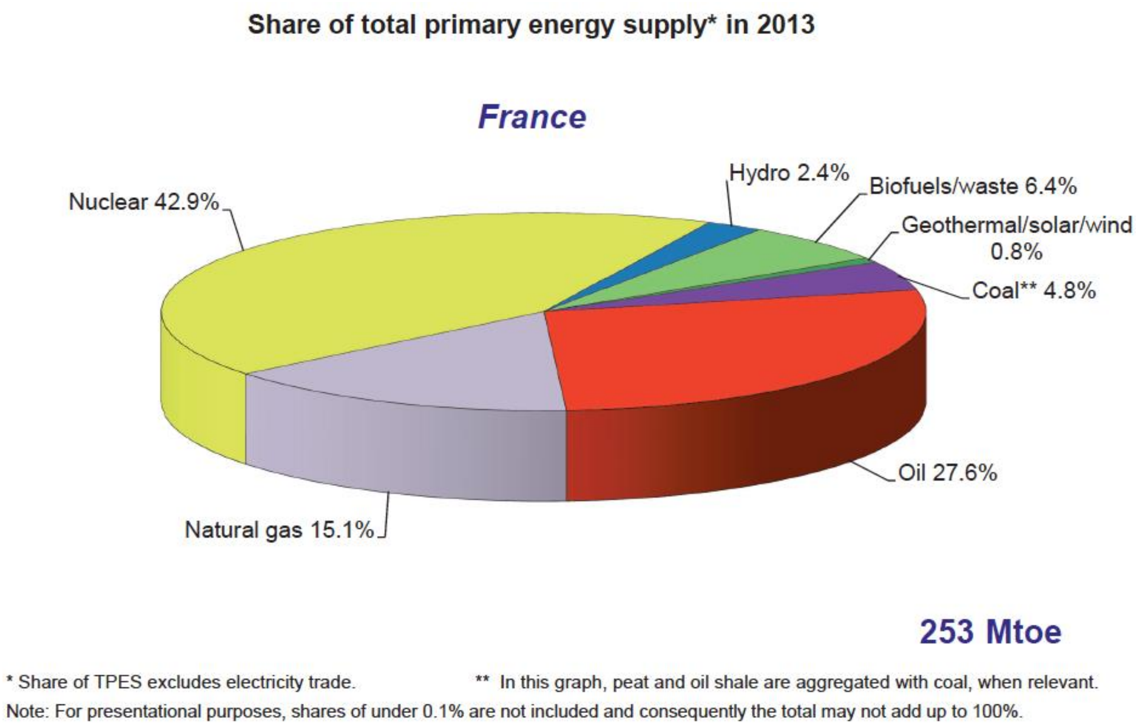

Figure 5 – Total primary energy supply by source, 2013.
Source: IEA Energy Statistics, 2015.

Electricity generation

The steep increase in the share of nuclear in electricity generation took place throughout the 1980s, as the plants constructed as part of the “Messmer Plan”, launched in 1974, came on line. Between 1970 and 2014, the production of electricity from nuclear origin was multiplied by a factor of 73 (from 6 TWh to 436 TWh), and its share of the total electricity generation increased from 4% to 78% (Ministry of the Environment 2015, 26).

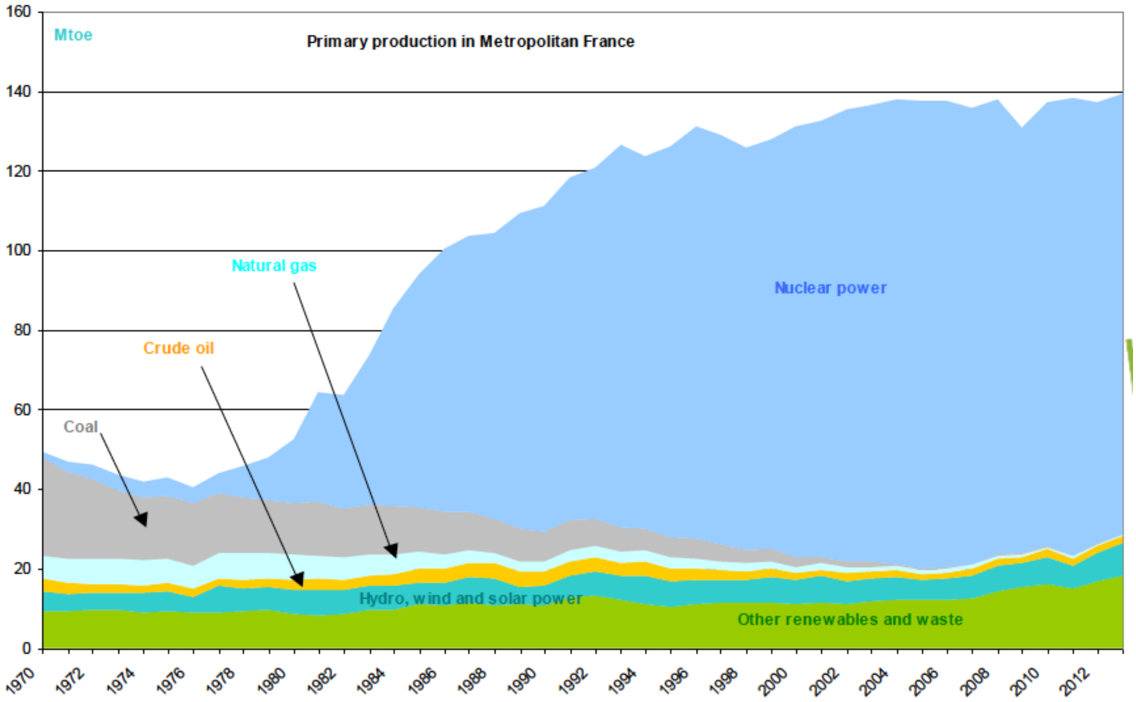

Figure 6 – Evolution of electricity generation in France by source, 1970-2014.
Source: Mordant (2015).

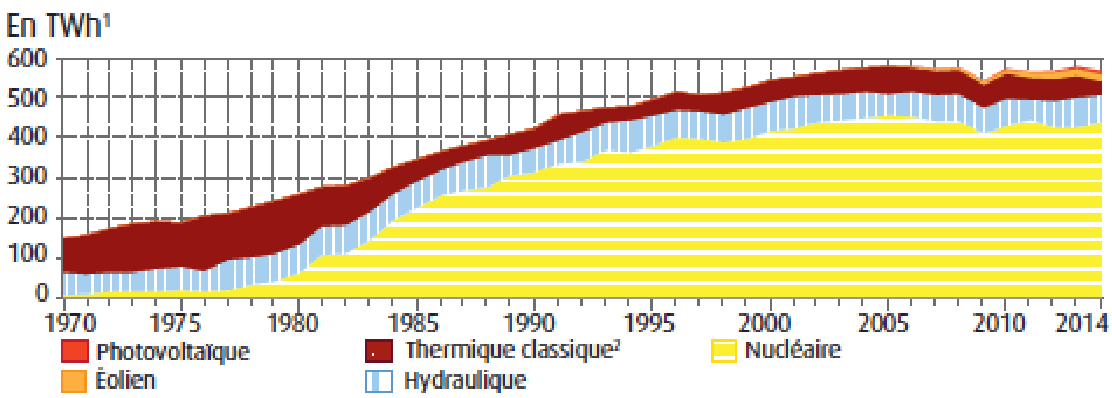

Figure 7 – Gross electricity generation by source, 1970-2014.
Source: Ministry of the Environment 2015, 26.

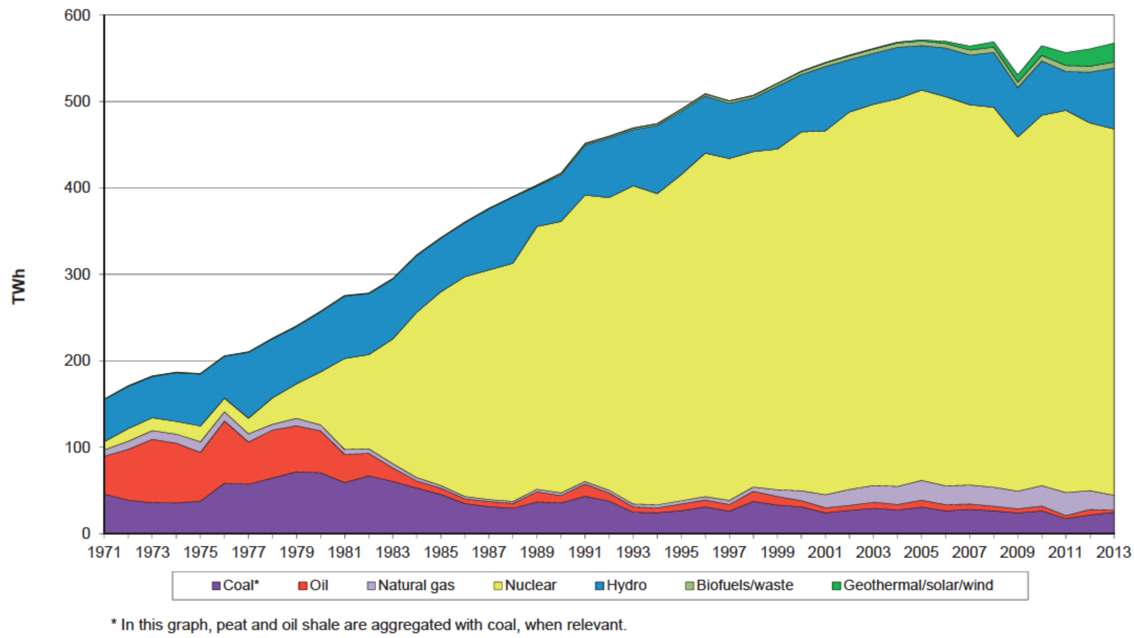

Figure 8 – Electricity generation by fuel, 1970-2013.
Source: IEA Energy Statistics, 2015.

Electricity consumption

Since the launching of the massive nuclear programme in 1974, incentives to the installation of electric heating facilities has rapidly increased the share of households in total electricity consumption. The share of residential and service sector of total electricity consumption more than quintupled, at an annual growth rate of more than 4%, while consumption by transport sector doubled and by industry (excluding steel industry) increased by about 50% (Ministry of the Environment 2015, 27).

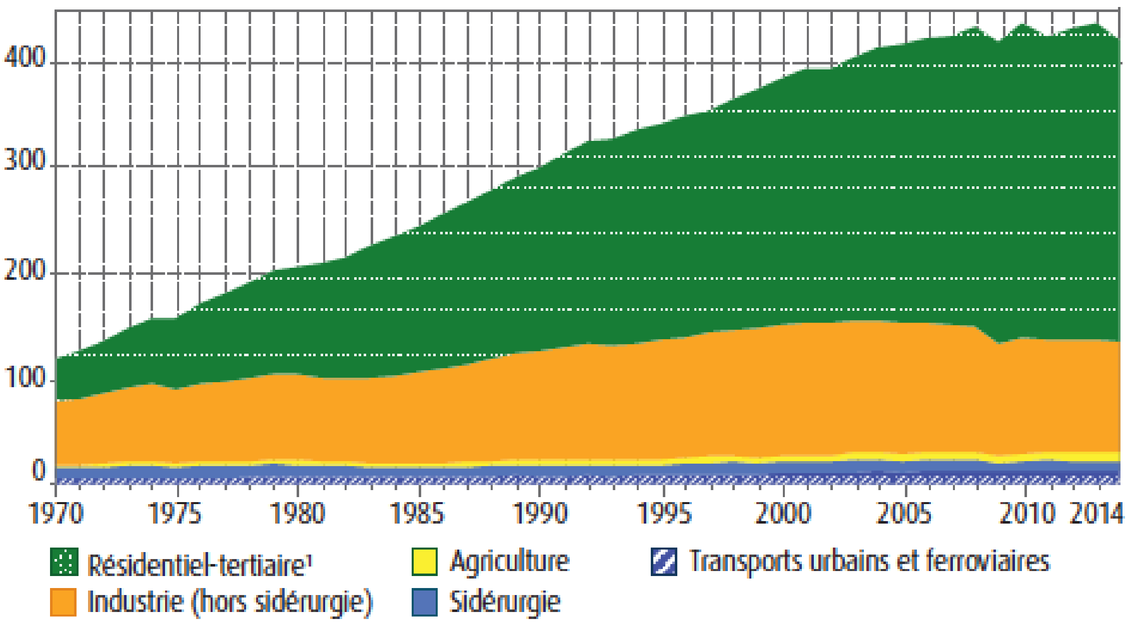

Figure 9 – Electricity consumption by final consumer, 1970-2014, in TWh. Corrected for climatic variation (*Source: Ministry of the Environment 2015, 27***).**

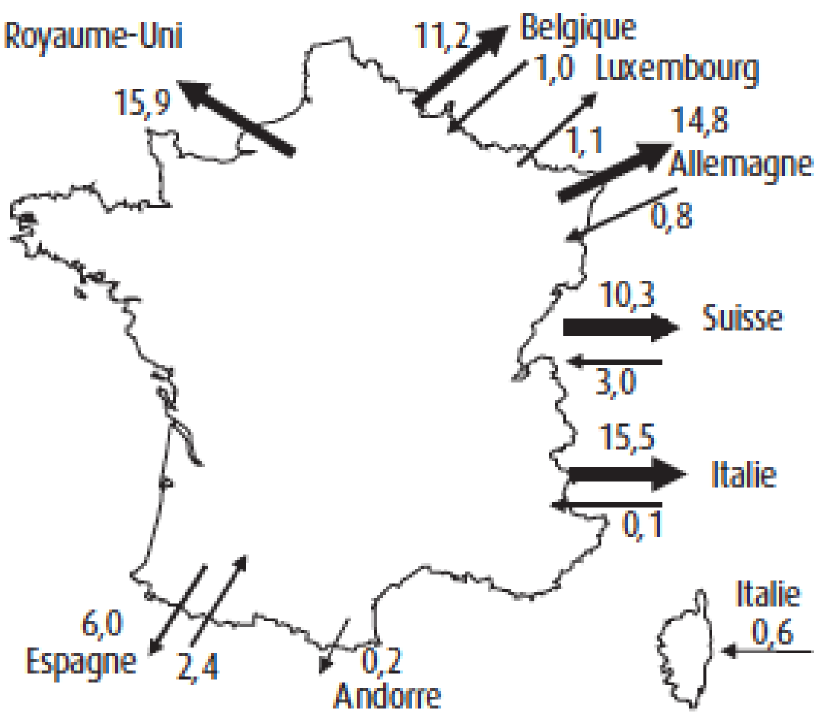

Figure 10 – French electricity exports and imports, 2014 (in TWh).
Source: Ministry of the Environment (2015, 29).

The figures in the graph above do not totally reflect trade between the two countries in question, because part of the electricity that crosses the border between two countries can be destined to a third country. In particular, while the balance of physical electricity exchange between France and Germany shows a large surplus for French exports, a part of these exports have their final destination in Belgium and Switzerland. In reality, France has a negative electricity trade balance with Germany. (Ministry of the Environment 2015, 29).

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WP2

GDR (German Democratic Republic)

Short Country Report

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HoNESt History of Nuclear Energy and Society

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Deutsches Museum

DIALOGIK

EHU Europos humanitarinis universitetas

TU/e Technische Universiteit Eindhoven University of Technology Where innovation starts

Friedrich-Schiller-Universität Jena

Swedish Defence University

GRE

KTH

LUT Lappeenranta University of Technology

upna Universidad Pública de Navarra

UPMC Sorbonne Universités

The University Of Sheffield.

Science Museum

spi Sociedade Portuguesa de Inovação

CONTENTS

Executive summary

This report belongs to a collection of 20 short country reports on the History of Nuclear Energy and Society (HoNESt, project Ref.662268). The reports tackle the complex sociotechnical system around nuclear energy. Nuclear developments, notably nuclear energy, are closely intertwined with social, economic, environmental, political and cultural spheres. Nuclear energy is also a globalized system involving transnational transfers of knowledge, materials, technologies, people and products including electrical power, medical elements, toxic wastes and other environmental hazards, materials, capacities and knowledge that must be carefully safeguarded. Nuclear energy is a complex social and technological phenomenon that influences societies but is also shaped by societies.

The short country reports are designed to assemble information and research results on the history of the relations between nuclear energy and society about all the different country cases in an accessible manner, and to document the findings with references.

The purpose of the country reports is threefold, addressing three different audiences:

1. to provide basic elements of narrative and analysis for further historical research by HoNESt researchers,
2. to provide information, context and background for further analysis for HoNESt's social science researchers,
3. to provide accessible information on nuclear-societal relations in the various countries for the purposes of outreach and communication with stakeholders (civil society, industry, associations, policy makers, journalists).

This report focuses on the history of the relations between nuclear energy and society in the former GDR. The main findings are:

The GDR planned to construct three to six nuclear power stations from the 1955 onwards. Even if, the GDR as the eastern part of Germany had had a long tradition of radioactivity and nuclear research dating back to the beginnings of nuclear physics, transnational knowledge and technology transfer was crucial for the GDR's plans. The transfer started in the 1950s by the

intention of the Soviet Union (USSR) to protect its own hegemony in Eastern bloc states by on the independent development nuclear technology. Government and academia of GDR struggled for a stronger position in the relationship with USSR. Their hegemonic status in the process of implementation of knowledge and technology were unchallenged. Nuclear energy formed the most important future option of the energy policy of the GDR. However, installation, expansion and use of nuclear power plants lagged far behind the expectations of experts and politicians. Attempts to control and guide everything by forecasts and plans failed because of the deficits of socialism. The first imported reactor (a research reactor at Rossendorf) was installed in 1957, and in 1966 the first NPP become operational. Since 1973 the second NPP followed and made a notable contribution to the energy economy for the first time. The powerlessness of the government manifested itself in ambitious nuclear energy programs which was never implemented. The wholesale adoption of Soviet technology and politicians' own positions concerning the incident at Chernobyl severely damaged the program. All decisions were made by the party and state apparatus and state authorities in camera of the public. There was no considerable civil movement in the GDR until 1988/89. But amazingly the newly arisen civil rights movement enforced the shut-down and decommissioning of all nuclear power facilities in the territory of the GDR in the course of the "political turn" / the “reunion” in 1989/90.

1. Historical Context (narrative)

1.1. Introduction to the historical context

After the Second World War atomic research ground to a halt in the east of Germany first. On one hand it was due to the drain of nuclear scientists in the west, the closure of institutions like the Kaiser Wilhelm Society and the claim for intellectual reparations of scientists and technical devices in the Soviet Union. Moreover, the Allied Control Council Law strongly limited scientific research. This changed only in the middle of the 1950s when the occupation regime of the Soviet Union was reduced. The peaceful use of nuclear energy was never basically questioned by the government of the GDR and was fixed quite early in Party Congress and Council of State decisions. Nuclear technology was part of a state doctrine, a decisive part of the national identity, which was intended to represent the superiority of socialism and contribute to the general prosperity of the population.

Immediately after the UN conference in Geneva in August, 1955 the GDR began a systematic campaign in newspapers, broadcasting company and television to take away people's fears of the "spectre" atom and to inspire for peaceful use of the nuclear energy.

On the 11th of October, 1955 the Politburo, and on the 10th of November, 1955 the Ccouncil of Ministers made a decision on the civil use of nuclear energy: the foundation of a central research centre and an "Office for Nuclear Research and Technology" (Amt für Kernforschung und Kerntechnik - AKK), comparable to the nuclear ministry formed shortly before in the Federal Republic of Germany (FRG). In 1955 an agreement by the USSR was concluded for the construction of a nuclear power plant. The ambitions were big: "About 20 nuclear power stations should go to the net till 1970”, one leader of the AKK forecast in the SED newspaper "Neues Deutschland" in 1957. In 1956 the Central Institute of Nuclear Research (ZfK) was founded in Dresden-Rossendorf. The Rossendorfer research reactor (RFR) was put into operation in 1957. 1962 the Rossendorfer ring zone reactor (RRR) and 1969 the Rossendorf arrangement/design for critical experiments (RAKE) was established. In 1962 the State Headquarters for Radiation Protection which were responsible for nuclear security and radiation protection were founded. This licensing and supervisory authority was renamed in 1973 as State Office for Nuclear

Security and Radiation Protection (SAAS). At that time one of the advertising slogans was “bright future – nuclear energy".

After the first International Atomic Conference in Geneva in 1955 the GDR just followed as the FRG, an international trend to speed up the adoption of nuclear energy. But already in 1962 the nuclear programme was reduced again. The Energy Commission of the Council for Research had come the conclusion that electricity demand could be met until 1970 without nuclear energy. With this decision the development was adapted to the restricted economic possibilities of the GDR. While first an independent development of NPPs was intended the State Plan Commission chose to import NPPs from the USSR. In 1965 the first nuclear energy programme planned thermal reactors and quick breeders beside the NPP I (Rheinsberg) and the NPP II (Greifswald). In 1966, after a five-year delay, the NPP I Rheinsberg came into operation with fuel supplied by the USSR. NPP I was used for energy production, but also for research and training. In 1968 politicians and scientists questioned the safety and security of the breeder reactor and the fuel cycle on account of the politically suspect and highly toxic plutonium. As a result, the GDR ended its research and involvement in breeder technology. In the beginning the radioactive waste was reprocessed by and finally stored in the Soviet Union. Nevertheless, in 1970 a national final repository site was developed in Morsleben, although there had been doubts about its geological stability. In 1969, with the start of construction work of the NPP II (Nord – Greifswald) the GDR entered into the energy production by nuclear power stations, intended by reduction of the need for lignite.

In 1973 the GDR joined the UN and also took up its membership of the IAEA.

Unit 1 and unit 2 of NPP II (Greifswald) were put into operation 1973/74. In 1977 the reactor of unit 3 and in 1979 reactor 4 started to operate. By this time nearly 10% of the electricity supply was generated by nuclear energy. Until the middle of the 1970s optimistic forecasts for a large role for nuclear energy still remained so the state planned to develop fast breeder’s reactors as well as thermal reactors. Nevertheless, in the realisation of the ambitious nuclear plans technical difficulties and safety and security problems were underestimated and the economic efficiency of nuclear energy was overestimated.

There had been plans for a third nuclear power station near Stendal on account of a resolution of the Council of Ministers in 1970. Four reactors with 1,000 MW of power were planned. In 1974 the building site was opened and, in 1982, the construction of the first reactors began. Nevertheless, the construction was characterised by construction faults, delays and large cost overruns. From 1973 there were plans for a fourth NPP near Leipzig.

Another nuclear energy programme was presented in 1983. This intended that growing electricity demand should be completely covered by nuclear power stations from 2000 onwards. Fast breeders and fusion reactors were planned for the time from 2020. In detail, the following should have come into operation:

- four additional units in Greifswald by 1998;
- four new reactors in the NPP III (Stendal) to 2000;
- other three reactors in a NPP IV; and
- from 2002 to 2010 another eight reactors in hypothetical NPPs V and VI.

Nevertheless, such plans were never realized, due to the problems of construction and operation at the existing sites. As of 1983, the Soviet Union had had difficulties with the serial production of nuclear reactors. Products from suppliers were defective and training was wrongly planned. The extension of nuclear power stations stagnated. In 1986, the construction of three other units was planned to finish at NPP II by 1990. However, substantially later than planned, because there had been delays of delivery and deficit in quality in the parts provided by the Soviet Union, only reactor no. 5 became operational in 1989. The other planned reactors were never finalised.

The Chernobyl inicident which had occurred in the fraternal Soviet Union was extremely concerning for the GDR’s leadership. In the official news of the "Aktuelle Kamera" from the 28th April to the 14th May 1986, the accident, or “Super-GAU” was covered up by every trick in the book: the problems were "overemphasised" and, therefore, checking the GDR’s reactors was “not relevant" - there would be no danger. Moreover, the differences in the construction of the GDR reactors in comparison to Soviet models were highlighted, as well as accidents in NPPs of western countries were enumerated and a "specific scaremongering" was described.

Chernobyl had caused a higher sensitivity of the public. Given the incapacity of the Soviet Union to develop and construct NPPs according to western safety standards, cooperation with the west was sought, in particular with the FRG. Initial exploratory talks took place in 1987. At the same time, there were attempts to improve the security of nuclear power stations by a flood of new rules and regulations. The insufficient security concept of the Soviet reactor design led subsequently to incidents in nuclear power stations. Such an incident in Greifswald led to partial core meltdown in 1989.

The mismanagement of the NPPs led to a stronger control and discipline of the staff by the Ministry of State Security (MfS). From 1989 the GDR felt exposed to growing pressure from international agencies and decided for shut-down of the NPP Rheinsberg in 1992.

Up to the political turn and reunification there were only isolated protests of a small number of people against the use of nuclear energy. The citizens had no say in any decisions, local or national, and discussions/discourses were suppressed. At the end of the 1970s the anti-nuclear power movement in the west could not be simply ignored any more, and the state tried to persuade their own population that atomic energy production was only risky under the societal conditions of capitalism/imperialism.

Although, data about the raised radiation due to Chernobyl was kept secret, the level of secrecy increased uncertainty in the population. There were first inquiries of concerned citizens in which soon incorporated criticism of the leadership. Which lies and total concealment had ruled in the GDR in terms of the NPPs, became known to the public only in 1989. Sebastian Pflugbeil (Neues Forum) as a Minister under the Modrow government has proven “background materials” and documents. From confidential papers of the "permanent control group for system security" the ailing/ dilapidated state of the GDR nuclear power plants and organizational problems were documented. Pflugbeil had informed before as a civil rights campaigner against uranium mining and nuclear power plants in the GDR. His recommendations for safety deficiencies and costs for retrofitting contributed decisively to the termination of nuclear energy production in the GDR. The security of the NPPs were characterised as absolutely insufficient by internal papers and retrofitting or shut-down were recommended. The reactors in Greifswald had for instance no containment and the pressure vessels were brittle. Both alternatives, retrofitting or decommissioning, were difficult choices because of the high cost. The attempt to sell the dilapidated facilities in the course of privatizing the electricity market failed. Because of technical and above all economic reasons – essentially the imponderabilites of the licence procedure for retrofitting and a decreasing electric consumption at the same time – no investor was found for old NPPs of Soviet design. Finally, the state decided to decommission all nuclear facilities in the GDR. This was done essentially before the official reunion on the 3rd of October, 1990.

1.2. Contextual narrative

1.2.1. Regulators and actors

- Ministry of Coal and Energy (Ministerium für Kohle und Energie)
- Commission of Energy as part of the State Planning Commission (Energiekommission bei der Staatlichen Plankommission) and the
- State Planning Commission itself as the most important instrument of central instrument for planning in the GDR
- Politburo of the SED (Socialist Unity Party of Germany)
- Central Committee of the SED (ZK)
- Council of Ministers of the GDR (MR)

The legislative power was with the last one. Normally decisions were negotiated between the chair of the State Planning Commission, the Politburo member responsible for economic questions and the ZK secretary. All decision makers worked in general together in different functions and many committees. The constitution of bonds of trust could not be determined. The population did not trust in these power bearers normally as they had lived too isolated for a bond of trust.

There were no nuclear companies existing, just operators of the single nuclear power plants (Rheinsberg and Greifswald). Other industries tried to avoid any involvement in the development or construction of nuclear equipment, supplies or fittings because of the hegemony of the Soviet Union, scarcity of experts and material and a lack of knowledge and expertise.

In the GDR, nuclear physics was exclusively a governmental task. The party leadership of the SED directed the governance and every decision required SED ruling first. The governmental declaration of the USSR from the 18/01/1955 “About the help for other countries with establishment of scientific-technical centres of nuclear physics” induced activities in the GDR. SED-Party/governance established numerous institutions (see Figure 1). Hence, on the 10th November 1955 the most important authorities were founded: the Office for Nuclear Research and Nuclear Technology (Amt für Kernforschung und Kerntechnik – AKK) which was subordinated directly to the Council of Ministers, and the “Scientific Council for the peaceful Use of the Nuclear Energy” (Wissenschaftliche Rat für die friedliche Anwendung der Atomenergie - WR). From the middle of 1962 the structure was totally reorganized: The AKK and WR were dissolved or integrated into new boards (committees). The AKK’s competence transferred to State Plan Commission (Staatliche Plankommission – SPK) and the WR was merged into the Council for Research (Forschungsrat – FR). At the same time the “State Hheadquarters for Radiation Protection” (Staatliche Zentrale für Strahlenschutz – SZS) was founded which took over all duties of the supervision and control of nuclear material, equipment, processes and work. The final decisive power remained at the Council of Ministers, the government of the GDR.

Everything was regulated by national law and decisions would acquire the agreement of the Soviet Union. There finally was just one operator: the Ministry for Coal/lignite and Energy. The nuclear power plants were placed directly under this top management, a model which followed the USSR’s structure of economics. Sharing practise meant copying Soviet structures, regulations and/or the trial for a unique way on a very low and largely hidden level (See narrative of the “Wissenschaftlich-Technisches Büro für Reaktorbau”).

1.2.2. Nuclear Power Plants

The distribution of the nuclear assemblies across the GDR can be seen in Figure 2 (section 4, Facts and figures). All the criterias for their location were set by the Government of the GDR and the Soviet administration, which was the general contractor.

The huge energy problems of the GDR which resulted, above all, from the almost complete absence of fossil fuels and extremely low power station capacities, led to the adoption of nuclear energy.

Location/site criteria:

- far from coal mines;
- relatively close to areas with a demand for electricity and thermal power;
- the construction site should be calculated so that "the middle of the ventilation chimney of the power station shall be at least at 3 km from places/villages/cities, including the housing area/residential estate of the power station";
- for the required coolant/cooling water, a need of 25,000 m³ per hour was taken as a basis;
- the level of the construction site should be, at least, three to four metres above maximum floodwater;
- no ground water at a depth of 10-12 metres;
- infrastructural provision (street and rail).

Were power plants built in peripheral places?

The GDR was a densely populated area in the middle of Europe. Peripheral places were not available – so, nuclear stations could be built only in the more or less settled places. Nevertheless, this was no explicit postulated criterion for a nuclear power plant. (Reichert 1999; Strauß 2012; VKTA 1999)

There was no involvement of people or public. The leadership of the state and party avoided every participation or discussion of these problems, like in the USSR. Sensitive subjects like environment, nuclear energy or social problems, *per se* linked to energy industry, were consequently excluded from public discourse or were exclusively treated by a certain circle of specialists. There were just a small group of activists, although in this case they should rather be considered as "observers". They were driven by general environmental concerns/care and tried to record information and changes. A specific institution in this context was the Institute of Limnology, founded in 1959 – see narrative section.

For the ZfK Rossendorf (near Dresden) a nuclear research reactor was installed in 1956/57. The type WWR-S (water/ water – reactor – serial type) of Soviet design worked with (10 percent enriched) uranium 235 with distilled water as a coolant, moderator and reflector and achieved a maximum of 5-10 MW. The reactor was important for production of radioactive isotopes by radiation of elements in the active zone. The construction was realized totally by Soviet enterprises. On December 12th 1957 the reactor reached the critical point for the first time.

The first power plant for the energy supply was positioned close to Rheinsberg in a peripheral area of Mecklenburg. The atomic power station I (KKW I) of the GDR with 270 MW should have been built in two stages of development and construction from 1957 to 1972. The start of the construction work for the Soviet VVER-210 reactor was in reality in May 1960. In 1966 the reactor went in to operation. The second stage of development was not realized. The reactor served primarily as a test reactor for equipment out of GDR production and for educational/training purposes. The fabrication was organized by a division of theoretical development, supply, construction work and training for the associates in all parts and for the operation between the Soviet Union and the GDR. The regulations of this collaboration, however, were not clearly contracted. Recurring problems in all parts of the process and especially in the cooperation with Soviet Union are probably the reason for the failure of project.

The second nuclear power station the KKW Nord was intended near Greifswald. KKW "Bruno Leuschner" (KKW Nord) was also planned as a collaboration betweenthe GDR and the USSR. The Soviet Union should deliver the basic concept, the main equipment and the reactors completely. The plan was to install 500 MW in two successional stages and 1000 MW in two other stages of development and construction. The Soviet reactors VVERs of 440/230 were planned for blocks I to IV of the first and the second stage – constructing period from 1970 to 1972. The allocated construction time for the blocks V to VIII with the new 1000 MW from the USSR was from 1974 to 1977. Construction for the blocks I and II of the first stage started on time. However, by 1972 it became clear that there would be no 1000 MW reactors. The GDR government agreed to change the plans on another four blocks of the type VVER-440 / 213 – the succession type of the common reactors. On account of the rise in price, lacking specialists and staff and supply through the USSR, considerable delays on the construction and start of operation challenged the project. Thus block 1 went into operation only in1973, block 2 in 1974, block 3 in 1977 and block 4 in 1979. Blocks 5 and 6 were only just finished before the reunion, while the blocks 7 and 8 remained still in progress. New safety regulations caused additional delays in supply and construction.

Already in 1971, the construction of a new nuclear power plant was decided at the VIIIth party Congress of the Socialist Unity Party of Germany (SED Parteitag). The nuclear power plant III (KKW III) should be placed near Stendal close to Magdeburg. While the first plan worked with 2 stages of development of 500 MW, the Soviet side recommended in 1976/77 to assemble four 1000MW units to take into account the modern development in the power station construction. Despite of the start of construction work in 1974 a decision for redesign was made by the Council of Mministers in 1979. This initiated a restart of construction work in 1981. Now four blocks should be equipped with reactors of the type VVER-1000 / 320. The works were not finished before 1990 and no work had started on blocks 3 and 4.

There were additional attempts and decisions for two other power stations: A VVER type near Dessau and a "quick breeder" near Leipzig. Both projects did not get beyond a preliminary planning phase.

There was no privatization – all the plants were funded by state. Further information regarding energy industries and German reunification see report of FRG.

Wende – political change:

In the course of the peaceful revolution the conditions of the state facilities on the construction and operation of the nuclear power plants changed basically in autumn, 1989. The Ministry of the Environment of the FRG increasingly took influence on the nuclear energy situation in the GDR. In January, 1990, the visit of Minister of the Environment, Klaus Töpfer, was accompanied by enormous public interest. It typified a more intensive cooperation in the area of the radiation protection and in nuclear matters in general. West German media were becoming significantly important as a source of information about the state of the nuclear facilities in the GDR. They articulated considerable reservations towards the Soviet technology. The "state the art" of the technologies and their use was during the cold war was always the subject of confrontation in both German states. After the political and economic failure of the GDR, West German media referred to the technical arrangements in the GDR with a certain arrogance. The mass media of the FRG showed sharpened consciousness for the potential risks ofnuclear energy. Sensitised by decades of dispute for these problems, they turned with criticism now also against the nuclear power plants of the GDR.

A growing pressure on the “officials”, responsible for the nuclear energy in the GDR, arose. Concerned citizens expected information about the safety and security of the nuclear facilities. Now, however, the SAAS could give more open accounts corresponding to the expectations of the population for more comprehensive information under the new political conditions. On the 13th November 1989 the secrecy was finished by environmental data. A new order permitted the publication of data on radioactivity and the safety and security of the nuclear power plants. In their answer on critical further inquiries from interested people the employees of the SAAS certainly suggested that although secrecy had been enforced, this did not mean that they were indifferent to safety concerns. After the incidents in GDR power plants, but also after the incidents at Three Mile Island and Chernobyl the SAAS had initiated a wide range of measures to raise the security of the reactors. At the same time the employees of the SAAS persisted on the correctness of the choices made. In particular, they defended the introduction of new limits values for allowed radioactive charges of food by arguing that after Chernobyl there existed no internationally enforced limit values which would have done justice to the exceptional case. There was no danger to health, even if the agreed limit values had been exceeded for a short time.

The political change of 1989/1990 created absolutely new conditions for German cooperation. Under the government of Hans Modrow, the Institute of Energetics in Leipzig, as part of the company for nuclear power plants (Kombinat Kernkraftwerke “Bruno Leuschner“), worked for an ambitious nuclear energy programme. Less ambitiously, but substantial from enterprise-strategical meaning were the plans to upgrade and retrofit the Soviet nuclear power plants in the GDR with western technology. Siemens / KWU already in discussion with the VEB KKW "Bruno Leuschner" had gone now on the offensive in terms retooling/reconfiguring the instrumentation and subordinate control technology. ABB and Westinghouse also made offers. Besides, the West German companies pursued not only the aim to guarantee the security of the East German nuclear power plants according to FRG nuclear legislation. They also wanted to develop an upgrade configuration for the Soviet VVER reactors across all of Eastern and

Central Europe. The decision, to switch off and decommission nuclear power plantsterminated these efforts.

Prior to this decision active critics of nuclear power from the GDR played an important role. In the course of the reuinfication these groups gained members with a voice with political weight. On the 5th of February the central “Round Table” sent several representatives of the environmental movement to the government under Hans Modrow. Among them Sebastian Pflugbeil who had been responsible (by order of the round table as a Minister without Portfolio) as an expert in the safety and security of the reactor blocks 1 to 4 of the Greifswald nuclear power plant (KKW Nord). The authors of the certificate/experts opinion made demands to switch off all four blocks immediately. They prepared the ground for the phase-out of nuclear energy in the GDR. There followed other certificates/expertise’s of the Ecological Institute of Freiburg (Öko-Institut Freiburg) and the independent Institute of Environmental Issues (Unabhängigen Instituts für Umweltfragen) about blocks 1 to 8 as well as investigations of the Society for Reactor Security (Gesellschaft für Reaktorsicherheit). Consensus for a shut-down of the blocks from 1 to 4 of the nuclear power plant Greifswald was passed. For blocks 5 to 8 the certificates contradicted. However, in the process of the reunion of the FRG and the GDR the present principles of the nuclear energy politics of the GDR were also questionedsince the GDR’s political objective of a very self-sufficient energy supply was now irrelevant. Moreover, in differentiated political discussions about energy concepts of the western industrial states, research institutes expressed themselves increasingly against a concentration of the electric energy production in few locations with big block units in the late 1980s. The ecological movement called for a strong decentralisation of electricity production. In course of the reorganisation of the electricity economy, finally, the West German energy supply enterprises took over the electricity supply of the GDR by the majority. They have had no serious interest in a further operation of the nuclear power plant at Greifswald or continuation of nuclear power plant construction in general. Since reunification there has been no suggestion of refurbishing existing plants, or constructing new plants in the eastern part of the expanded Federal Republic of Germany.

1.2.3. Fuel

The enriched uranium came from the Soviet Union. Although the GDR disposed of important uranium deposits they were firmly included in the plan for energy industry of the future. The access was kept by the mining plans of the Soviet Union. Within the scope of reparations, a Soviet German corporations was founded (SDAG "Wismuth") which excavated specifically Saxon and Thuringian uranium deposits. The GDR had to buy their fuel from the Soviets.

1.2.4. Waste

Situation see Figure 2

Until 1918, potash salt was mined in Morsleben first, afterwards up to 1969 also stone salt. After finishing the extraction, the mine was selected in 1970 from a total of ten salt mines as a final disposal/repository site for weak-radioactive and medium radioactive waste. After investigations, tests and the first trial storage of radioactive waste, approval was given in 1972. The ERAM final repository site for radioactive waste Morsleben (Endlager für radioaktive Abfälle) was put into operation in 1978 at first for a test. In 1981 a limited approval was given to the continuous operation with a validity of five years. On the 22nd of April 1986 the unlimited approval to the continuous operation for the disposal of weak-radioactive and medium radioactive waste with predominantly short half value periods was guiven. Permit authority and supervisory authority was with SAAS, and the operator the state-owned combine of nuclear power plant "Bruno Leuschner" – Greifswald. In 1965 the State Headquarters for Radiation Protection (SZS) of the GDR began with the investigation for a central final disposal site location for all kinds of radioactive rubbish/material of the republic. In the course of the selection procedure ten locations were considered. Three, inter alia the shafts at "Bartensleben" (Morsleben) and "Marie" (village Beensdorf) were shortlisted. Important criteria were that the media for storage should be salt, the available subterranean cavities should be a suitable size and the mine should be either ready for use, or easily made ready. The location approval was given in 1972/73. The first part approval for the retrievable storage of 500 cubic metres of radioactive material from the overfilled Central Interim Storage of the GDR in Lohmen near Dresden was pronounced in 1971/72. These storages began on account of economic considerations even before the rebuilding measures (establishment approval in 1974) restored the salt mine enough for it to become final repository site. During the subsequent years little amounts of radioactive materials were stored, although only in 1978/79 the authorization was given. The limited approval for continuous operation was given on the 20th June 1981 and pronounced on the 22nd April 1986 for an unlimited period. A closing approval in whose frame only the proof of the long-time security was to be produced was not given any more. In the end of the 1980s the preparations ran for another approval phase which should also allow the storage of high-level radioactive materials. This approval also was not reached in connection with the reunification.

Some few isolated criticising voices concerning Morsleben were already vocal in the 1980s. Thus, documents of some citizens who questioned nuclear waste disposal in Morsleben still survive. There was not an organised opposition against Morsleben, like in other cases of GDR opposition/discourse. An essential reason was the secrecy of the repository site and security problems. Ideological education had had influence on the political activity of the people too especially in the border area. Moreover, attempts were made to influence critics of nuclear energy to get them on a course close to officials.

In their rare public statements, the ERAM was put as a symbol of the socialist progress and the peaceful use of the nuclear energy. A representation from 1972 saw it as an "important plan in the area of the environment protection for the whole GDR and the COMECON ". The GDR presented a model (Vorzeigelager – flagship installation) which corresponded to the legend of "clean nuclear energy" and was valid in the Eastern bloc as "a model" for a nuclear waste repository.

Information about the ERAM was circulated to the IAEA, and approved by high-ranking officials, eager to promote the ERAM model. The President of State Office for Nuclear Security and Radiation Protection (Staatliches Amt für Atomsicherheit und Strahlenschutz SAAS – early SZS), Prof. Sitzlack, introduced the concept of the ERAM at the 22nd IAEA conference in 1978. The SAAS provided statements, publications and other mentions of the ERAM among other things with the Ministry of Lignite/coal and Energy (Ministerium für Kohle und Energie- MKE). This led to complaints that SAAS was sharing "politically injudicious and inappropriate formulation" in its statements and the documents shared with the IAEA. However, the SAAS declined West German interview requests and any requests of bilateral consultations. This was excused by the fact that IAEA information did not have to be made public.

Further “the political sensitivity of such questions is suitable for the attacks of western mass media". Visits of people from the Non-Socialist Economic Territory (Nichtsozialistisches Wirtschaftsgebiet – NSW) were not possible on account of the border situation of the ERAM. On the other hand, there were negotiations with West German companies about the purchase and storage of nuclear waste in 1976. Whereby attention was paid how much insight can be granted to the West German customers without encouraging, perhaps, spying. Systematic information of the public was not planned. Only with a dangerous increase of rumours and discussions about safety and security, like in 1987 in village Beendorf, was information provided. At a meeting of the locals officials reassured the public like the western politicians: ERAM does not present any danger for the environment.

The secret police STASI saw the danger that with later critical statements for the hazardous and toxic wastes storage in a pit Marie one could refer to an IAEA recommendation (recommendation against the common storage of toxic and radioactive waste). For the preventive protection of the pit Marie (escape shaft and ventilation shaft of the ERAM) against terror, violence and demonstrations an action plan was compiled and developed in 1987.

The placement close to the border brought the risk of "republic escape" with itself, the first unofficial members (Inofizieller Mitarbeiter - IM) the STASI used in the ERAM to provide information and prevention in this regard. Other duties were the protection from terrorist or "demonstration" attacks (demonstrative” Angriffe) against the repository site, the supervision of secrecy and also of safety standards as well as the counter-intelligence.

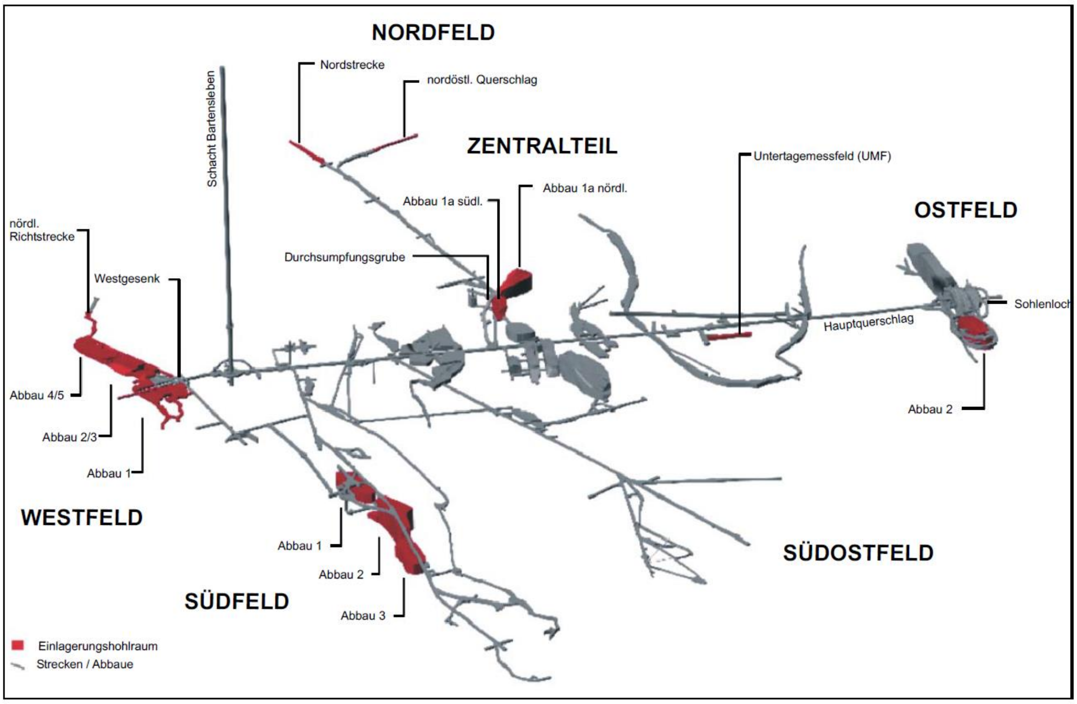
Beside a short phase of negotiations between the GDR and the FRG for building of a nuclear power plant (beginning of the 1970s) there were longer, constant and more concrete negotiations on the subject of storage of radioactive waste. From 1975 to 1979 possibilities were explored. Besides, concrete inquiries of delivery were also made and numbered in foreign currency. Nevertheless, this possibility, always in the focus of interest of the weak economy of the GDR, was rejected by a decision of the Politburo for unknown reasons on 30th January 1979. Followed by other, nevertheless half-hearted negotiations about a long-term contract on the “disposal of waste materials from the FRG on the territory of the GDR“ continued until the end of 1980. The termination of these negotiations was closely related with FRG intentions of a final storage facility in Gorleben, on the other side of the inner-German border. (see FRG Country Report)

A similar request of Austria was immediately rejected with decision from the 20th July 1977. It concerned the storage of radioactive waste of the nuclear power plant “Zwentendorf” (See Austrian Country Report)

The GDR could store the accrued radioactive waste itself because of the late implementation of nuclear power plants and the small quantities involved. Moreover, the rock salt mine Bartensleben close to Morsleben was used from the beginning of the 1970s. It was altered in stages to the final repository site. The camp is known as ERAM -and with the reunion in the supervision of the Federal Office for radioactive protection.

Between 1971 and 1991 and from 1994 to 1998, 36,754 cubic metres of low-level and intermediate-level radioactive waste was disposed of. Furthermore, small amounts of radioactive waste were stored intermediately.

From 1971 to 1991 and from 1994 to 1998, altogether 36,754 cubic metres of low-level and intermediate-level radioactive waste were disposed of in the Morsleben repository for radioactive waste (ERAM). This also includes 6,621 sealed radiation sources. About sixty per cent of the inventory currently being stored originates from the time after the repository had been taken over by the BfS in the course of reunification, starting on 3rd October 1990.



Morsleben: Einlagerungsbereiche auf der 4. Sohle (-372 m NN)

The data on the waste that has been disposed of and stored intermediately has been documented and archived. The major part of the radioactive waste originates from the operation of nuclear power plants and from the decommissioning of nuclear installations. Other waste originates from the nuclear industry, research institutions, federal state collecting depots or, respectively, directly from small waste producers and other users (e.g. the Federal Armed Forces and medicine).

The permanent operating licence of 1986 permitted the storage of radioactive waste in solid and liquid, aqueous form and in the form of sealed radiation sources. Until 1990, the liquid, aqueous waste was solidified underground directly on the repository site (in situ). Later on, this technology was no longer applied. It was only permitted to dispose of special radioactive waste in Morsleben (such as waste that may rot or ferment, toxic waste) and, since 1990, this also included liquid waste, after it had been immobilised. In corresponding operational provisions it was regulated how this immobilisation was to be achieved.

Among others, the following forms of radioactive waste existed:

- building rubble
- contaminated soil
- cemented, pressed and unpressed mixed waste (e.g. contaminated working equipment and laboratory waste, protective clothing, tools, plastic foils, filter and insulation materials)
- metallic waste (such as fittings, piping, cables)
- combustion products
- cemented wash water, solutions and concentrates
- sealed radiation sources

Furthermore, solely low-level and intermediate-level radioactive waste was allowed to be disposed of. For this purpose, the radioactive waste was classified in six radiation protection groups, based on the respective gamma dose rate, activity concentration or activity. Depending on the type of waste, it was permitted to dispose of certain radiation protection groups only.

From 1971 to 1991 radioactive waste with a total activity of 180,000 gigabecquerels and, from 1994 to 1998, waste with a total activity of 91,000 gigabecquerels was disposed of. Due to the radioactive decay, the activity of the waste decreases over time. At the end of 2014, the total activity of all waste disposed of in Morsleben amounted to about 93,000 gigabecquerels. This means that during that period of time 93,000,000,000,000 (93 trillions) of nuclei decayed and the activity decreased to about one third of the initial value. For comparison, the activity of waste stored intermediately in the Morsleben repository amounted to ca. 170,000 gigabecqerels on 31st December 2014.

The last radioactive waste was taken to Morsleben on 28th September 1998. Even if no more external radioactive waste is disposed of in Morsleben, there is still some waste arising in the control area that may be contaminated – so-called own waste. Examples of this are the air filters from the diesel-driven vehicles used in the control area.

The proper and long-term safe enclosure of the waste is still outstanding. This must take into consideration the safety aspects occurring in an ageing mine and must delay and limit the release of the radionuclides contained in the waste to the extent that all protection goals are achieved. The Federal Office for Radiation Protection (BfS) applied for the decommissioning of the Morsleben repository under nuclear law. The plan-approval procedure is currently underway.

1.2.5. Electricity

Data of the electric energy production and consumption see Figure 4 Facts and Figures.

In the area of the energy production only marginal changes are recognized. The most essential energy source was and remained the lignite (brown coal) which made more than ¾ of the energy production. Nuclear energy made from begin of the 1980s approx. 10 percent from the complete energy production.

For the energy consumption is to be ascertained that a bigger part of the growing demand is solved by oil. In the consumption the nuclear energy with approx. 3 percent played no role.

1.2.6. Safety and security

During the implementation: The Office for Nuclear Research and Nuclear Technology (AKK) was responsible from 1955 for the procurement, radiation protection, repository, security and control of all radioactive materials. The State Headquarters for Radiation Protection" (SZS) was founded on 9/1/1962. This was subordinated directly to the Council of Ministers (Ministerrat). With this decision all duties of protection and the security were with the SZS

With the SZS an independent central institution with responsibility for all problems of the radiation protection should be created. The strict separation of the responsibility for the development and use of nuclear energy (including ionising radiation) and the monitoring/control of safety was confirmed with the foundation of the State Office for Nuclear Security and Radiation Protection (Staatliches Amt für Atomsicherheit und Strahlenschutz - SAAS).

In August, 1973 the SAAS was founded and dissolved within the scope of the measures of German reunification in July 1991.

In the course of the time numerous changes and enlargements arose. Tthe SAAS was in charge of:

- the guarantee of the nuclear security;
- extensive medical investigations and controls in the field of radiation protection,
- education and training (up to the offer of postgraduate studies);
- the international cooperation with the Soviet Union and the states of the Council for Mutual Economic Assistance (Comecon – RGW);
- representation of the GDR at the International Atomic Energy Agency (IAEA) in Vienna;
- the realisation the Treaty on the Non-Proliferation of Nuclear Weapons.

The SAAS fixed for the GDR binding limit values, approximate values and normatives to nuclear security and radiation protection. It gave authorisation for all kinds of the use of radioactive materials, for nuclear installations or other users of ionising radiation.

1.2.7. Unique issues for the GDR

As the GDR joined West Germany, most of the participants/actors were wound up:

- significant insights are fixed in written form by historians (see bibliography) focused on technical issues or political processes;
- the late entry of the GDR into the nuclear physics and nuclear energy program;
- the complete import of power station technology from the USSR;
- economic problems also dominated the energy industry;
- the long duration of the construction (KKW Rheinsberg nearly 9 years; KKW Nord nearly same) and the problems with specialists, staff, material and the cooperation with the Soviet Union;
- high dependence from the USSR by planning, equipment, construction and also with staff qualification;
- very rare studies of social analysis of nuclear development – it was from the start no issue, just very late in the 1980s it becomes a topic (after Chernobyl);
- some studies of social activities and environmental problems existing (see bibliography).

After WWII, not a single institution in the Soviet Zone (Sowjetische Besatzungszone – SBZ)/GDR was able to pursue nuclear research and technology with the aim of an independent nuclear energy program. Moreover, the special situation of Germany had to be considered: The laws of the Allied Control Authority with the law No. 25 – amongst others prohibition of applied nuclear research – were valid until 1955. Also the personnel situation was difficult. Before the end of the war many physicists and engineers were moved with their institutes in the west, another brain drain in the occupation process of the zones also went westwards and other scientists were drawn off in a recruitment wave to contract work in the Soviet Union. Just at the universities of Rostock, Halle and Jena very limited research and studies took place.

The GDR is the only case of the study in which a state does not exist anymore. The development of the nuclear energy economy of the GDR was liquidated. This lies, nevertheless, not only in the accession of the GDR to the FRG, but rather economic reasons, security questions and the dependence to the Soviet Union were decisive.

On the other hand, the specific of public reactions/movement (opposition) in totalitarian states must be recognized. This was defeated by special conditions which do not find themselves in the democracy-focused design of our study. Similar challenge is valid for the studies of other Eastern bloc countries.

Other special issues:

- decision and control by government (state), no integration industry / enterprises;
- all decisions were made at political level, under premise of agreement of the SED party;
- decisions were made only partially with reference to specialists;
- inclusion of the industry ceased, also economics ministries were not considered with decisive questions and planning questions;
- beginning with euphoric foundation of many institutions without clear structure/separation of the problems;
- struggle for power of the institutes and administrations;
- constantly changing competences during the period of the start and implementation;
- centrally planned economy in which, for unrealistic political demands, no stop mechanism existed – “state plan of nuclear energy“ from 1983 on;

- very few specialists for planning and construction of nuclear power plants;
- war reparation by mining uranium by the USSR;
- in spite of using GDR's own considerable uranium deposits, the reactor's fuel had to be bought from the USSR;
- GDR was a totalitarian state: protest was very challenging against a state doctrine – nuclear energy was a state doctrine;
- energy-politics: nuclear power was very problematic for the GDR; absolutely missing the required know how, the specialists and the staff, the economic basis and the access to own uranium was kept; on the other hand, the energy demand could to be mastered by lignite (own resources), industry was mastered the procedures of coal-fired power plant (even if ineffectively);
- conflict of interests between politics / energetics and industry which preferred rather the traditional coal-plant technology;
- a difference between the claim of own nuclear power economy and the reality of the coal-based energy supply;
- german physicists and engineers were captured by Soviets within the scope of intellectual reparation, they came back from 1952 to 1957 primarily in the GDR (e.g. Gustav Hertz, Max Steenbeck, Heinz Barwich); the influence of the "specialists" on the development of the nuclear power economy must be considered;
- Klaus Fuchs, known as "nuclear spy", lived in the GDR and worked on nuclear-physical and nuclear-energetic questions in the Central Institute of Nuclear Research Rossendorf (ZfK). Fuchs worked as a theoretical physicist in Los Alamos and had brought atomic secrets to the Soviets;
- restrictive and absolutely regulated communication strategies towards the public regarding questions of the nuclear energy and related problems (security, environment; economy);
- no official survey about public opinion in relation to environmental problems was made;
- the event of the "turn" (Wende) is historically unique, must be considered the process of reunification and its effects on evaluation and disconnection / dismantling of the nuclear arrangements and power plants;

1.2.8. Conflicts

There were only a few conflicts regarding nuclear energy in the GDR. Mostly the issues were not directly connected to nuclear facilities – there were information strategies for the public in terms of ecological data that were raised as an issue; there were the missing involvement of locals in processes of the siting of power plants; another issue was the deployment of missiles in East and West Germany – in this context the exposed situation of Germany as border area between East and West Bloc; of course Chernobyl was the major issue – information politics (taking the western media power into consideration – a very special situation), protection of the people, integration of public risk assessment and discussion of risks.

A blind belief in technology was one of the keys for the entrance into the nuclear energy economy for the GDR. Obvious economic problems in terms of energy production seemed to become solvable by the use of nuclear power and technology. On top of that the GDR disposed of uranium deposits and hoped up until reunification for the possibility of its use. Later with the experiences of the construction of the KKW 1 in Rheinsberg, the big delays and the dependence on the Soviet Union, the first serious doubts were expressed among involved experts and specialists. From these developments the GDR tried to substitute lignite, coal as well as nuclear power with oil and natural gas. When the world market conditions were not to be fulfilled any more for the GDR to resort again to nuclear energy and intensified the construction of the KKW II and the development of other power plant locations. Chernobyl made a clear cut and demanded the reworking of all state plans in which nuclear energy was a component. The control of information and the general state doctrine did not allow a blatant break with the subject of nuclear energy, but all following steps were drastic. Consequently the shut-down and decommission of all nuclear power plants took place at the end of the GDR in 1989/90.

1.2.9. Society and nuclear energy in the GDR

The first unstructured environmental "movement" in the GDR was present by the end of 1970. More openly striking protest would have yielded immediately to repressions, if not even arrests by the SED regime and its servants (e.g. police, state security– STASI). The actions were aimed first only ecologically, e.g. so-called "Baumpflanzaktionen" (actions of tree planting) or

“Fahrradkorsos” (cavalcades of bicycles) against the atmospheric pollution were directed above all from the youth against the dreariness of the satellite towns. From these forms of self-determined actions discussion circles developed to cover political as well as environmental problems. The activities mostly took place under the roof of the Protestant church´s protection (Wolle: 268ff). The first groups originated in Mecklenburg, in the northeast of GDR. Groups from Leipzig, Dresden and also Berlin amongst others became prominent later. To preserve the aim of the party and state apparatus, the social and political control of society, the monopoly of information and exclusivity in organisation in all public issues was paramount. topics of discussions and participants could therefore be limited and controlled. Sensitive subjects like the environment, nuclear energy or social problems, per se linked to energy industry, were consequently excluded from public discourse or were exclusively treated by a certain circle of specialists. The admitted "official" (state) public – protagonists of state institutions, like e.g. National Board for Atomic Safety and Radiation Protection of the GDR (SAAS), strictly followed these rules – particularly in case of Chernobyl. The handling of environmental information provides a typical example of the systematic control of public: From 1970 there were "environmental reports" which were treated at first in the mass media and also in specialist publications. From 1974, after a local debate around heavy metal pollution in the Erzgebirge, "environmental report" publications were completely ceased and were just made accessible to a specific and small circle of selected experts or politicians. From 1982 only seven members of the political leadership received the annual reports, from 1986 only Günter Mittag as the Economic Secretary of the SED-Party (Paucke, 1994; 41). Based on this deficit of information and by virtue of interested professionals and amateur circles in the society informal groupings - a "counter-public" was formed (Matthes; 107ff/ Fehr; 217ff). Within the framework of this inner GDR counter-public came the formation of an expert's structure for certain problem areas and public actions or meetings of interested people within a scope of local/regional issues. Experts for the area of the nuclear weapons and nuclear energy were above all the physicist Sebastian Pflugbeil, the mathematician Joachim Listing and Michael Beleites. Journalistic activities independent of the State were the next step under the umbrella of the Protestant church. For the area of the nuclear energy the following publications are pertinent:

- “… not the last word. Nuclear energy in the discussion.” (1987);

- “Pitchblende. Uranium mining in the GDR and its effects.” (Beleitis, in 1988;)
- “Energy and environment. For consideration of justice, peace and responsibility for creation in answer of environmental problems in the GDR.” (Pflugbeil/Listing 1988)

These publications with the stamp “only for the internal-church use” reached a wide audience, because they could exclusively cover the demand for information. In addition, documentations and material collections were provided under the umbrella of the church and "counter-experts" gave lectures. Information and clarification was tolerated and successful via scientific data compilations and in conjunction with the “imperialistic” abuse of physical-technical inventions. In case of inner (own) problems clarification was prevented inwards drastically.

Within the context of the Chernobyl incident in 1986, extensive data were collected by the SAAS. However, it to informing and appropriately instructing the concerned population was always avoided. These data were accumulated and summarised in the reports SAAS 349 (1987) and 353A (1986) to 353E (1989). These reports demonstrated the sequence of events and the causes of the reactor meltdown promptly, explained the measures of the IAEA and predicted first effects on the area of the GDR (report SAAS 353A).

In the following reports measuring results and their methods are given as well as conclusions of solely numerical nature. Due to Chernobyl the national monitoring network was extended to up to 215 measuring points. The supervision of radioactivity was carried out in ground-proximate air layer, in the fallout, in surface waters, crop plants, food products and material goods. In addition, a measurement took place in people as incorporation rating. Although, the limit value was exceeded, there wasno acknowledgement of this in reports, in recommendations or information given to the population population, or in protective actions. SAAS was in a position to easily warn the public about the consumption of fresh milkhowever, they chose not to do so. The reports remained secret. They became accessible to a broader public only in the course of the political turn, however, still under complicated conditions. Not to underestimate the effect of the public tele-media from the Federal Republic (FRG) which was accessible to almost all GDR citizens. The disseminated information, warnings and advices together with the lack of information from GDR sources led to considerable social tensions. The spatial proximity to the accident site suggested for the area of the GDR a bigger impact. The only exception in the non-existent public discourse of nuclear energy questions based on the novel "Accident: A Day's News" (1987) of Christa Wolf. The sector of art and literature was one of few areas in which the domination/monopoly of view/perspective of the state and party system (SED) could not fully be enforced. Christa Wolf followed up in "Accident" not only the problem of residual risk, she directly assessed Chernobyl and described the disorientation of the people, the influence of the west media and the polarising position of the experts. The latter just made abstract presentation or trivialized depictions in the public sphere. Based on the everyday problems she comes to the reasonable end, “that the risk of the nuclear technology with almost no other risk is comparable and that with an even minimum factor of uncertainty one has to abandon this technology absolutely” (Wolf, 112).

Subsequently, the impact of this novel was a discussion in the GDR-academy’s magazine "Spektrum" within the short time from autumn 1988 till May, 1989. The "official" experts (e.g. Albert, 1988; Rambusch, 1989) argued that there is no alternative for power generation in the GDR. Beside of these the publication of counterviews (Böhme, 1988; Vogel, 1988; Seyfarth, 1989; Schmidt, 1989; Rüdiger, 1989) and calls for an open discussion led to a new quality in the first “public” discourse. Even though if it was by far not a broadly based societal debate, this isolated case remained at least as the first step for the participation of experts from both: the “official” public and the “counter-public”. (Matthes, 109)

In the GDR critical discourses were problematic in general. The case of nuclear energy seems to have been a unique case with no parallels. Orewas slightly different, but everything around nuclear energy took place like all matters of significance: without the participation of the public.

1.2.10. Risk perception and management

October 1956: After abolition/decontrol of the Control Council Act No. 25 a comprehensive research with radioactive isotopes could begin also in the GDR in 1956. The SZS had over all control of regulation, shared later with the SAAS.

1974: The regulations constantly were adapted to the current state of science and technology as well as the international recommendations in the field. At that time, there existed 46 regulations which considered all the international recommendations to the full extent already.

1983/84: Important steps for the development of the law for the use of nuclear energy and the effective protection of man and the environment against the hazards of nuclear power and the harmful effects of ionising radiation were the revised version of the nuclear energy law and the anew conceived regulation about nuclear security and Radiation Protection Ordinance.

During the last years of GDR increasing attention of the control of raised natural radioactivity was dedicated in the uranium mining areas, even if immediate control of the Soviet-German Stock Cooperation (Sowjetisch-Deutsche Aktiengesellschaft – SDAG) was not possible, e.g. for "SDAG-Wismuth".

Before Chernobyl the USSR system of risk management was used. Some additional investigations were made on initiative and distinct interest of GDR scientists.

For the perception of risk in the GDR three specific features has to be appointed: The faith in the controllability of the nature by technology (human) after the Marxist Theory of the equalization of technical and social progress in which scientific-technical mental styles became ideological underpinned and politically privileged. This led almost to the entire absence of a critical public. The space for a relevant discussion of dangers and risks and the ambivalence of technology was considerably restricted. In general concepts of risk and safety were provided not as a precaution, but were seen as a subsequent improvement. This is also due to the separation of the departments in the science (e.g. separation of biology, medicine, physics among others). In the GDR, security meant, in the first line, effectiveness and maximum availability. In this context categories of availability and security were relevant in this order. The GDR was only restrictedly capable in the field of security equipment. They were defeated by the hegemony of the USSR. In fact, it was not allowed to add new components to the Soviet project for GDR. Every change of the project planning/design was accompanied by difficulties, delays and also a risk to the warranty coverage. Independent development of security equipment was per se in contradiction to contractual regulations. There were no opportunities for testing under real conditions and a huge lack of operational experience also played a big role for limited participation of GDR-experts in development of security issues. By the lack of data, one fell back in the GDR on the probability calculus for the judgement of the risks and the safety measures. Hereupon for identified problem zones/areas the "instrument" of the repetition check was inserted. Nevertheless, this approach led to statements of security experts with no scientific basis. (Kahlert: Kernenergieentwicklung. S. 76ff; Reichert 1999; VKTA 1999)

These developments and problems they tried to cope by a balance strategy based on highly qualified operating staff and diligence in the operation of the nuclear power plant. Exclusively degreed-engineers were appointed and every shift had a triple management / supervision: shift leader, reactor operator and an engineer on duty. Many of the engineers were trained/educated/qualified in the Soviet Union and in general there existed very strict operating regulations. The slogan was “Intelligence instead of concrete”. In 1973 a simulator for nuclear accidents/incidents was put into operation in “Rheinsberg” power plant.

The radioactive radiation emitted by Chernobyl led in the area of the GDR to considerable contamination, in particular the limit was exceeded in milk, grass and leafy vegetables. The politburo was informed daily from the SAAS about the situation. Nevertheless, after a exceedance of limit value of raw milk with radioactive iodine of 1,450 Bq/l on the May, 3rd 1986 the state declined other measurements or their documentation. In parallel it ran in other danger areas. Finally, the SAAS fixed in the report No. 13 new boundaries. This was a concealment of the extreme limit value excesses. The GDR media collaborated with the public authorities and reported information slowly, and played down the importance of the news.

The reluctant politics for publicity was in stark contrast to the consequences for nuclear power plants in operation. The persons in power were so alarmed that one implemented 68 changes in the security area for the project Stendal, the nuclear power plant in planning/design phase. Consequences for the operating nuclear power stations became clear (Rheinsberg and KKW Nord). This based on the letter of Gorbachev to Honecker from the 2nd of June, 1986. The main focuses of the international cooperation, creation of a messaging system and from recommendations to the security of nuclear power plants, as well as the cooperation by the development of sure reactors, became decisive for the next period of time. 6th of August, 1986 “operational recommendations for the improvement of security of nuclear power stations” were consigned/committed by the council of ministers of the USSR to the GDR. The far-reaching examination and control measures enclosed revision of plants and anti-emergency plans. Introduction and conversion immediately happened. Subsequently independent steps were suggested which the changeover on GDR technology for security and control systems. In March, 1987 based on the governmental decree “increased use of nuclear power” from 1983 a coordination group were founded. Their activity preliminarily orientated on the basic principle of “guarantee and enforcement of the security in nuclear energy” in the GDR. The group met often and contributed substantially to the development of requirements and awards of research contracts in terms of security.

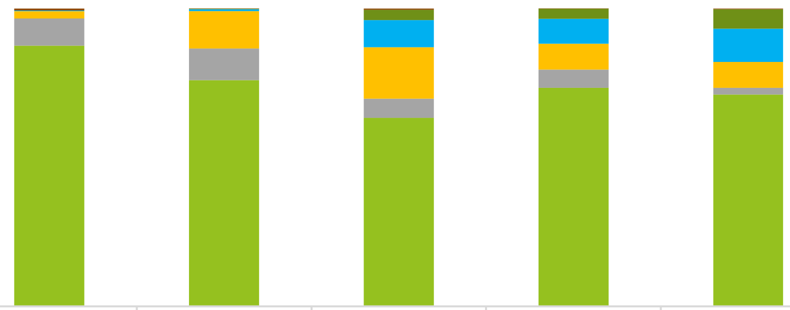
As a consequence of Chernobyl the growing international contacts in the field of Reactor security and Radiation protection the willingness to co-operate increased immensely. This interest was not only limited to security questions. In a direct and selective way one tried to win new suppliers for nuclear power plant equipment. Particularly, interests existed in collaboration with the USSR and later also the FRG. Nevertheless, the plan for a trilateral cooperation between the USSR, the GDR and the FRG prepared 1989 of was overtaken by the events of time and never came to fruition.

1.2.11. Sources and discourses

See Figure 4 Facts and Figures

The maximum of the nuclear energy in the GDR’s energy supply amounted to 12 percent in 1980. Then the portion in spite of the state plan "nuclear energy" of 1983 sank less than 10 percent. After Chernobyl it remained static. Finally, the portion of nuclear energy in energy production was about 10.3 % in 1989. In the area of electric energy consumption, the nuclear energy contributed as shown in the figure below.

Primary Energy Consumption in %



	1960	1970	1980	1985	1990
Others	0,7	0,1	0,5	0,1	0,3
Nuclear Energy	0	0,2	3,4	3,4	6,5
natural gas	0,2	0,6	9,1	8,3	11,2
crude oil	2,5	12,6	17,3	8,7	8,7
(hard) coal	9,1	10,6	6,4	6,1	2,2
Raw Lignite	87,5	75,9	63,3	73,4	71,1

The energy supplies of the GDR were based, above all, on the use of local lignite beds. Thus, the GDR covers her need in primary energy sources to about seventy percent with its own brown coal, which stand like coal, gas, nuclear energy, oil and water power at the beginning of every energy conversion. Mineral oil, mainly imported from the Soviet Union, as well as natural gas covered the primary energy needs up to 9 or 11 percent in 1988. The energy industry has supplied the remaining ten percent by nuclear energy, coal and other energy sources, for example water power.

A comparison with Federal Republic of Germany for the cover of the primary power demand underlines the exceeding high proportion of the energy source lignite played in the energy balance of the GDR. The FRG based with her primary energy supply above all on the mineral oil which covers about 40 percent of the need. Brown coal, with a portion of eight percent in 1988, was behind coal (about 19 percent), natural gas (16 percent) and nuclear energy (12 percent) a rather subordinated rank. The GDR relied on lignite for the supply of electric energy. More than eighty percent of the generated electric energy came from power stations which were fuelled by lignite. And, finally, brown coal is, above all purified/upgraded as a lignite coke material and brown coal briquette, the most often used heating material of the industry, trade, governmental facilities and not least also of private households. Thus, for example, still 60 percent of the flats were equipped with single stove heating. The required gigantic amount of more than 300 million tonnes per year were mined in open-cast mines. The brown coal surface mines were concentrated above all in the West-Elbe district around Halle and Leipzig as well as in the Lusatian district in the east of the GDR, around Senftenberg and Cottbus. With this output the GDR was the global market leader and reached narrowly about one third of the lignite extraction worldwide per year.

1.2.12. Lignite

Since the foundation of GDR, the portion of the lignite of the cover of the primary power demand was fluctuant between 65 and 90 percent. Differently to the Federal Republic which covered about 60 percent of her power demand by imports the GDR was able to cover the biggest part of the energy consumption, namely about 70 percent, with own raw materials. With an annual output of more than 300 million tonnes (t) lignite the GDR was by far the biggest brown coal producer of the earth; 311 million t of brown coal were mined in the GDR in 1986 what corresponds to one quarter of the worldwide annual production. The Soviet Union as a second largest brown coal producer of the world extracted only possibly half as many like the GDR. Europa’s largest uranium deposits of were on the area of the GDR. Highest hopes for the nuclear energy use were also accompanied by the expectation to an independent supply with nuclear fuels one day. The GDR discovered uranium in Thuringia as well as at the south of the Erzgebirge which were exploited/mined by the Soviet-German joint venture "Wismut SDAG". The uranium from these areas went completely to the Soviet Union where it was processed to reactor fuel, and perhaps also into nuclear weapons. Despite of waiver of reparations (1954) uranium deposits were not available for the installation or consolidation of a nuclear energy economy. The faith in a future use of the resource uranium had established with the political decision makers as well as in the area of the science experts. The Soviet Union did not relinquish the sovereignty to dig for uranium until reunification in 1990. In retrospect this demonstrates the stranding of the whole planning’s concerning a nuclear energy economy. The GDR worked on building a common power grid with both Poland and Czechoslovakia and on establishing a network of Soviet-built nuclear power plants. However, the largest source of

GDR's power was from large thermal power stations that mainly used low-grade lignite. Chernobyl confirmed the wisdom of GDR's move away from the Soviet-designed nuclear power plants, but foreign energy sources were not a part of the replacement effort. As a result, more lignite plants and mines were planned and opened. By 1988, lignite accounted for 83 percent of GDR's electricity production, and 74 percent of total energy production. The GDR was mining 320 million tons of lignite — roughly 25 percent of global production.

The GDR's energy system, which was dominated by domestically produced lignite, was characterized by large thermal power plants, lagging levels of efficiency, and a lack of pollution controls. The GDR then pursued a dual policy of attempting to reduce energy consumption (without raising energy prices) and of replacing imported energy with domestically produced lignite. This policy carried a range of high economic, social, and environmental costs. The government opened large open cast mines (strip mines) that required the evacuation of villages, relocation of roads, and lowering of water tables. Further costs were borne when the lignite was burned, releasing high amounts of air pollution for a relatively low energy value.

The fundamental for life and every kind of development in GDR was the "scientific socialism". Everywhere a limitless faith in science was pursued. Forecasts and plans were an indispensable part of this world view. With it the energy industry also was highly dependent on forecasts of the power demand and energy consumption. For the different stages of development and investments regarding nuclear energy in the GDR forecasts were decisive over and over again. In particular, the state believed that this country, poor of raw material, needed to establish a widely independent energy industry with the help of nuclear energy. It is difficult to estimate how appropriate or accurate the forecasts were. Forecast were given with the intention to keep balance between actual possibilities and the wish of the party leadership. The use of the nuclear energy was never questioned in principle in the GDR. It was stated in Party Congress and Politburo decisions. However, this does not reflect the way the political base lines should be filled specifically. Controversies about the choice of reactor types or the necessary extent of own research and development refer to conflicts of interests between different actors. Discussions between scientists, the industry and representatives of the state plan commission (Staatliche Plankommission – SPK) made clear that in the GDR-specific decisive “environment” could become. In the 1960s basic changes were taken for the development of the nuclear power. Should technical or economic criteria determine, besides, the guidelines of the decision-making? In 1965 the SPK dominated with its position to avoid use of industrial own contributions for economic reasons and to import, instead, the main equipment ready for occupancy from the Soviet Union. However, the abstract defined principle of more international economic-technical cooperation formed the basis of this decision rather than the practical experiences of the engineers who were already occupied with the construction of nuclear power plants and coal-fired power stations on the base of Soviet equipment imports. The history of the nuclear energy use in GDR cannot be reduced to the technical development and economic function of the energy production. The nuclear energy also adapted itself in socialist progress hopes. As a large-scale technology nuclear power should show/prove the restrictions of the capitalistic system and the technical superiority of the socialism and incarnate the vision of general prosperity for the masses. The affinity of the socialist countries to large-scale technical projects has been ascertained repeatedly. Technologized visions were exploited as a part of the state ideology, opposition against large-scale technical projects was suppressed, the state appeared as an initiator for all development. Mass production and craze for the huge and spectacular shaped the style of Soviet technologies. This also applied for the nuclear power plants - Soviet type which were used in the GDR. Exaggerated expectations of efficiency and the industrial development of the Soviet Union was characteristic for the establishment of nuclear research and nuclear technology in the GDR after 1955. The termination of the intensified nuclear energy program of the GDR appears as a logical step of energy politics to the real possibilities. The "huge size" of the development tasks overwhelmed the capacities of the “small GDR“. The political leaders had to concentrate the scanty resources upon well-chosen industrial branches. For example, the “chemicalisation” of the GDR industry sped up at the nuclear industry in the 1960s. Even if the production of energy-intensive raw materials and products was a reason for the extremely high energy consumption in the GDR, nevertheless, structure-changing interventions were missing in the economy. The structural-based high energy consumption of the GDR remained as the decisive factor of the energy policy.

Research and development in the GDR was very specifically characterised by partly foreign-policy, partly by domestic decisions of the GDR leadership. The Berlin wall and all corresponding decisions were a clear example. This includes for example the embargo by the COCOM list (List of Coordinating Committee on Multilateral Export Controls) – hence western high tech products were available only very limited. This includes for instance western technologies which were re-developed by imitation in the GDR, however, an increasing dependence on Soviet products and supplies too. This makes a link to the nuclear energy use in the GDR. Since 1975, the oil crisis also affected in the COMECON, in 1979/1980 occurred of another rise in prices. At the beginning of 1980 the Soviet Union already shortened natural gas deliveries to the GDR. In 1981 they lowered the crude oil deliveries subsidised by the COMECON- price formation mechanism to the GDR about 2 million tonnes. Besides, the GDR competed with western countries for primary energy sources from Poland and Soviet Union since beginning of the 1980s. These energy-political events had serious consequences for the macroeconomic situation and worsened the economic crisis of the GDR. In view of the more and more difficult situation on imports of primary energy sources the political leadership made the decision for replacement of oil. The concentration of investments lignite was made to substitute the oil imports with local energy sources. The leadership of party and governance accepted in the light of energy security the ecological and, with rising mining costs, also the economic results of the forced lignite use with a considerable environmental impact by sulphur dioxide. In 1989 the GDR had the biggest pollutant emission of sulphur dioxide per inhabitant in Europe. The decision for the oil replacement meant a clear shift away from the energy-political guidelines of the early 1970s. The plans pursued at that time the objective to strive a change of the energy structure on the basis of natural gas, oil and nuclear energy. Exclusively nuclear energy became more fesible on account of the restricted import possibilities. Though with nuclear energy no overall, but at least a far-reaching independence of the electric energy production was to be achievable. Continuously the political and economic leaders stressed that there was no alternative to a reinforced use of the nuclear energy. However, the construction of the nuclear power plants already slowed during the 1970s. In 1976, the third and fourth development stage of the nuclear power plant Greifswald temporarily came to a standstill, after the Soviet Union had adopted/renewed directives and compiled a new reactor project with an improved safety and security concept. The construction of the nuclear power plant III near Stendal began with a total uncertainty on reactor types to be established. The delays of the power station construction had a harmful effect towards the economic and energy policies and planning activities. Thus the delays of the power station construction contributed to a considerable cost increase.

Nuclear power was seen as the single option to resolve the energy problem of the GDR for a long time. But in the end every time it was not the nuclear power which provided greater security in terms of energy needs and supply. Recourse to lignite always was the result. Because of non-existing debates on nuclear power there was no reciprocal impairment.

1.2.13. The “political turn” and the reunion

From the huge number of the energy-political threads in the process of transformation (nuclear industry, coal, competition, Kommunalisierung) above all the conflict of municipalisation arose as the key determinant for restructuring of the East German energy economy. The transformation is marked above all by the attempt to pursue energy policy about property, that is, above all, about privatisation politics. Without doubt the transformation of the East German energy economy has been a process in which East German as well as a huge number of West German actors have been involved. The takeover of judicial and institutional system from the federal republic continued till 1997/98. The restructuring of the nuclear economy was a process which began in the course of the political upheavals in 1989 and was determined with the decommissioning of all nuclear power plants till autumn 1990. With the opening of the borders the GDR lost the political sovereignty on the 9th of November, 1989. In January, 1990 the minister of environment of the FRG by order of the council of ministers of the GDR visited Eastern Germany and one expected the proposal of common security analyses to the nuclear power plants of the GDR. As a result of the visit a common commission for “nuclear-technical safety and security and ray protection” was formed. Different common working groups for security, ray protection, disposal and nuclear right belonged to this commission.

The visit of Töpfer was accompanied by protests of anti-nuclear activists from East and West Germany in front of the building site of the KKW III in Stendal. At this time, it was reasonable to assume the continued operation of the nuclear power plants in the GDR in cooperation with the German Federal supervisory authorities and the power station industry (in particular Siemens KWU). Nevertheless, the visit of the German Federal Minister of Environment synchronised with the formation of the anti-nuclear interests and groups which had originated from the civil rights movement of the GDR. Alarmed by the signals of conservation for nuclear power plants in GDR the central “round table” gave order for an examination of the status of the facility of Greifswald which contributed substantially to the shut-down of the nuclear power plants.

The nomination of the experts traces back to the Minister without Portfolio, Sebastian Pflugbeil, and concerned four consultants from FRG and three from GDR. Every person was probably rather assigned to the camp of the nuclear sceptics. In the result one recommended an immediate shut-down and decommissioning on the basis of material problems as well as from system-technical view. In July, 1990 a study of the Ecological Institute of Freiberg (Öko-Institut Freiberg) and the independent Institute of Environmental Issues Berlin (Unabhängiges Institut für Umweltfragen Berlin) examined other parts of the Greifswalder nuclear power plant and the power plant under construction Stendal, but also the Rheinsberg plant was judged. All certificates correspondently came to recommendations of closure of the construction/facility. The central juridical argument was the establishment/introduction of the FRG nuclear law also in the GDR to the 1st July 1990. In the end, the opponents of further operation prevailed in particular by the establishment more substantial financial barriers for the reconstruction and mandatory requirements in respect to assurances. There came uncertainties concerning approval and duration of an operating licence.

The West German power suppliers who could take over the electricity supply without any problems on the basis of own overcapacities won influence on the energy-economic development of GDR. In August, 1990 the RWE Energie AG, the Bayernwerk AG and the PreussenElektra AG took over the electricity supply of the GDR in a "trust contract". Nevertheless, the environmental remediations and the nuclear power stations in operation were consciously excluded. Upon conclusion of the contract the East German nuclear energy economy had lost every support. In view of the above a continuation of the nuclear energy economy was neither politically nor economically enforceable to the public. These surprisingly strong public views became by some protagonists the decisive factor with regard to the shut-down and decommissioning of the complete nuclear energy economy of the GDR.

Already in November, 1989 Rheinsberg was shut-down because of security doubts. Beside the cited examinations and the change of legal situation the missing containment and the exposed position in the flight corridor of Peenemünde implicated decommissioning also in Greifswald. In addition, the industrial decline along with decreased power demand which became absolutely concrete in the middle of 1990. In summer, 1990 the blocks from 2 to 4 of KKW Nord were shut down. Because the district heating supply of the city of Greifswald was guaranteed by the nuclear power plant the block 1 followed right after construction of an oil fired power station in October, 1990.

In the end, the shut-down and decommission was a political decision which took the path of least resistance during the reunion of Germany. For another solution it would have required a discourse between advocates and opponents - above all at that time each party seemed unable and unwilling. The civil movement of the GDR saw and used the unique historically chance to close the chapter of nuclear energy in Eastern Germany once and for all and might give an impetus for the nuclear phasing-out /exit of the united Germany too.

2. Showcase

2.1. The Scientific-Technical Institute for Reactor Construction

2.1.1. Step into nuclear power under the light of energy predictions

"*In the course of the second five-year plan we will begin with the construction of the first nuclear power station in the German Democratic Republic*."

This announcement of Walter Ulbricht at the 3rd SED conference in March 1956 was in harmony with the political position of the GDR towards nuclear energy use. Based on the energy-economic situation of the country, on integration in the East-Bloc and on competition with the FRG it needed symbolic projects like nuclear technology to hide economic problems in the middle of the 1950s. The temporal coincidence of the seemingly unlimited possibilities which seemed to arise from nuclear power, and the discontinuation of law No. 25 of the Allied Control Council in 1955 led to a new set of organizational structures in both German states. The government of the USSR had strengthened this with the declaration for "Help for other countries for establishment of scientific-technical centres of nuclear physics" from the 18th January 1955 their hegemonies on issues concerning technology and science.

Quick decisions resulted often from a deficit research state, national pride and prestige of the socialist state and fear of losing experts.

Essential institutions were launched e.g.: the Scientific Advisory Board for peaceful use of Nuclear Energy at Council of Ministers (WR) chaired by of Gustav Hertz (1887-1975), the Office for Nuclear Research and Technology (AKK) directed by Karl Rambusch (1918-99), the institutes of the AKK (e.g. Central Institute of Nuclear Physics Rossendorf / Dresden (ZfK)) and the foundation of the Faculty for Nuclear Technology at the Technical College of Dresden.

2.1.2. Big brother Soviet Union

The contractual regulation with the USSR, which stated that

"…the choice of cadres and from specialists which are determined for the cooperation in the development of the NPP-project is led by the Soviet institutions…",

suggests a complete subjugation of the GDR under Soviet power concerning the construction of NPP I (Rheinsberg). Specialists for nuclear physics were in short supply in the GDR. An international connection did not exist, even with the "brother nation", the USSR. There was also no authority in matters of science and engineering that would have been capable to run the construction of a nuclear power plant.

At this time, the attempts of the GDR government to solve the nuclear energy problem by a complete import seemed coherent. Because one did not want to proceed, nevertheless, completely into the hand of the "brother", participation should be ensured by supply, partially planning and delegation of cadres for training in the USSR. Max Steenbeck (1904-81) had been assigned with scientific accompaniment of the process of NPP-construction and as a door opener on Soviet side. From 1957 in AKK a scientific working group, which became known as "group Steenbeck", was set up for this purpose. This ended up in foundation of the "Scientific-Technical Office for Reactor Construction" (WTBR) in June, 1958. The intention was to "plan and design the GDR future power stations working with nuclear energy".

The WTBR showed the clearest sign of the GDR to want to go own ways in the reactor constructions. With the later decisions of the state administration for the exclusive restriction on the Soviet reactor development/design the WTBR compulsorily had to come to a conflict between assigned tasks and real conditions. The phase-out of own works to nuclear energy creeps up from 1962, until the final agreement for total import with Soviet Union on 14th July 1965.

2.1.3. Atempt of an origin path

Steenbeck recruited out of his immediate circle at the university of Jena young physicists; from the AKK, employees were head hunted as well as from state-owned specialized companies.

Among other things, Steenbeck pushed through for its staff the invalidity of a formal obligation concerning non-entrance of the western sectors of Berlin.

In the first phase was an intensive familiarization in preliminary plans, as far as these existed and were accessible. The state of knowledge on nuclear physics or reactor technology did not exist for many of them. For this reason a number of cadres should collaborate as soon as possible with the Soviet planning agency "Teploelektroprojekt" in USSR. Literature must have extensively existed or been accessible, and almost during whole existence of the "group Steenbeck" and WTBR active conference participation was in western than in eastern countries. A tradition of weekly colloquiums to special nuclear-physical, technical or safety and security problems was generated. Nevertheless, the "group Steenbeck" worked self-sufficiently rather theoretically or observant. The use of western German or American terminology was due to literature access and/or linguistic barriers.

Steenbeck considered successfully a whole range of special disciplines by the power station construction. For example, a biologist was integrated to observe the effects of temperature on the environment raised by discharging heated water, the material dynamism and the hydrologic regime at lake Stechlin and lake Nehmitz. This led to the foundation of a research Centre for Limnology on the 12th March 1959.

2.1.4. Working program

With directive of the MR, WTBR was founded the 14th June 1958. As a general task were established: “To conduct research and development concerning the construction of reactor arrangements and to educate socialist cadres in the area of nuclear research and technology for our national economy“. In charter it was explained more specifically in addition:

- "Theoretical and technical calculation, development and construction of reactors;
- Treatment of basics for the construction of reactor arrangements including measurement, management and control systems as well as the radiation protection;
- Preliminary planning of reactor arrangements, instructions of the executing companies at construction process, engineering and if necessary individual solutions in collaboration with engineering departments and manufacturers;

- Investigation of different variations of power reactors on economic efficiency and technical problems or feasibility;
- technically, economically evaluation of construction and operation with reactor designs and elaboration of measures to the increase of the economic efficiency and operational safety;
- technical and scientific coordination of all research and development works concerning reactors;
- Education, training and instructions of specialists for development, construction and operation of reactors."

Max Steenbeck was officially appointed to the chair of WTBR at its foundation. While the group Steenbeck, with only a few employees, started at the beginning of 1957, at the end of 1959, there were already 125 employees. Therein 75 were engineers and 21 scientists, the rest were skilled workers or employees of the administration. In 1960 the number of staff rose to 169 employees.

In addition to scientific employees, high-school graduates were employed as assistants for numerical calculations. Within the scope of the socialist teamwork help was provided by the institute of applied mathematics of the AdW regarding numerical and mathematical problems of reactor calculation. Graduates at the Institute of Theoretical Nuclear Physics at the Technical College of Dresden made calculations for reactivity of uranium water reactors after different methods within the scope of dissertations.

The first research tasks of WTBR were rather general. They included the co-operation/assistance in the process of construction of the NPP 1 – 1st stage of development; the preliminary planning of the NPP 1 – 2nd stage of development and the creation of the scientific-technical conditions for the other prospective planning for a nuclear energy program. These main points were sustained by means of specific work assignments.

On July, 1957 the main issue was the discussion of the preliminary project from Soviet project organization, Moscow TEP (Teploenergoprojekt). Besides, their own proposals to the design of NPP could be implemented, so three cooling loops in the first circulation. The power plant was designed in original with just one loop. An NPP of that design would not have been operable without extreme security risk on "half load".

2.1.5. Problems

In summer 1959, Max Steenbeck expressed serious doubts with regard to the behaviour of the NPP in case of incidents. The worries concerned above all pressure and thermal capacity of the reactor filling which cannot withstand by the reactor cover, just as little as the reactor building. The AKK hypothesized a “pressure balance of 3 ata”, while the calculations of the WTBR started at double or triple. One agreed on the examination of the calculations. The radioactive contamination of the atmosphere should be included with complete leak of the fission products from cooling circulation 1 in the subsequent evaluation, taking in considerations of calculations for Hiroshima and small US-reactors. Steenbecks position: The German side is not exempt from any responsibility in the worst case.

Most important tasks of the WTBR were:

- Nuclear reactor physics and physics of the first circulation;
- Explorations of new and existing variations of power reactors;
- Thermal technology and flow engineering for reactor and first circulation;
- Concept designs for reactors;
- Concepts for the construction of reactor arrangements including measurement, management and control systems as well as the radiation protection;
- Basic conceptions for nuclear power plants and economic issues concerning the use of the nuclear energy;
- Technical and economical evaluation of construction and operation;
- Design and planning of 2nd stage of NPP 1 Rheinsberg;
- Education, training and instructions of specialists for development, construction and operation of reactors.

From 1960 above all the “development of a project study for the 2nd stage of development of the nuclear power station I with substantially improved pressurized water reactor”.

The employees of the WTBR attended at many conferences and visited exhibitions or other institutes in context with the prioritized project "Nuclear power plant". Thus about 30 scientists could visit the Soviet Union in 1960 and, against the general trend, above all also nuclear facilities in “Great Britain, West Germany, Sweden and Italy“. Besides, "the lack of own tests was compensated by these visits at least to small part [and thus poor choices […] can be avoided]”.

Even if staff was successfully recruited, the lack of specialists could not be compensated completely in WTBR. This was a general issue of the construction of the NPP 1, a general issue for all special needs in GDR. As a result studies could not be carried, for example, the study of the department of economy of nuclear energy on subject: “cost comparison coal / nuclear energy“ in 1960

Within the scope of the project engineering, but in particular with the construction of the NPP "Rheinsberg" severe problems appeared in cooperation with USSR. Besides, big problems were named concerning exchange of technical documentations and particularly with material orders.

Steenbeck: “The impression about the cooperation between the different countries of the western world demonstrates the cooperation that cooperation in socialist camp, in particular by the Soviet Union has to be improved necessarily in the area of the nuclear research and nuclear”.

Max Steenbeck commended openly in 1959 concerning the situation of nuclear energy economy: “For a larger NPP, whose operation is expected in 1970, one has to start with all preparations from personnel training via project engineering and construction up to manufacturing far before 1965. With support by the USSR many independent supplies should possible.” 1961 the situation becoming more acute concerning "Rheinsberg", so Steenbeck expressed his “serious concern for the construction of the atomic power station” addressed to AKK and the SPK:

“There is no doubt that we would save mostly from the position of a purely financial balance if we stop the construction immediately and left the present building as a torso.”

2.1.6. Efforts in resolving the crisis

The GDR government tried to meet these problems above all with structural measures that led subsequently to numerous re- and new structured players in energy sector and at last also a new adjustment of the energy policy. In the situation of an economic crisis in which the GDR was the development of the nuclear energy economy was terminated. Beside structural steps there were above all the measures of the “new economic of system” of a state central economy which signed for the following development. WTBR fell victim to the structural changes. With an order from the 7th March 1961, the WTBR was dissolved retrospectively to the 31st December 1960 in a typical manner for the GDR. By the 1st January 1961 the VEB EpkA had taken tasks and duties of the WTBR.

2.1.7. Estimation

WTBR were founded by intention of own ways in the nuclear energy sector, after all important decisions for the coming epoch were made. Not to underestimate is the position of the Office: Nationwide as a vicarious agent and at the same time engine of ambitious economic and political plans regarding solutions of the energy question. In parallel WTBR became a protégé/ward without enough support by hegemonial claim of the USSR.

The cooperation with the industry was necessarily quite intensive and marked by big challenges, because WTBR not only head hunted experts, but put in addition pressure on companies. With transition of the duties to VEB EPkA all works for second stage of "Rheinsberg" were stopped – the end of any autonomous development for nuclear power plant construction in GDR.

2.2. The Research Centre for Limnology

2.2.1. Overview

The 1st February 1959, the research centre for limnology was founded by the committee of the research council of the (East) German academy of the sciences to Berlin. The centre had the head office in Jena and a branch office in the Stechlinsee near of the village Neuglobsow. Theodor Schräder (1904-1975) was appointed to the first head of the research centre. The foundation of a research centre for limnology was closely in context with the construction of the first East-German nuclear power station near Rheinsberg on the shore of the lake Stechlin. In spite of the euphoria in the nuclear energy at that time one was aware of the dangers by radiation as well as the influencing of the ecosystems of rejected heat. Effects of the temperature raised by discharging of warmed up water on the environment, the material dynamism and the hydrologic regime of the lake Stechlin were expected and accordingly started research in this area. Therefore, in the years 1958 and 1959 it came to foundation of two institutes with relation to lake Stechlin -to the research institute for hydrometeorology with head office in Berlin and also a branch office at lake Stechlin as well as the research centre for limnology, one of the precursor's facilities of the IGB (Leibniz-Institut für Gewässerökologie und Binnenfischerei - Leibniz-Institute of Freshwater Ecology and Inland Fisheries). The lake Stechlin and its catchment area under influence of the NPP operation became the main object of the researches of both institutions.

2.2.2. Foundation of the Research Centre for Limnology

Made by the decision of Academy of Sciences of the GDR, data on the environmental impact in the area of the lakes affected by a NPP were first accessible by the foundation of a Research Centre for Limnology. The major task of the research centre was basic limnologic research in thermally loaded lakes. Observation of characteristics of an oligotrophic layered hard water lake and a mesotrophic lake – lake Stechlin and Nehmitz – was central. In particular, the physicist Max Steenbeck (1904-81) and the biologist Kurt Mothes (1900-83) exerted their influence for an intensive research in both lakes, which were connected artificially by the “Polzowkanal”. Steenbeck had given directions for a “complex biological research program lake Stechlin“.

With effect from the 1st of February, 1959 the foundation the research centre with head office in Jena and a branch office near lake Stechlin was decided by the advisory board of the German Academy of the Sciences. Theodor Schräder became appointed as the first head of the research centre and manages it till 1969.

Crucial point of the foundation was the construction of the first East-German nuclear power plant at lake Stechlin with an external coolant circulation. Already at that time especially Steenbeck was aware that thermal discharges by warmed up coolant from NPP from ecological view would not remain without consequences for flora and fauna, bacteriological conditions as well as for mineral balances.

2.2.3. Limnologic basic research in a thermally loaded lake

The following major tasks ought to be explored by the research centre (at example of Lake Stechlin):

- basic research in the whole area of Limnology as the science from interactions/ interrelations between the inland water as a biotope and its inhabitants as biocenosis;
- clarification of questions relating synecology of the organisms in and along inland waters of all kind including the identification of any biogeographic problems;
- descriptive as well as experimental research for maintenance of the autecology and system of aquatic organisms.

In 1962 Schräder founded the limnological journal “Limnologica” which developed increasingly to an important and respected voice/platform of the national and international limnology. The journal shaped quite decisively in time before “political turn” the scientific exchange with the western foreign countries. Since 1992 the magazine is published in cooperation from “German society for Limnology (DGL)” with Elsevier Ltd (Urban& Fischer) and is part of Science Citation index Expanded (SCIE) since 1993.

2.2.4. Reform of the Academy, contract research and integration in the ZIMET

In 1969 the scientific focus of the research centre had to be shifted on contracted research within the scope of the "academy reform". Principal client for this ecological research was the ministry of environment and water economy, later the academy and the ministry of science and technology. This conversion led to a high bureaucratic expenditure and tied up a lot of resources from the continuous scientific work.

From 1972 to 1991 the research centre for Limnology lost independence and was integrated as a department into the Central Institute of Microbiology and experimental Therapy (ZIMET) Jena and belongs to the East-German Academy of Sciences.

In context of the reunion a comprehensive evaluation took place for all existing research facilities of the Academy of the Sciences and Academy of Agricultural Sciences by Evaluation

Commissions conducted on behalf of the Science Council (Wissenschaftsrat), which advises the German government. In 1992, in consequence the Institute of Freshwater Ecology and Inland Fisheries (IGB) was founded in Berlin as a new blue list institute with a substation in Neuglobsow - department Limnology of layered lakes. During the following years workplaces and lab equipment as well as field instrumentation could be modernised. This enabled to waters-ecological research and theory at highest level.

2.2.5. Heat stress by NPP

A “large-scale waters-ecological experiment with uncertain outcome“ said the scientist Peter Kasprzak: About 300 million litres of coolant from the NPP Rheinsberg, ten degrees more warmly than water of lake, flooded into the lake Stechlin – daily and for more than 20 years.

Within one year the lake ran completely through coolant system of the power station. To examine the effects of the heat influx for the ecosystem lake Stechlin, was the founding mission of the research centre. At that time nobody could anticipate the topicality of the research projects to ecological effect of temperature rise on inland waters fifty years later.

The thermal stress ended with the shut-down of the power station at the end of 1989; but the studies of the scientists persisted. Thus, fifty years later, there is a source of data about lake Stechlin which might count to most extensive and significant worldwide. For the modern climatology the results of the long-term study are invaluable.

Hope, the waters may return to balance before NPP, has not come true. The data show concerns the very complex and time-delayed reactions of waters. Particularly during the last fifteen years the state of the Stechlin has clearly changed (e.g. shortening of seasonal ice coverage).

3. Events

3.1. Event 1: Entrance to nuclear energy

Immediately after the UN conference in Geneva in August 1955 a systematic information campaign in newspapers, broadcasting company and television was initiated to dissipate the fear of the "spectre" atom and, instead, inspire the peaceful use of the nuclear energy to the population of the GDR.

On the 11th October 1955, the “Politburo”, on the 10th November 1955 also the “Minsiterrat” (Council of Ministers) made first a decision to the civil use of the nuclear energy, to create a central research centre and an "office for nuclear research and nuclear technology" (AKK), comparably to the nuclear ministry installed shortly before in the FRG. In 1955, an agreement with the USSR was made and used in 1957 by the council of ministers to establish the "scientific advice for the peaceful use of the nuclear energy" which should consult the government. The ambitions were big: "About 20 nuclear power stations should go till 1970 to the net”, so the AKK in the SED newspaper "Neues Deutschland" in 1957. In the end just the construction of the first power plant “Rheinsberg” from 1956 to 1966 was realised. And this was not more than a test reactor and more or less in use for training and research.

3.2. Event 2: Diminished nuclear programme after 1962

Already in 1962 the nuclear programme was reduced again. The energy commission of the “Forschungsrat” (FR) recommended in the end, that one can cover the power demand till 1970 without nuclear energy and bring down the investments. So the development was adapted to the restricted economic possibilities of the GDR. At first an own development of nuclear technology was planned, also in the breeder technology, in the end of 1963 the “Staatliche Plankommission” (SPK) resolved within the scope of the specialisation within the COMECON (Council for Mutual Economic Assistance) to import all arrangements completely from the Soviet Union. In 1965 the first nuclear energy programme was also given in which beside the atomic power station 1 (Rheinsberg) and the atomic power station 2 (Greifswald) the use of other thermal reactors and fast breeders were planned, without any independent development.

The nuclear power station Greifswald was part of the governmental agreement with the Soviet Union in 1965. One chose the location in a sparsely populated region and in a manner that radioactive clouds should be blown in case of accidents by the west wind on the sea.

3.3. Event 3: A new nuclear energy programme

In 1983 another nuclear energy programme was presented. This intended that all main power stations on nuclear energy base should deliver electricity from 1990 on and from 2000 the growing demand should be completely covered by nuclear power stations. In the governmental visions fast breeders and fusion reactors were planned. In detail four reactors with a capacity of 1,000 MW should go to the net, beside four blocks in the location Greifswald, until 1998 in the KKW III in Stendal, to 2000 other three with 1,000 MW in a planned KKW IV and from 2002 to 2010 other eight reactors with 1,000 MW in planned nuclear power stations V and VI. Nevertheless, such plans turned out as a pure utopia due to the problems of construction and operation. From 1983, the Soviet Union had serious difficulties in the production of atomic reactors. The products from supplying industries were insufficient and the training capacities were wrongly planned. And also in the construction of traditional pressurized water reactors (PWR) of the type VVER 1000 there have been in the Soviet Union breakdowns and delays. The completions of nuclear power stations stagnated.

3.4. Event 4: Chernobyl

The Chernobyl incident, which had occurred in the eastern bloc partner USSR, was extremely uncomfortable and difficult for the GDR government. Between the 28th April and the 14th May 1986, the GAU (worst case) was covered/suppressed by every trick in the official newscasts of the “Aktuelle Kamera” (News). All the news was considered as "hyped", and, therefore, it was considered that checking the GDR reactors was not relevant as there would be no danger. The "MDR" has put into archives the telecasts of the “Aktuelle Kamera” Chronology of GDR reports. One emphasised different construction method of the GDR reactors, enumerated nuclear accidents in western countries, and in "Neuen Deutschland"(Newspaper) even of a "specific scaremongering" of Soviet-hostile circles. Because Chernobyl had caused a higher sensitivity for security and the Soviet Union could produce no nuclear power stations at Western safety standards. Cooperation with the West, in particular of the FRG, was sought after 1987. At the same time, there were attempts to improve the security in nuclear power stations in process or under construction by new regulations.

The mismanagement led to a stronger control and disciplining of the nuclear power station staff by the Ministry of State Security of (Ministerium für Staatssicherheit). The growing international pressure on the GDR-Government lead in 1989 to the decision to close down the atomic power station "Rheinsberg" in 1992. Up to the "Wende" (wall came down) there were only isolated protests of the population against the use of the nuclear energy. The citizens had no voice in location decisions, discussions were suppressed. As the western anti-nuclear power movement of the seventies could not be simply ignored any more, one tried to persuade own population that the technology of the atomic energy production is not a danger for itself, but it brings risks only in connection with capitalism.

3.5. Event 5: Decommission

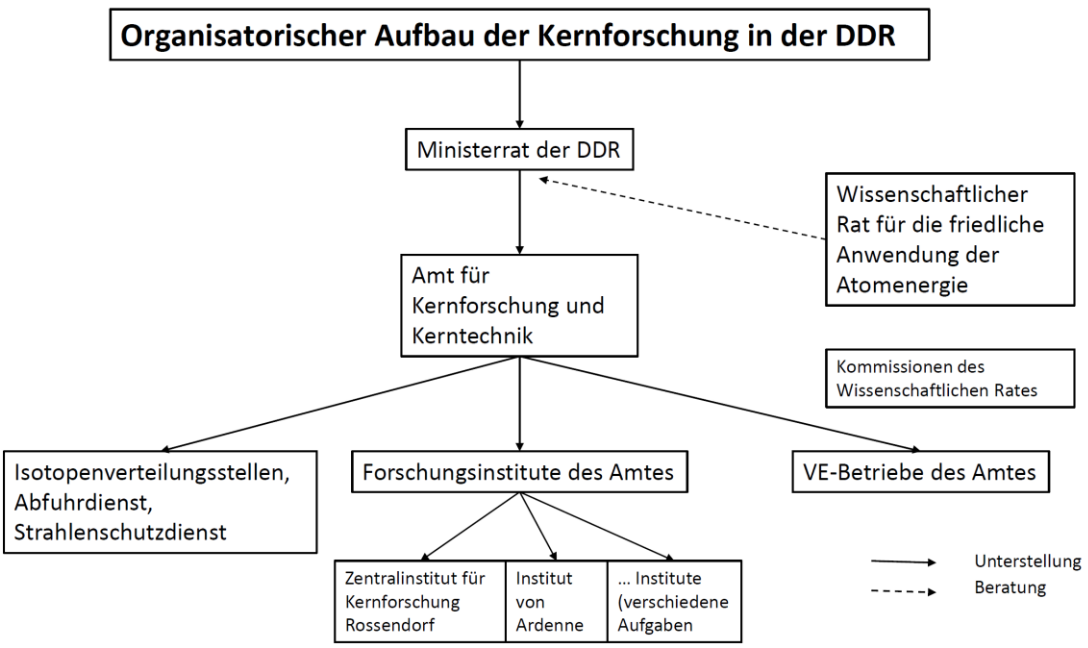
The mismanagement and misinformation which had ruled concerning nuclear power stations of the GDR became known to the public only in 1989. Sebastian Pflugbeil (Minister in the last GDR Government) examined background materials and documents. From confidential papers of the "Ständigen Kontrollgruppe Anlagensicherheit" (permanent security control group) arose the ailing state of the GDR nuclear power plants and basic organizational problems: defects in qualification, labour organisation, slackness and alcohol abuse. Up to the end no one has obtained detail information about the steel used for the reactor pressure vessels. There were problems with used materials, measuring instruments which did not functioned, and so on. Pflugbeil had protested before in campaigns against uranium mining. His tributes to safety deficiencies and costs for reconstruction induced the end of the history of the nuclear energy in the GDR decisively.

After the reunion in 1990, the FRG took over the inheritance of the nuclear politics of the GDR and had to make decisions. In the beginning of 1990 Umweltminister (minister of environment) Klaus Töpfer at that time visited the GDR and examined Morsleben, the atomic power station Greifswald and the building site of the atomic power station Stendal. The security of the stations was even by internal papers of the Eastern bloc and the “GDR atom control” evaluated as absolutely insufficient and reconstruction or decommission were recommended. Thus the reactors in Greifswald had, e.g., no Containment.

4. Facts & Figures

The purpose of this section is to give an overview of nuclear power in the GDR. This section contains such data as number of reactors, reactors' locations, technical and chronological details of reactors' construction as well as statistics on electricity production, periodization and social connections to nuclear constructions. This data can be used as a supportive material to the following sections of the country report and in order to understand the overall country's situation. Key dates and abbreviations used in this report are presented in the beginning of this section.

4.1 Structure of Nuclear Physics



4.2 Map of nuclear Assemblies

4.3 Data of nuclear facilities[1]

Forschungsreaktor ZfK Rossendorf

Typ	WWR-S, heterogen, thermisch
Brennstoff	Uran auf 10% an U235 angereichert
Konstruktionsmaterial	Aluminium und nichtrostender Stahl
Kühlmittel	Destilliertes Wasser
Moderator	dto.
Reflektor	dto.
biologischer Schutz	Destilliertes Wasser, Gusseisen und Spezialbeton
Leistung	maximal 2000 kW

[1] Reichert

KKW I Rheinsberg

Reaktortyp	WWER-210
Nettoleistung	62 MWe
Bruttoleistung	70 MWe
Baubeginn	01.01.1960
Inbetriebnahme	09.05.1966
Netzsynchronisation	06.05.1966
Betriebsstunden	130.000 h
Gesamtbruttoerzeugung	9.000 GWh
Zusätzlich	Forschungsarbeiten sowie wissenschaftlich-technische Betreu-ung der Kernkraftwerke; Aus- und Fortbildung von KKW- und Fremdpersonal sowie Studenten
Kommerzieller Betrieb	10.10.1966
Abschaltung	01.06.1990

KKW II Nord (Greifswald)

	Reaktor	Leistung	Baubeginn	Inbetriebnahme
Block I	WWER-440/230	440 Mwe	1970	1973
Block II	WWER-440/230	440 MWe	1970	1974
Block III	WWER-440/230	440 MWe	1972	1977
Block IV	WWER-440/230	440 MWe	1972	1979
Block V	WWER-440/213	440 MWe	1976	1989 (Probebetrieb)
Block VI	WWER-440/213	440 MW	1976	fertig gestellt
Block VII	WWER-440/213	440 MWe	1978	im Bau
Block VIII	WWER-440/213	440 MWe	1978	im Bau

KKW III Stendal

	Reaktor	Leistung	Baubeginn	Inbetriebnahme
Block I	WWER-1000/320	1000 MWe	1982	im Bau
Block II	WWER-1000/320	1000 MWe	1984	im Bau
Block III	WWER-1000/320	1000 MWe		Planung
Block IV	WWER-1000/320	1000 MWe		Planung

4.4 Energy data's (production and consumption)

Percentage of different energy sources in the electric energy production GDR

Energieträger	1955	1960	1970	1980	1986
Rohbraunkohle	63,2	72,7	83,2	78,1	83,3
Braunkohlebriketts	9,0	6,8	1,8	0,6	0,4
Steinkohle	6,1	4,4	1,4	0,5	0,2
Mineralöl	k.A	0,1	2,6	1,2	0,6
Wasserkraft	1,7	1,5	1,8	1,7	1,5
Kernbrennstoff	--	--	0,7	12,0	9,5
Sonstige	20,0	14,5	8,5	5,9	4,5

Percentage of the most important energy sources in the primary energy consumption GDR

<table>
<tr><th>Energieträger</th><th>1950</th><th>1960</th><th>1970</th><th>1980</th><th>1986</th></tr>
<tr><td>Rohbraun</td><td rowspan="2">> 99,0</td><td>87,5</td><td>75,9</td><td>63,3</td><td>69,4</td></tr>
<tr><td>Steinkohle</td><td>9,1</td><td>10,6</td><td>6,4</td><td>6,1</td></tr>
<tr><td>Erdöl</td><td>--</td><td>2,5</td><td>12,6</td><td>17,3</td><td>10,7</td></tr>
<tr><td>Erdgas</td><td>--</td><td>0,2</td><td>0,6</td><td>9,1</td><td>10,3</td></tr>
<tr><td>Kernenergie</td><td>--</td><td>--</td><td>0,2</td><td>3,4</td><td>3,3</td></tr>
<tr><td>Sonstige</td><td>k.A.</td><td>0,7</td><td>0,1</td><td>0,5</td><td>0,2</td></tr>
</table>

4.5 Abbreviations

AdW	Academy of Sciences of GDR
AKK	Office for Nuclear Research and Technology
AKW	Nuclear Power Plant; see NPP or KKW
BfS	Federal Office for Radiation Protection (FRG)
BGBI	Federal Law Gazette
BMAt	Federal Ministry for Nuclear Affairs
BMU	German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
BUND	Friends of the Earth Germany
COMECON	Council for Mutual Economic Assistance (RGW)
DA	Demokratischer Aufbruch
DAtK	Deutsche Atomkommission
DDR	Deutsche Demokratische Republik
DGL	German society for Limnology
ERAM	Morsleben Repository for Radioactive Waste
FR	Research Council of the Council of Ministers
FRG	Federal Republic of Germany (BRD)
IAEA	International Atomic Energy Agency
IGB	Institute of Freshwater Ecology and Inland Fisheries (IBG)
MfS	Ministry of State Security
MR	Council of Ministers of the GDR
NPP	Nuclear Power Plant
PWR	Pressurized Water Reactor
SAAS	State Office for Nuclear Security and Radiation Protection
SAG	Soviet Stock Cooperation (Sowjetische Aktiengesellschaft)
SDAG	Soviet-German Stock Cooperation (Sowjetisch-Deutsche Aktiengesellschaft)
SED	Socialist Unity Party
SPK	State Plan Commission

SU	Sowjetunion
SWR	Siedewasserreaktor
SZS	State headquarters for Radiation Protection
KKW	Nuclear Power Plant (NPP)
WR	Scientific Advicory Board for peaceful use of Nuclear Energy at Council of Ministers
WTBR	Scientific-Technical Office for Reactor Construction
ZfK	Central Institute of Nuclear Research Rossendorf / Dresden
ZK	Central Committee of the SED
ZIMET	Central Institut for Microbiology and experimental Therapy

4.6 Periodization of nuclear development

Weiß (1997) proposal refers to nuclear research and nuclear technology, nevertheless, encloses the nuclear energy sector with:

Ban:	1945 to 1955
Consolidation / Implementation:	1955 to 1959
Crisis:	1960 to 1964
Stagnation:	from 1965

Reichert (1999) focuses the development of the nuclear power economy. This led him to:

Preparation of a nuclear power economy:	till 1955
Initials and organization (Basics):	1955-1962
Break off of own ambitions:	1962 to 1965
GDR-nuclear energy economy within the scope of the COMECON (Council for Mutual Economic Assistance - RGW):	1966 to 1986

From 1966 to 1979 partial successes by introduction of the power stations Rheinsberg and Greifswald – zenith/summit of the nuclear energy economy of the GDR

In 1974 to 1986 increase of the problems in the subordinate position to the USSR;

End of the nuclear energy economy: from 1986

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WP2

Federal Republic of Germany

Short Country Report

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BENEFICIARY
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HoNESt History of Nuclear Energy and Society

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University of Copenhagen Faculty of Humanities

Deutsches Museum

DIALOGIK

EHU Europos humanitarinis universitetas

TU/e Technische Universiteit Eindhoven University of Technology Where innovation starts

Friedrich-Schiller-Universität Jena

Swedish Defence University

GRE

KTH

LUT Lappeenranta University of Technology

upna

UPMC Sorbonne Universités

The University Of Sheffield.

Science Museum

spi Sociedade Portuguesa de Inovação

CONTENTS

Executive summary

This country report explores the history of the relations between nuclear energy and society in the Federal Republic of Germany (FRG, West Germany). It belongs to a collection of 20 short country reports on the History of Nuclear Energy and Society (HoNESt, project Ref.662268) that tackle the complex sociotechnical system around nuclear energy. Nuclear energy is intertwined with developments in social, economic, environmental, political, and cultural spheres. Moreover, it represents a globalized system involving transnational transfers of knowledge, materials, technologies, people, and products including electrical power, medical elements, toxic wastes, and other environmental hazards, materials, capacities, and knowledge that must be carefully safeguarded. For instance, transfer of knowledge and ideas needs mediators like experts, politicians, activists, organizations, and the media to convey this knowledge from one context to another. Therefore, nuclear energy is a complex social and technological phenomenon that influences societies but is also shaped by societies. This short country report is designed to assemble information and research results on the history of the relations between nuclear energy and society in West Germany in an accessible manner, and to document the findings with references. The purpose of this country report is threefold:

1. It provides basic elements of narrative and analysis for further historical research.
2. It provides information, context, and background for further analysis for HoNESt's social science researchers.
3. It provides accessible information on nuclear-societal relations in West Germany for the purposes of outreach and communication with stakeholders (civil society, industry, associations, policymakers, journalists).

West Germany's Nuclear History in Brief

In the 1950s and the beginning of the 1960s, when the United States had launched the Atoms for Peace program and the first nuclear power plant went online in Germany, nuclear power seemed to be a modern solution to humankind's energy problems. Just over a year after the federal government had adopted the Atomic Energy Act in 1959 on the peaceful utilization of atomic energy and the protection against its hazards, the first nuclear power plant went online at the border of Hesse and Bavaria. With it, nuclear power in West Germany started as an industrial business. In the 1960s a phase of development and planning followed that was hardly noticed by the public. The first commercial nuclear reactor went on the grid in 1961, but it took many government incentives to convince energy companies to switch to nuclear power completely. The planning and building of nuclear power plants, radioactive waste disposal facilities, or reprocessing plants in the federal states of Baden-Württemberg (Wyhl), Schleswig-Holstein (Brokdorf), Lower Saxony (Gorleben), North Rhine-Westphalia (Kalkar), and Bavaria (Wackersdorf) provoked massive and recurring protests throughout the 1970s and 1980s. The protests against the construction of the plant in Wyhl (Kaiserstuhl) on the French border in Germany's southwest, gave power to the nascent environmental movement when—in 1975—30,000 people demonstrated, occupying the site and developing protest structures. The Chernobyl nuclear power plant catastrophe in April 1986 led to an upswing of intensified debates in Germany and also gave rise to the Mothers against Chernobyl movement. As a result, a Ministry for the Environment was founded at the federal level and citizens' initiatives—many initiated and run by women—sprang up in high numbers. In 1998, the red-green coalition agreement decided to phase out nuclear energy within 20 years. Two years later, the federal government and electric supply companies signed an agreement about the future operation of German nuclear power plants. After tsunami and partial meltdown at the Japanese nuclear power plant Fukushima Daiichi in 2011, the topic received renewed attention with continued protests. Chancellor Angela Merkel announced the shutdown of all German power plants by 2022 with eight of the 17 operating German reactors shut down immediately. Until March 2011, these 17 reactors produced 25 percent of the country's electricity. In 2016, the remaining eight reactors produced 16 percent, while half of Germany's electricity was generated from coal.

1. Historical Context (narrative)

1.1. Introduction to the historical context

Concerns about nuclear power were publicly expressed for the first time in the 1950s and 1960s and focused on the high costs, unproven technology, and dangers of nuclear waste disposals (Rudig 1990, 63). In later decades, activists criticized the federal government because they perceived the politics in which it pursued its big-industry projects as nontransparent and authoritarian (Glaser 2012, 12), and loyal state citizens often had experiences that turned their trust into scepticism. Large parts of the population frequently mistrusted both the state and the energy industry, and faith in the problem-solving strategies of experts and academics faded. Moreover, low-level radiation, catastrophic disasters, disposal of radioactive waste, and other environmental impacts were criticized (Schils 2011, 4), alongside a more general critique of large-scale technology. Finally, opponents doubted that there were issues with alternative sources of energy and disapproved of the lack of the political will to actually invest in it (Hubert 2012). The societal controversy over nuclear energy that had already begun in the 1950s has been interpreted as a true success story of Germany's social and political culture (Radkau 1987; Weitze and Trischler 2006). The controversy was carried out at all societal levels and integrated not only small groups of experts and stakeholders, but numerous intermediary social groups and actors.

1.2. Contextual narrative

On 7 May 1946, the Allied Control Council Law No. 25 came into force. With this law, the Control Council strictly forbade West Germany any strand of research that had civil and military applications, which included nuclear physics (Müller 1990, vol. 1., 44). Yet, the West German chancellor Konrad Adenauer and his government did not want to be excluded from international developments and were not inclined to accept Allied restrictions in this field. After the ratification of the General Treaty (also: Germany Treaty) in 1952, which regulated the relationship between the Federal Republic of Germany and the Western Allies (France, Great Britain, and the USA), Chancellor Adenauer and the physicist Werner Heisenberg publicly pushed for the construction of a nuclear reactor. To connect to international developments, an organizational frame was necessary. To this end, Adenauer initiated the building of a body that was to prepare the nuclear energy industry. The ratification of the Bonn–Paris conventions in 1955 put an end to the Allied occupation of West Germany and freed the way for the civilian use of nuclear energy (Tiggemann 2010, 47 et seq.). The primary goal of the West German government was now to reduce the research backlog of more than a decade and to found structures to support nuclear energy. In the same year, the West German government decided to convene the German Nuclear Commission—though it was not responsible to the parliament, it functioned as an advisory body to the Atomic Minister (Gleitsmann 1987, 34 and 38). A driving motif to promote nuclear energy was the pronuclear, euphoric atmosphere in West Germany, but it was accompanied by a fear of possible energy shortages in the future, after the Technical University in Karlsruhe had predicted a coal shortage for the mid-1970s (Radkau 1983, 113).

The euphoric atmosphere in West Germany was partly inspired by the first international conference on the Peaceful Uses of Atomic Energy organized in 1955 in Geneva under the leadership of the United Nations. The Federal Republic undertook steps for international cooperation and was amongst the founding members of the European Atomic Energy Community (also known as Euratom) in 1957 (Stamm 1992, 39 et seq.). Finally, it created the legal basis for the construction and operation of nuclear power plants in Germany: in 1959 the federal government adopted the Atomic Energy Act on the peaceful utilization of atomic energy and protection against its hazards (Atomic Energy Act 1959, 814). In the same year, the German Atomic Forum was created. Following the US American model, it became the representative for the private sector and the public for the support of nuclear energy (Müller 1990, vol. 1, 198 et seq.). In 1961, the forum opened up for interested organizations, companies, and associations. In the same year, the first nuclear power plant went online between Karlstein and Kahl at the border of Hesse and Bavaria, which heralded the start of nuclear power in West Germany as an industrial business. Soon German politicians spoke about a future that would solve all distribution problems through cheap atomic energy. A phase of development and planning followed which went nearly unnoticed by the public. Physicist and Nobel laureate Werner Heisenberg in particular became a driving force of the nuclear sector. For him, a powerful nuclear industry was crucial to the overall economic competitiveness of

West Germany, and he understood the forceful development of nuclear research centers as a necessary first step in that direction.

His vision of building up a strong federal atomic program, however, remained contested, along with the question of siting nuclear research facilities. Energy companies like Rheinisch-Westfälisches Elektrizitätswerk AG *(*RWE Power AG) or PreußenElektra, which paid for and operated the nuclear reactors, were especially critical of nuclear power because of the costs and the technical uncertainties involved. For instance, their relatively new facilities for producing brown coal would have been shut down if they had changed to nuclear energy—something RWE firmly rejected (Tiggemann 2010, 62). They were reluctant to adopt a new and unproven technology and pleaded instead for renewable energy. As a result, Franz-Josef Strauß's successor in the Atomic Ministry, Siegfried Balke, saw energy supply companies as opponents to his politics. He tried to use energy politics against the energy industry, for instance by keeping them out of the planning for the first atomic program (Radkau 1983, 116 et seq.). Until the end of the 1960s, RWE clearly gave preference to brown coal over nuclear energy. In 1968 the energy supply company staged a turnaround and took the lead in the German development of the nuclear industry by placing the order for Biblis A. Historians described the project as having set new standards in power plant construction worldwide (Tiggemann 2010, 63 and 176). The plant was built in the South Hessian municipality of Biblis and consisted of two units: unit A, with a gross output of 1,200 megawatts, and unit B, with a gross output of 1,300 megawatts. The pressurized water reactor Biblis A began operating in 1974. After the nuclear catastrophe in Fukushima in 2011, bloc A was shut down; however, bloc B was already in a scheduled revision and therefore did not have to be closed down.

In an effort to make a case against critics of the nuclear energy industry, the German government established major research centers in Karlsruhe and Jülich in 1956 and 1962 that soon became influential in European nuclear research and development. The plan to promote research to generate arguments against critics of nuclear energy worked only in part. This time, opposition came from civil society, especially women. Local women's associations in Karlsruhe were critical of the research centers because of the danger posed to citizens in a city with a high population density. The city of Karlsruhe had commissioned a survey that revealed that only 27 percent of interviewed women approved of the research centers, compared with 63 percent of interviewed men (Renn 1995, 762). The civilian and military use of nuclear power was a topic that frequently divided the sexes on the issue of quality of life. Green politician Petra Kelly expressed the opposing views of men and women on the military use of nuclear energy as follows: “[n]uclear war and war in general [is] a manifestation of the constant war between masculine and feminine values” (Women should push, 1984).

Not only women opposed research centers and nuclear sites— the 1950s was generally the time of the first protest wave in Germany. When the German government planned to equip the German army with so-called tactical nuclear warheads and launch sites for short-range missiles, 18 German nuclear scientists—including Nobel laureates Heisenberg, Max Born, Otto Hahn, Max von Laue, and Wolfgang Paul—opposed this with the Göttingen Manifesto of 12 April 1957. The proclamation pointed at the destructive power of these weapons and warned of the military and political consequences of nuclearization (Schirrmacher 2007; Lorenz 2011). The Campaign against Atomic Death formed in response to fear of the atomic armament of the German army and led to scepticism towards civilian nuclear facilities as well (Milder 2017). The decade also saw the foundation of critical nuclear energy non-governmental organizations, some of which were politically contested. One example was the “World Union for Protection of Life” (WSL), which became active in over 30 countries. The association was founded in 1960 by the Austrian writer, environmentalist, and former Nazi party member, Günther Schwab. Membership grew rapidly and from 1970 onwards, the WSL was an influential power in the growing ecology movement. For instance, the German WSL was one of the founding members of the “Bundesverband Bürgerinitiativen Umweltschutz,” which is the umbrella organization of all environmentally active citizens’ initiatives in Germany. Due to its partly right wing activities and members, the German WSL branch was banned from the international association in 1985 and dissolved in 2001 (Kirchhof 2011, 36 and 41; Engels 2006, 78 and 332). These first protests differed from later ones because protestors did not take direct democratic measures or cooperate transnationally.

These steps were taken for the first time in the mid-1970s with the protest against a power plant in the Badensian village of Wyhl. The actions are widely recognized as the starting point of the anti-nuclear movement in Germany and historians have interpreted them as a national site of memory deeply embedded in German culture (Rusinek 2003). Though—as explained above—this protest was not the first one, it did become an example to activists for later protests.

In 1973, Wyhl was chosen as the site for a nuclear power plant, which caused direct opposition. In the following two years, signatures and appeals against the construction of the nuclear power plant were submitted to the Mminister of the Interior. When these actions did not affect the political decision, local people—who were transnationally supported—increased their opposition and occupied the construction site. In 1975, it was decided that construction should be interrupted, but the decision was reversed and the site in Wyhl was occupied once more. In March 1977, the administrative court withdrew the construction license for the plant but later initiated a process of second instance. In 1982, the Minister-President of Baden-Württemberg declared the construction of the nuclear power plant in Wyhl unnecessary and confirmed his decision five years later. In the end, the plant was never built (Engels 2003, 350 et seq.; Tiggemann 2010, 212 et seq.).

A few other projects played particularly critical roles in the public debate in West Germany. The (planned) building of reactors in Brokdorf, Kalkar, Wackersdorf, and Gorleben caused a further shift from optimism to pessimism over nuclear energy and triggered massive protests as well as violent disputes between activists and police. In 1975, 25,000 people took to the streets in Wyhl; in 1977, 40,000–60,000 people demonstrated at the site at Kalkar; and two years later, in 1979, 100,000 people joined the Gorleben track protest. Up until then, the rallies against nuclear facilities had been the biggest in West Germany's protest history (Mende 2011, 332).

Concerns about a light-water nuclear power reactor proposal at Brokdorf, near Hamburg, had become a public issue in November 1973 (the plans for it dated back to the late 1960s). But it was not until 1976 and 1977—during the first construction phase—that opponents started to protest violently against it. The police had learned from their experience at Wyhl and wanted to avoid similar incidents at all costs. Shortly after receiving the permit for building the reactor, the police cordoned off the Brokdorf site. That night saw violent clashes between opponents and the police and, a few weeks later, 30,000 people demonstrated against the project. This led to a halt in construction that was justified by the lack of a disposal strategy for spent fuel. In 1981, construction continued and about 100,000 people demonstrated, causing a severe confrontation with police once again. More conflicts with the police followed in 1986, the year the Brokdorf nuclear power reactor eventually started operating (document, Glaser 2012, 12 et seq.).

In 1985 the Deutsche Gesellschaft zur Wiederaufarbeitung von Kernbrennstoffen mbH (German waste disposal company DWK) decided to build and operate a reprocessing plant in Wackersdorf, a municipality in the district of Schwandorf in Bavaria, Germany. When they started clearing the woodland, 30,000 people demonstrated, occupied the building site, and erected a hut village. After the Chernobyl nuclear power plant catastrophe in April 1986, the violent dispute between police and anti-nuclear activists reached its peak. A large number of initiatives—many organized and run by women—mushroomed, such as the group “Mothers against Nuclear Power,” which took part in hearings against Wackersdorf (Blomeyer and Wurzbacher 2016; Wurzbacher 1988; Mütter 1988). Finally, the protesters were successful: the energy company Vereinigte Elektrizitäts und Bergwerks Aktiengesellschaft (United Electricity and Mining Corporation, VEBA) changed its politics and was no longer interested in the reprocessing plant, resulting in a building freeze in 1988.

The building of a radioactive waste disposal facility in Gorleben, Lower Saxony, which was planned as a future deep final repository for waste from nuclear reactors, also provoked massive protests. The decision to use Gorleben as site for storing nuclear waste came in 1977 under Chancellor Helmut Schmidt (SPD) and Prime Minister Ernst Albrecht (CDU, conservatives). Before the decision was made, over one hundred salt domes had been considered. Most important were the geopolitical criteria, such as the sparse settlement at the border area close to East Germany. Protest against the decision arose early on and the site was given up as a final repository. Today the plant serves as an intermediate storage facility for waste from Germany's nuclear power plants, which is reprocessed in France and then sent back to Germany for final storage. Current protests against nuclear energy in Gorleben are directed at the annual transport of dry cask containers from France to Germany and continue to demand a huge police presence (Glaser 2012, 15; Khoo and Rau 2012, 156).

An interesting technological project that failed and later became an enterprise of the burgeoning leisure sector was the construction of SNR-300, a pilot-scale fast breeder reactor, in Kalkar. The project started in 1972 as an international collaboration. Built to produce 327 megawatts of electricity for the Rhineland, SNR-300 was a solution to limited uranium reserves in the Federal Republic and a means to become independent from energy imports in the near future. Criticism soon arose about the safety of the breeder and international demonstrations took place in 1974 and 1977. Experts expressed their concerns about the reactor coolant as well as the controlling process, and a four-year halt in construction was agreed upon. Even after the construction of SNR-300 was completed in 1985, the government of North Rhine-Westphalia did not authorize use of the building because of unforeseeable risks in operating the reactor. The shutdown of the project was announced in 1991, and the unused machines and facilities were transferred to reactors and production complexes in other countries. Finally, the reactor was sold and turned into an amusement park.

The transition from optimism to pessimism manifested in Germany's political landscape too. While the Social Democratic Party (SPD) strongly advocated nuclear energy as a trigger for technological and industrial modernization during the 1950s and 1960s, it switched sides and became a critic of nuclear energy in the 1970s. In 1998—under the newly elected Social Democratic Party (SPD) Chancellor Gerhard Schröder—the red-green coalition decided to phase out nuclear energy within 20 years. The Christian Democratic Union (CDU) and Free Democratic Party (The Liberals, FDP) coalition government that was elected in September 2009 was committed to rescinding the phase-out policy. Yet, after the Fukushima Daiichi nuclear disaster in 2011, Chancellor Angela Merkel announced the closedown of all German power plants by 2022. Parliament and most German politicians approved of the moratorium.

Women were often at the forefront among critical citizens and since the 1970s they had raised their voices louder than ever. Many of them argued that there was an essential connection between the suppression of women in a patriarchal society and the subjugation of nature, resulting in its damage. They pointed out that humans are no longer an integral part of the environment and claimed a new concept of nature focusing on intuition, emotionality, and spirituality (Thiessen 2010, 37–44). The Protestant theologian, political scientist, and colleague of Petra Kelly, Eva Quistorp, was one of the first women to talk publicly about this ecofeminist theory when she gave a presentation entitled "Women and Mothers against the Destruction of the Natural World" at the Free University of Berlin in 1976 (Quistorp 1979, 152). Within the ecofeminism school of thought, positions based on difference feminism theory emerged, elevating gender differences to a defining category. The theories implied differences between men and women with regard to their biological and social gender but claimed the principle equality between genders. This newly formulated political trend within the broader feminist movement presented female qualities as non-deficient and aimed at putting an end to the perception that women were an aberration from the male norm. It created a positive reference to shared femaleness and became a source of emotional strength and legitimization for political activities in the women's peace movement of the 1980s (Flaake 2005, 158–175). In particular, the Chernobyl nuclear power plant catastrophe in April 1986 led to an upswing of intensified debates in Germany. Women highlighted the differences between the sexes and founded new initiatives, informed themselves and others about the risks involved in the civilian and military use of nuclear power, published leaflets, gave speeches, and organized conferences. One example was the international congress "Women and Ecology: Against the Feasibility Delusion" that took place in Cologne in October 1986 and was organized by feminists in the local area, by the Greens, and by the autonomous women's movement (Lenz 2010, 855).

Historiography has given various reasons why the opposition against nuclear power was generally strong in Germany and also violent at times. Historians found answers in Germany's national socialist past, which might have resulted in a strong scepticism towards the authorities as well as a lack of religious influences in the movement, as can be found in the United States. Others emphasize society's criticism of cost-benefit analyses. First, nuclear opponents feared future generations' accusations that their ancestors had failed to act against the atomic industry and had become its accomplices instead; children and grandchildren had made similar arguments regarding the country's national socialist past. Those who did not wish to be seen as traitors and followers had a duty to oppose nuclear power. Additionally, large parts of the population frequently mistrusted the state and the energy industry, and faith in the problem-solving strategies of experts and academics faded. Up until then, loyal state citizens had had experiences that had turned their trust into scepticism (Interview Szepan). In particular, the suspicion that state authorities would bend practice and law to favor the interests of nuclear energy advocates also supported doubts against the state within non-critical circles. They saw a connection between the extension of atomic energy and democratic deficits and argued that the atomic lobby lacked transparency as well as honesty. Opponents perceived the relationship between the atomic industry and the population as one of traitors and victims. This mistrust in the truthfulness of state and the nuclear industry justified militant actions for some activists. Additionally, the police's brutal responses to militant acts and the obvious intention of some politicians to criminalize dissidents only increased skepticism and suspicion of authorities in politics and the economy in Germany. (Schüring 2015, 89 et seq.; Tompkins, *Grassroots* 2016, 117; Mende 2011, 330 et seq.).

Second, a different understanding of civil disobedience, as can be found in the US, is also emphasized. The historian Michael Hughes argues that non-violent protest in America has two origins that were missing in Germany and might have resulted in a greater openness to violent actions. According to Hughes, these influences stemmed from the American author and philosopher Henry David Thoreau's argument for disobedience to an unjust state, as well as from the Christian roots of the US American Civil Rights movement (Hughes 2014, 236–253). Violence as a means of political dispute could be found especially in leftist political activists, such as in communist cadres as well as the Sponti scene (Mende 2011, 333 et seq.). Third, resistance against nuclear power plants also expressed a critique of large-scale technology. In the opinion of many citizens, the costs of the facilities far exceeded the benefits, which indicated an estrangement from rationalist faith in progress (Engels 2006, 348).

On a global scale, different environmental, peace, disarmament, and anti-uranium movements inspired each other worldwide. This was possible through a significant transfer of ideas conveyed through activists, politicians, experts, social organizations, and the media, which functioned as transmitting agents for relevant information, ideas, and values. Transfer of ideas did not necessarily result in cooperation between ecological groups on a broader scale. There were a number of reasons why social movements did not always find it easy to cooperate. For one thing, there may have been too many social movements to be united under a single cause, sometimes even in one nation state. Moreover, despite common ideologies and views, each movement had a different focus, and the lack of a common "language" hampered this coalition building further. Another reason is that it was difficult to maintain international contacts and to travel, both of which were vital to transnational collaboration. Travel distances and costs generally prohibited many activists from international involvement and transnational cooperation, at least until the last quarter of the twentieth century. Finally, the internal structure, different strategies and choreographies, cooperative culture, and diverse social milieus of the environmental action groups could sometimes lead to misunderstandings and be an obstacle to coalition building between groups and movements. Cooperation worked slightly differently at nuclear sites that were close to borders, because some of the “obstacles” described above only applied to a minor extent. Where nuclear sites were close to two or sometimes three different countries, people of diverse nationalities usually had similar interests. Furthermore, since the travel distances were rather minimal, it was easier to join and support local protests. This was the case in protests against nuclear plants in Wyhl and Cattenom (interview Avena) where French and German activists worked together, or in Kalkar, as the common protest of Dutch and German activists shows (Kirchhof and McConville 2015, 332–333; Tompkins, *Grassroots* 2016, 131 et seq.).

While activists learned from each other how to organize protests more effectively, government officials and police chiefs too learned from confrontations, as the Wyhl case shows. Since the interactions between activists and the police became increasingly violent, the latter developed special strategies to protect reactor sites and hinder activists from lasting occupation (Milder 2014, 197).

1.3. Presentation of main actors

Government, as the main funder of research and development, has been a strong proponent of nuclear power until recently, specifically through various ministries such as the Federal Ministry of Nuclear Affairs, which was founded in 1955, or the Federal Ministry for the Environment, Nature Conservation, Building, and Nuclear Safety, which was founded in 1986 under the name Federal Ministry for the Environment, Nature Conservation, and Reactor Safety. Bodies like the Reactor Safety Commission, which was set up by order of the Ministry of Nuclear Affairs in 1958, also had a strong interest in the sector. Responsibility for licensing the construction and operation of all nuclear facilities is shared between the German federal government and the federal states, which confers something close to a power of veto to both.

Science has been another driving force of the nuclear sector. The physicist Werner Heisenberg, Nobel laureate and science advisor to Chancellor Konrad Adenauer, opted for an early and strong engagement in atomic research to pave the way for industrial activities and international collaboration (Carson 2010; Carson 2002). Allied restrictions in applied nuclear research and technology were only lifted in 1955 when West Germany received sovereignty, but in the early 1950s a number of both large-scale nuclear research centers and university-based research reactors had already been founded, including big science establishments in Karlsruhe, Jülich, Geesthacht, and Munich (Rusinek 1996; Oetzel 1996; Interview Popp 2016). When the foundational mission of these centers came to an end in the 1970s, they diversified into many other fields of both basic and applied science, including renewable energies. But up until today, the centers have kept a foot in the nuclear realm and continue to conduct research and training, particularly in nuclear safety.

Private companies have been vital in the construction of German reactors. In the foundational period of the 1950s, however, the energy industry was hesitant to engage in the nuclear sector and it needed the state to set the scene (Radkau 1983). Once established, the nuclear industry became the core proponent of nuclear energy and continuously attempted to enlarge nuclear markets both domestically and abroad. The engineering company Siemens and its subsidiary company Kraftwerk Union (KWU) had a monopoly position in developing nuclear power plants for Germany for decades, until after the Fukushima nuclear disaster in September 2011 when Siemens withdrew from the nuclear industry. At the same time, it concluded its cooperation with the global leader AREVA—a French multinational group specializing in nuclear power and renewable energy, whose German branch is in Erlangen (Interview Schuch and Meyer zu Schwabedissen). This leaves four remaining nuclear energy companies: E.ON Kernkraft GmbH (the biggest German energy company), Vattenfall Europe Nuclear Energy GmbH (the Swedish company opposed the phasing out in Germany, which gave it a bad image), RWE Power AG (critical of nuclear power in the 1950s for cost reasons and pleaded for renewable energy), and EnBW Energie Baden-Württemberg (the third-biggest energy company, which suffered heavy financial losses after the phase out because of strong investments in nuclear power). The state subsidized or gave indirect financial benefits for the construction and operation of nuclear plants (at the expense of taxpayers). Thus, some critics point out that the costs for nuclear energy had been held low artificially with the help of subsidies worth billions (AtomkraftwerkePlag—Atomlobby Konzerne and Atomlobby Subventionen).

Professional associations including the German Atomic Forum (founded 1959) and the Nuclear Society (founded 1969) often have strong formal and informal links to each other. For example, the former is a member of the latter organization and supports it financially. Moreover, there are links to politics, e.g. well-known institutions funded by the federal government, such as the Deutsche Bahn AG, the Helmholtz Center Munich and Berlin, and the Max Planck Institute of Plasma Physics, to name a few, are members of the German Atomic Forum and the Nuclear Society, among others, and support them through membership fees. Further associations are: Bürger für Technik (BfT), Energie-Fakten.de, Europäisches Institut für Klima und Energie (EIKE), Informationskreis KernEnergie (IK), Initiative Neue Soziale Marktwirtschaft (INSM), Internationale Länderkommission Kerntechnik (ILK), Nuklearia e.V., Reaktor-Sicherheitskommission (RSK), Rheinisch-Westfälisches Institut für Wirtschaftsforschung (RWI), TÜV SÜD, Wirtschaftsverband Kernbrennstoff-Kreislauf und Kerntechnik (WKK), and Women in Nuclear (WiN) (Government’s reply to minor interpellation 2014).

Trade Unions supported the use of nuclear energy for decades. When the “green” nuclear opponent Frank Bsirske became head of the trade union Ver.di (Vereinte Dienstleistungsgewerkschaft) in 2008, the new service union took a critical stance on this technology. At around that time, the trade union IG Metall (union for heavy industry, engineering, and electronics) started to cooperate with the anti-nuclear movement as well because they saw a future for jobs in the field of renewable energies. After the nuclear disaster in Fukushima in 2011, the trade union head of industry for coal mining, chemical industry, and energy demanded sufficient alternative energies, but no longer questioned the phasing out of nuclear energy (von Appen 2011, 36; AtomkraftwerkePlag—Gewerkschaften und Atomkraft).

Society: in the 1970s, German society became increasingly skeptical of nuclear power. The controversy was carried out at all societal levels and integrated intermediary social groups but also experts that founded alternative ecological research institutes; like the Freiburg Öko-Institut (Institute for Applied Ecology). It was founded in 1977 and is one of the most important institutes in its field in Germany. Protests against nuclear sites took direct democratic measures, engaged in transnational cooperation, and resorted to extreme violence at times. Opposition to the construction of a power plant at the Badensian village of Wyhl was carried out by local inhabitants, especially wine farmers, but transnationally supported. For the first time, actions became especially violent with protests against the light-water reactor in Brokdorf, which caused “civil-war-like confrontations between police forces and opponents of the project” (Glaser 2012, 12; Kirchhof 2013, 2015; Kirchhof and Meyer 2014; Mende 2011; Milder 2014; Tompkins, *Better* 2016). The movement finally culminated in a new party, the GREENS, which was founded in 1980.

2. Showcase

Wunderland Kalkar

The Kalkar project started as an international collaboration in 1972 when the Belgian-German-Dutch Fast Breeder Nuclear Reactor Ltd. was founded in Essen. The company instructed the Siemens subsidiary Interatom to carry out the construction of a fast breeder sodium cooled nuclear reactor (SNR-300) in Kalkar and the foundation stone laying ceremony took place in 1973. The site was supposed to comprise a total area of 17,000 square meters with an output of 300 megawatts. The motivation to build the reactor was the limited uranium reserves in the Federal Republic of Germany. Advocates of atomic energy hoped that by building the breeder, minerals could be utilized efficiently and Germany could cease to be dependent on energy imports in order to generate electricity in the foreseeable future. The Rhenish-Westphalian Power Plant (RWE, which in 2000 merged with Vereinigte Elektrizitätswerke Westfalen, or VEW) originally chose the North Rhine-Westphalian village of Weisweiler as site for the fast breeder. But it seemed too risky to build a reactor in the broader Aachen city region because of its density of population. The idea was given up and the sparsely populated area around Kalkar was chosen instead (Marth 1992, 43). Soon criticism arose about the building of the fast breeder, based on doubts about the safety of nuclear energy, and in 1974 around a thousand people, predominantly from the Netherlands, took to the streets. A mass rally three years later was attended by 40,000 people (some authors speak of 50,000 [Tompkins, Grassroot(s) 2016, 129] or even 60,000 people, [Mende 2011, 332]) from France, the Netherlands and West Berlin. The police presence is regarded as the biggest in the history of the Federal Republic of Germany. The police were extremely violent and many demonstrators felt they were treated like terrorists. The writer, feminist, and co-founder of the German Green Party, Jutta Ditfurth, remembers how activists on their way to Kalkar were stopped by the police so that many could not reach their destination:

"A commuter train from Duisburg to Kleve was stopped in open country by Federal Border Guard helicopters. Federal border guards and police officers with truncheons, gas masks, tear gas canisters, and submachine guns surrounded the train and harassed the passengers. … They stopped our buses and closed motorways across the whole state. In their large Federal

Border Guard helicopters, they flew low over demonstrators, landed, beat them up, and flew off" (Mende 2011, 337).

According to the former Foreign Minister and co-founder of the Green Party Joschka Fischer, the events at Malville and Kalkar signaled the end of this form of extraparliamentary mass resistance against the construction of nuclear power plants. (Mende 2011, 337).

Another example further demonstrates that the government's treatment of members of the anti-nuclear-movement, or even of people who were only suspected to be opponents of nuclear power, was reminiscent of defense against terrorists. The German engineer Klaus Traube was managing director of Interatom, which had built the nuclear power plant SNR-300 in Kalkar. Originally a proponent of nuclear power, Traube reconsidered his views in the early 1970s after having read the Club of Rome's *The Limits to Growth*. When the German secret service suspected (falsely) that he had passed on secret information to the Red Army Faction (RAF), they illegally wiretapped Traube's apartment and he lost his job because the Federal Intelligence Service (Bundesnachrichtendienst or BND), one of the three German secret services, informed his employer about the issue. The illegal operation was uncovered in 1977, Traube was cleared of all charges, and the government was plunged into a crisis, as a result of which the then federal Minister of the Interior, Werner Maihofer, was dismissed (Mrusek 2011).

The anti-nuclear movement's opposition rose even more in the coming years, especially with the impact of the accident at the Three Mile Island nuclear power plant in the USA in 1979. Two court proceedings were launched against Kalkar, the second of which was the biggest in the history of the Federal Republic of Germany. Engineers that were involved in the process calculated that statistically every five years a "GAU" (a German acronym for worst-case scenario) would be a possibility at Kalkar (Kalter Kaffee 1984, 78, and interview with Szepan 2016). Moreover, experts expressed concerns about the coolant and the control process that was considered to be too difficult. On the one hand a Bethe-Tait accident (Bethe 1956) could not be ruled out; on the other hand liquid sodium was used for cooling, which was chemically especially aggressive. In contrast to the low-enriched uranium of conventional reactors, it was possible to also produce atomic bombs with the uranium that was used in the breeder, as Jo Leinen – leading figure of the anti-nuclear movement, later Environment Minister of Saarland –

pointed out. Because the technology would have to be exported to be profitable, countries which had not had atomic bombs before would now get the chance to gain access to them (Bretschneider 2011). Since the opponents of the construction lodged a constitutional complaint before the Constitutional Court, the German parliament's commission of inquiry ordered that construction be interrupted for four years in light of the safety concerns. Because of the difficulties involved in construction, the costs of the project also rose. From the initially planned 500 million marks (ca. 900 million euros), the price rose to 1.7 billion marks. In the end the whole project cost seven billion marks, which was 14 times higher than the original price (Meyer-Larsen 1981). When the North Rhine-Westphalian social-democratic/liberal coalition endorsed the anti-nuclear course, the Minister of Economic Affairs, Horst Ludwig Riemer (FDP), blocked the partial construction licenses, which caused a crisis.

The construction of SNR-300 was finally completed in 1985 and the reactor was put into partial operation: the sodium coolant was running through the coolant loop and the reactor was ready to receive nuclear materials. The operational costs totaled 105 million marks (today 93 million euros) annually. Against the wishes of the federal government and the Christian-democratic/liberal coalition, the state of North Rhine-Westphalia (which was the authority in issues concerning nuclear power) rejected the authorization to begin operations at the plant. The Minister of Social Affairs and Labour of North-Rhine-Westphalia, Friedhelm Farthmann (Social Democratic Party), who was responsible for the planning permission, argued that commissioning the plant was irresponsible because the risks were ultimately not calculable. According to the atomic law the federal government was able to enforce the authorization but did not want to carry the responsibility for the controversial SNR project alone. One reason for this decision was the disaster in Chernobyl that had happened in April 1986 and caused the atmosphere in West Germany to become increasingly critical of nuclear energy (Interview Avena 2016). No politician wanted to make unpopular decisions and risk negative results in the upcoming elections for the German parliament in 1987. Instead, the German government decided not to take SNR-300 into operation at that time. In the coming years, the applications underwent time-consuming examinations. According to SNR advocates the whole process was delayed so long that the closing down of the reactor was unavoidable. Moreover, since energy consumption had risen slower than expected, electricity suppliers were no longer interested in the commissioning of the reactor. The termination of the project was announced by the then German federal Minister of Education and Research, Heinz Riesenhuber, on 21 March 1991. The reasons for this decision were a) the certain radioactive contamination of system parts when commissioning the reactor which b) would cause high costs and preclude further use of the complex buildings. The mega project, thus, had developed into a huge investment failure.

Successively the new and never used equipment and machines were sold because demolishing the whole complex would have cost another 75 million euros and was economically not possible. The owner of the reactor core was the RWE Power AG, but the company had no license for fuel which was enriched with plutonium. Therefore the plutonium was integrated into so-called MOX fuel elements (MOX = mixed oxide fuel which is an alternative to the low-enriched uranium [LEU] fuel used in the light-water reactors) in La Hague's reprocessing plant and eventually used in traditional nuclear power plants. Moreover, 12 unused blanket fuel assemblies that contained depleted uranium were transferred to the United States. Here the mostly decommissioned nuclear production complex, Hanford Nuclear Reservation on the Columbia River, took the assemblies in.

The German government sold the complex for 2.5 million euros at a public auction in 1995 to the Dutch entrepreneur Hennie van der Most, who converted it into a leisure park. The price was rather low for an object that had cost multiple times that to build, but since the German government did not want to cover the cost of dismantling the nuclear facilities at Kalkar itself it agreed to the price. At first the amusement park was called Kernwasser Wunderland ("Corewater Wonderland"), but this name probably reminded guests too much of the project's original purpose, so it was renamed later as Wunderland Kalkar ("Kalkar Wonderland"). The space, originally intended to become one of Europe's landmark nuclear projects, is now open to the general public. Besides hotels to stay in overnight, and bars, pubs, and restaurants for culinary enjoyment, the "wonderland" offers a family amusement park with climbing walls, white-water rides, flying carousels, and merry-go-rounds offering fun and adventure for the whole family (Kohlrausch/Trischler 2014, 229 et seq. and Wunderland Kalkar Webpage).

3. Events

3.1. German Atomic Program—First Nuclear Research Center

Who was involved: Federal government in general and the Federal Ministries of Atomic Affairs and Economics in particular, state governments of Bavaria and Baden-Württemberg, communities of Garching, Munich, and Karlsruhe, German Research Foundation, technical universities of Munich and Karlsruhe, atomic physicists, and NATO.

When and where did it take place: In the years 1952 to 1957 in the states of Baden-Württemberg and Bavaria and in the communities of Garching, Munich, and Karlsruhe.

What type of process was it—changes over time: Formation of nuclear research infrastructure and science policy process. When the Allied restrictions on nuclear science and technology seemed to come to an end in 1952, the German Research Foundation established a committee on atomic physics headed by the renowned physicist Werner Heisenberg. As early as November 1952, the commission demanded the establishment of a federally funded nuclear research center. Heisenberg, who worked in close collaboration with Chancellor Konrad Adenauer and became an informal advisor of the federal government, saw his hometown of Munich as the only possible location for the first German nuclear reactor station. He presented his ideas for a research reactor that would run on natural uranium, and thus not require US uranium enrichment facilities, to the federal Minister for the Economy, Ludwig Erhard. At the same time the state of Bavaria was improving its chances of being chosen as the reactor site by establishing the subject of nuclear physics at the Technical University of Munich. The driving force there was the physicist Heinz Maier-Leibnitz (Carson 2002, Carson 2010, Gleitsmann 1988, Eckert 1999, Trischler 2015). What followed was an intensely fought competition between the state governments of Bavaria and Baden-Württemberg with the cities of Karlsruhe and Munich with their respective technical universities as candidates for the siting of the federal reactor station. When the federal government finally decided on Karlsruhe, it took into consideration a veto by the NATO Supreme Allied Commander Europe, who favored a site more distant from the Iron Curtain than Munich.

While Munich ultimately lost out to Karlsruhe in the contest for the reactor, the Max Planck Society came up with a compensatory solution that enabled Heisenberg to save face by accepting the Bavarian offer to move the Max Planck Institute for Physics from Göttingen to Munich. In addition, Bavaria was compensated with a light-water reactor for research based in Munich (Forschungsreaktor München, or FRM), headed by Maier-Leibnitz and administered by the Technical University of Munich. It began operation in Garching, near Munich, in October 1957 as the first German nuclear reactor and was quickly followed by a rapidly expanding research infrastructure of reactor stations, including the big science centers at Karlsruhe, Jülich, Geesthacht, and Hamburg.

Evaluation of engagement events: The intervention of the NATO Supreme Allied Commander Europe in the siting conflict points to the interrelations of the civil and military dimensions of the nuclear sector. Although the scientific community tried hard to present nuclear science as a strictly civilian endeavor, not least to strip it of its historical origins in the so-called “Uranverein” (a project to develop nuclear weapons) under National Socialism, military rationales did play a substantial role in West Germany’s early nuclear history (Kelleher 1975, Cioc 1988, Küntzel 1992, Hanel 2015).

Relevant documents: articles in science and engineering journals, media reports in e.g., Süddeutsche Zeitung, Frankfurter Allgemeine Zeitung, Tageszeitung, Die Zeit, Der Spiegel, Federal Archives of Germany (German Atomic Program), State Archives of Bavaria and Baden-Württemberg, Archives of the Deutsches Museum (Papers of Heinz Maier-Leibnitz), Archives of the Max Planck Society and the Max Planck Institute for the History of Physics, State Archive Karlsruhe (GLAK), interview with the head of the Research Center Karlsruhe, Manfred Popp.

3.2. Civil Society Interaction—The Wyhl Example

Who was involved: Federal state government of Baden-Württemberg, Federal Ministry of the Interior, Kraftwerksunion (subsidiary of Siemens and AEG, a company that built nuclear power plants), planners, and activists.

When and where did it take place: In the years 1972 to 1977 and 1982 to 1987 in the state of Baden-Württemberg and in the community of Wyhl. Court cases took place in the cities of Fribourg and Mannheim.

What type of process was it—changes over time: Public participation and public communication. Before Wyhl was chosen to be the site for a nuclear power plant, politicians and planners considered the community of Breisach in the southwest of Germany as a possible site which – in the summer of 1972 – caused direct opposition because local farmers and wine growers expected negative environmental effects caused by emissions from the planned wet cooling towers. The federal state government did not want to risk the coming state elections and put the plans on ice. A year later it became publicly known that a new site in Wyhl had been found, which was only a few kilometers away from the original site and caused direct opposition again, this time well-organized. In 1973 and 1974 some 100,000 signatures and appeals against the construction of the nuclear power plant were submitted, including to the federal Minister of the Iinterior, who at that time was Werner Maihofer (FDP, liberals). This did not change the political decision at first and on 17 February 1975 the construction of the first reactor was started even though the final license for the building of the nuclear power plant had not yet been granted. This provoked opposition again, mostly from local people, many of them wine farmers, who spontaneously occupied the site and were supported in their resistance by activists from the nearby town of Fribourg. Crucial to this resistance was the successful fight against the erection of a lead chemical plant in Marckolsheim in neighboring French Alsace on the other side of the river Rhine. On 21 March 1975 the administrative court ruled that construction should be interrupted, which was overturned half a year later after an objection made by Minister-President of Baden-Württemberg, Hans Filbinger (CDU, conservatives). In autumn 1976 some 1,000 inhabitants demonstrated against Filbinger. Because the preparations for construction continued and site electricity connections were installed, the site in Wyhl was occupied by protestors again. In March 1977 the administrative court withdrew the construction license for the plant. But two years later the administrative court of Baden-Württemberg opened up a second case. In 1982 the court of justice decided again that the construction of the nuclear power plant was legal and caused a rally of 30,000 opponents. Filbinger's successor as Minister-President of Baden-Württemberg, Lothar Späth (CDU, conservatives), declared that the construction of the nuclear power plant in Wyhl would not be necessary before 1993 and in 1987 he reconfirmed this decision, stating the plant would not be needed until the year 2000. The plant was never built and was turned into a nature reserve in the mid-1990s instead (Engels 2003).

Evaluation of engagement events: Wyhl has been interpreted by historians as a national site of memory deeply embedded in German culture (Rusinek 2003). The protest against the possible nuclear site in Wyhl was not the first protest against nuclear power in Germany, but the protest structures that were developed here are widely recognized to have served as an example for the West German environmental movement in later protests. Fribourg in Baden-Württemberg, the so-called "green" city, is a leader in environmental protection, renewable energy, and sustainability today. It produces less waste and consumes less water than comparable cities and is leading in solar energy research. The founding of certain related institutes was inspired by the environmental movement's protests; the Öko-Institut (Institute for Applied Ecology), founded in 1977 is one of the most important institutes in its field in Germany.

Relevant documents: newspaper articles, e.g., in Die Zeit (Kühnert 1977), reports by German non-governmental organizations, e.g., BUND (BUND 2014), film documentaries (Nabel 2013), Federal Archives in Koblenz, Archive for Social Movements Fribourg, protest flyers and calls to protest, squatting journal "Was wir wollen," archive of the Bundesverband Bürgerinitiativen Umweltschutz (federal association for citizen initiatives in environmental protection), Bonn.

3.3. Civil Society Interaction—The Wackersdorf Example

Who was involved: Bavarian State Ministry for Regional Development and Environmental Questions (StMLU), Deutsche Gesellschaft zur Wiederaufbereitung von Kernstoffen mbH" (DWK), cabinet, police, activists.

When and where did it take place: In the years 1980 to 1988 in Bavaria, especially the municipality of Wackersdorf in the district of Schwandorf.

What type of process was it—changes over time: Public participation and public communication. In 1980 the Bavarian State Ministry for Regional Development and Environmental Questions (StMLU) was authorized by the cabinet to find a site for a reprocessing plant (Wiederaufarbeitungsanlage, WAA). Two years later the Deutsche Gesellschaft zur Wiederaufarbeitung von Kernbrennstoffen mbH" (DWK) made an application to the StMLU for the granting of a nuclear licensing procedure for the construction and operation of a WAA in Wackersdorf. Even though other possible sites were debated, Wackersdorf was chosen because a "high potential of protest […] (was) not to be expected" (Schardinger 2012, 18). In 1985 the DWK finally decided on Wackersdorf as appropriate location for the construction site and announced the development plan. After the clearing of the woodland had started, a major demonstration with 30,000 people took place in Wackersdorf. Demonstrators occupied the building site, erected a hut village, and called it "Freies Wackerland" (free Wackerland) (Knoll 2006). Citizens' initiatives, such as the Mothers Against Nuclear Power, raised objections to the reprocessing plant at a hearing in Neunburg. Here, they claimed for themselves and their families, especially their children, the fundamental right to life, health, physical integrity, and free development of their personality, which they did not see as being guaranteed if the reprocessing plant was built (Wurzbacher 1988, 1). The objections had to be handed in by a specific deadline to the approving authority, in that case the Bavarian Ministry of the Environment, which invited the people who protested to the hearing. The previous speaker before the women's initiative at the hearing was Robert Jungk, author of the influential book *Der Atomstaat* (*The Nuclear State*). The audience the "Mothers" spoke to consisted of the approving authority, who were in favor of the reprocessing plant, representatives of the DWK, who had proposed the building of the reprocessing plant, and experts such as radiation biologists, who were consulted by the approving authority to justify factually and technically the envisaged authorization. As Karin Wurzbacher, member of the Mothers Against Nuclear Power reports, the atmosphere in the hall was "in the beginning bored – now we patiently endure the "Mothers" and then we call it a day and [the men in the audience] showed a friendly face. In the end they were probably impressed. The representatives of the DWK showed no emotions whatsoever, they just reported their prepared answers" (Blomeyer and Wurzbacher 2016 and Wurzbacher 1988).

Up until the Chernobyl nuclear power plant catastrophe in April 1986 the Bavarian state government kept proclaiming publicly that hazards were not to be expected, either from the reprocessing plant or from any other nuclear power plant. The Chernobyl disaster – the so-called Super-GAU – then led to the peak of the violent disputes between police and anti-nuclear activists. West German police armed with stun grenades, rubber bullets, water cannons, CS gas, and CN gas were confronted by demonstrators armed with slingshots, crowbars, and Molotov cocktails at the site of the nuclear reprocessing plant in Wackersdorf (Germans 1986). Finally, the energy company VEBA changed its policies and was not interested in the reprocessing plant anymore. Additionally, the prominent advocate of the reprocessing plant, the Bavarian Minister-President Franz-Josef Strauss, had died, so the building plans were frozen in 1988.

Evaluation of engagement events: The plans for the plant were abandoned in 1988. It is still unclear whether protests, plant economics, or the death of Minister-President Franz-Josef Strauss, a strong proponent of the plant, in 1988 led to the decision (Isenson 2009).

Relevant documents: media reports in Süddeutsche Zeitung, Frankfurter Allgemeine Zeitung, Tageszeitung, Die Zeit, Der Spiegel, interview with the head of the energy company VEBA (Walraff 1989), film documentary about Wackersdorf (BUND 2015), printed papers of the Bavarian state parliament (Final report of the committee on Wackersdorf 1986), documents in the archive of the initiative Mothers against Nuclear Power, photographs of protests organized by the initiative by Cornelia Blomeyer, statements about and transcripts of appeals against Wackersdorf by Cornelia Blomeyer and Karin Wurzbacher, report by Thea Bauriedel about contemporary experiences in Wackersdorf, documents in the archive of the Deutschen Gesellschaft für die Wiederaufarbeitung von Kernbrennstoffen (DWK).

3.4. Civil Society Interaction—The Gorleben Example

Who was involved: Politicians, activists, German Society for the Construction and Management of Long-Term Waste Storage Units (DBE mbH), police, Federal Agency for State Protection and Counter Terrorism, Brennelementlager Gorleben GmbH (a subsidiary of the Society for Nuclear Services, GNS, which is owned by the energy companies E.ON, RWE, and Vattenfall Europe).

When and where did it take place: village of Gorleben in the district of Lüchow-Dannenberg (Lower Saxony). Controversies since 1977 up until recently, especially then when there are cask transports to the site in Gorleben.

What type of process was it - changes over time: Public participation and communication process. The only controversial nuclear project that still has relevance today in Germany is the repository site near the village of Gorleben (Lower Saxony, former West Germany). The decision for a storage site for nuclear waste came comparatively late. In the beginning the government did not see need for action to create a final repository because the quantity of waste was relatively small. For instance, high level waste did not exist because the reactor's fuel elements were brought back to the countries they came from. In cases where high-level waste was produced, the government planned to reduce the volume by reprocessing it and keep an open mind about further technological developments instead of deciding on certain methods just yet (Tiggemann 2010, 121 and Müller 1990, vol. 1, 525). Germany and other countries considered different ways of storing radioactive waste. Ideas that were considered and/or debated were storage in space, in ice caps on earth, or in the sea. All of these concepts were contested and the Federal Republic decided to concentrate on disposal onshore in salt deposits. Because of the existing salt domes in Lower Saxony, the government considered a site for storage in this state. To this end, in the years 1967–1978 it tested the former salt mine Asse II in the Asse mountains of Wolfenbüttel for research purposes as a deep geological repository for radioactive waste (Tiggemann 2010, 126 et seq.).

In the end the government decided in favor of storing nuclear waste at the Gorleben site, a decision that came about in 1977 under Chancellor Helmut Schmidt (SPD) and Prime Minister Ernst Albrecht (CDU, conservatives). At the site, there exists today:

1) a storage unit for radioactive waste which emits faint heat;

2) an interim storage unit for dry cask storage;

3) a conditioning plant (and a pilot plant in a salt dome).

1) The salt dome was intended to become a **long-term storage plant** for different kinds of radioactive waste and is run by the German Society for the Construction and Management of Long-Term Waste Storage Units (DBE mbH), but at present this use is still controversial and it has not yet been finally decided upon. It was the then Minister-President of Lower Saxony Ernst Albrecht (CDU) who decided on the site in Gorleben in 1977. Reasons for the choice were political and economic, especially the closeness to the East German border and the low population density in the area (Endlager Gorleben 2009). Soon public protest arose against the plans. In 1979 a convoy of 500 tractors went to Hanover, and on 31 March that year the biggest demonstration in the history of Lower Saxony took place with 100,000 people present. Afterwards, Minister-President Albrecht declared the plans as not feasible, which ended them (Jaschick 2010). In parallel, test drillings for the repository were carried out and were also accompanied by strong protests and a hut village was erected called “the micronation ‘Republik Freies Wendland’” (Free Republic of Wendland). The hut village was evacuated in the same year by police forces. Protests against the repository plans have continued ever since and have been carried out granted by action groups like Bürgerinitiative Umweltschutz Lüchow-Dannenberg (Citizens’ Initiative for Environmental Protection Lüchow-Dannenberg) or Bäuerliche Notgemeinschaft (Farmers’ Emergency Association).

2) The site for **an interim storage unit for dry cask storage** was built between 1981 and 1983 in the face of massive protests and collisions with police. Protesters suffered from fractured ribs, insured kidneys, fractured heads, and blinded eyes that were caused by water guns (Geisler 2010). Opponents of the transports were systematically spied on by police and the Federal Agency for State Protection and Counter Terrorism (Verfassungsschutz 2001). Because of

litigations and massive protests, the plant only started operating in 1995 with the first so-called Castor (**ca**sk for **stor**age and transport of radioactive material) transport. Two casks filled with spent fuel from various German reactor sites and high-level nuclear waste from reprocessing facilities in France where shipped to the interim storage facility in Gorleben. The second transport was shipped in 1996 with one cask from the reprocessing plant in La Hague and a third transport a year later, in 1997, included six casks. The fuel elements and vitrified waste block containers are in dry casks standing in a hall above ground and cooled by the surrounding air. They will stay in the casks for decades until they have cooled down from 400°C to 200°C and an appropriate repository has been found. Within these first three years the number of protesters increased from 4,000 to 10,000; police numbers increased to three times as much (from 7,600 to 30,000). As of 2011, 113 casks had been shipped to Gorleben. The Castor transports often become large events and receive remarkable national media coverage for several days in a row.

3) In Gorleben there is also a **"pilot conditioning plant"** where tests are made to condition the fuel elements in order to store them in a deep repository, and also to reload the containers for the vitrified waste blocks into containers suited to long-term storage. For technical reasons the dry cask storage containers are not suitable for long-term storage and cannot be placed in the salt dome.

Evaluation of engagement events: Like the anti-nuclear protests in the decades before, the clashes between opponents and police became extremely violent. The government's handling of it was perceived as inappropriate by the anti-nuclear movement and the broader public alike (Glaser 2012, 16, Narr 1997, Hintergrund 2010).

Relevant documents: Media articles e.g., Der Spiegel (Gorleben 1982), Gorleben archive (also accessible online, e.g., for Gorleben chronicle), online archive and active archive on documents for Bürgerinitiative Umweltschutz Lüchow-Dannenberg, archive of the Rechtshilfe Gorleben, Gartow, archive of the state parliament of Lower Saxony, Federal Archive in Koblenz, archive of the research mine Asse, Remlingen, Castor transport reports (Narr 1997).

3.5. Energy transition after Fukushima

Who was involved: Professional associations (e.g., the German Atomic Forum) and the Federal Government (Social Democratic Party and the Greens, later also the Christian Democratic Party), Germany's Ethics Commission on Safe Energy Supply, energy companies.

When and where did it take place: In the years 1998–2011 on the government level.

What type of process was it—changes over time: Communication process.

In the year 1998 the red-green coalition decided to phase out nuclear energy within 20 years (Munsberg 1998). In 2000 an agreement about the future operation of German nuclear power plants between the federal government and electricity supply companies was signed (Informationskreis Kernenergie 2015). After the tsunami and partial meltdown at Fukushima Daiichi in 2011, the topic received renewed societal attention. Chancellor Angela Merkel announced that all German power plants would be closed down by 2022 with eight of the seventeen operating German reactors being shut down immediately (Germany 2011). There have always been strong links between the government and professional associations based on collaboration that goes back decades. When the German government decided to phase out nuclear reactors, lobbyists such as the German Atomic Forum and the Nuclear Society tried to counteract the so-called Energiewende (energy transition). Since then, even the German Atomic Forum has made its peace with the goals of the German energy transition and has begun to focus its activities on keeping up engineering competence in dismantling nuclear reactors and radioactive waste storage (Interview Güldner). Energy companies like Areva changed their policy to focus on export and scientific research instead of processing fuel elements (Interview Schuch and Meyer zu Schwabedissen).

Evaluation of engagement events: The evaluations of the event vary in Germany and Europe. German society, politicians, and historians interpret the controversy over nuclear energy, including the phase-out, predominantly as a success story (Radkau 1987, Weitze and Trischler 2006) and regard the process as deeply democratic. In contrast, many other countries and academic colleagues are critical of the violence of the debates and protests (Hughes 2014) and consider the phase-out decision as "a misguided and potentially damaging interpretation of the precautionary principle" (Moore 2012). This shows that nuclear energy and society's perception and interpretation of the developments vary considerably from country to country.

Relevant documents: Interviews with Matthias Schuch and Christian Meyer zu Schwabedissen from the German subsidiary of the French energy company Areva, and Ralf Güldner, president of the German Atomic Forum, documents from Federal archive, newspaper articles e.g., in Der Spiegel, TAZ, Die Zeit, Koblenz, agreement between the Federal Government of Germany and the energy supply companies, numerous media reports, archives of energy companies e.g., PreußenElektra, Hanover, archive of the Green Party, Berlin, Archive of Social Democracy (archive for documents on the SPD), Bonn, Archive for Christian-Democratic Policy (CDU), Sankt Augustin.

4. Facts & Figures

The purpose of this section is to give an overview of nuclear power in Germany. This section contains such data as the number of reactors, reactors' locations, technical and chronological details of reactors' construction, as well as statistics on electricity production, periodization, and social connections to nuclear construction. This data can be used as supportive material to the various sections of the country report and in order to understand the overall country's situation. Key dates and abbreviations used in this report are presented at the end of this report.

4.1. Data summary

- Germany shut down most of its reactors following the Fukushima accident in 2011.
- Previously, Germany had 17 operating reactors, which provided 25 percent of electricity in the country.
- Public opinion about nuclear power in Germany is negative.

4.2. Key dates and abbreviations

Key dates:

1955	After the Federal Republic of Germany gets its sovereignty, Chancellor Konrad Adenauer and the Federal Government establish Federal Ministry for Atomic Issues (16 October 1955), and Franz-Josef Strauss becomes minister for atomic affairs.
1956	Nuclear research centers in Berlin, Hamburg, Geesthacht, Jülich, and Karlsruhe.
1957	Establishment of the European Atomic Energy Community (EURATOM) in March and founding of the International Atomic Energy Agency at the end of July.
1957	The first nuclear reactor in Germany, called "nuclear egg," starts operations at the end of October. It is a research reactor at the Technical University of Munich.
1958	Establishment of the Reactor Safety Commission (Reaktor-Sicherheitskommission—RSK).
1959	Establishment of the German Atomic Forum (Deutsches Atomforum)—a platform to connect business, science, and industry for promotion of peaceful nuclear energy.
1959	The Atomic Energy Act is announced in Germany, which makes construction and operations of NPP legal.
1960	FBR project in Karlsruhe.
1960	The Atomic Energy Act comes into force in January and the first Radiation Protection Ordinance comes into force in September.
1961	In March, the Karlsruhe Nuclear Research Center puts FR-2 into operation, a heavy-water reactor and the first German-built reactor.

1961 First time electricity from a nuclear reactor is generated for the national grid by Kahl research NPP (VAK).

1967 Experimental nuclear waste storage in the Asse salt mine.

1969 Establishment of the German Nuclear Society (Kerntechnische Gesellschaft).

1974 Construction of first 1,200 MWe reactor in the world begins in Germany at Biblis NPP.

1976 Anti-nuclear demonstrations in Brokdorf.

1977 The first German-made FBR reactor is put into operation at the Karlsruhe Nuclear Research Center.

1977 Anti-nuclear demonstrations in Kalkar.

1981 Mass anti-nuclear demonstration in Brokdorf becomes violent.

1982 Beginning of foundation construction for Germany's first large uranium enrichment plant, in Gronau.

1986 Massive anti-nuclear demonstration against the construction of the Wackersdorf reprocessing plant in response to the Chernobyl disaster.

1986 Founding of the Federal Ministry for the Environment, Nature Conservation, and Reactor Safety (BMU).

1986 Decision to phase out nuclear energy in Germany within 10 years at the SPD party conference.

1986 The Brokdorf NPP is put into operation.

1990 German reunification and shutdown of nuclear power reactors in East Germany.

1998 Federal elections and formation of the coalition government, which decides to phase out nuclear energy as a future policy.

2009 New government cancels the phasing out of nuclear energy.

2010 The coalition government decides to give life extensions to NPPs.

2011 After the Fukushima disaster, parliament decides to speed up phasing out of nuclear power. Phase-out policy is reintroduced in Germany and eight reactors are shut down immediately after Fukushima.

Abbreviations:

AEG	Allgemeine Elektricitätsgesellschaft
ANP	Advanced Nuclear Power
BBR	Joint venture of Brown, Boveri & Cie. (UK) and Babcock & Wilcox (USA), now ABB
BBC	Brown Boveri
BBK	BrownBoverie-Krupp Reaktorbau
BNFL	British Nuclear Fuels Limited; renamed Westinghouse
BWR	Boiling Water Reactor (SWR 1000)
EPR	European Pressurized Water Reactor
EVU	Energieversorgungsunternehmen (energy supply enterprise)
ERAM	Endlager für radioaktive Abfälle (nuclear waste repository)
EURATOM	Europäische Atombehörde (nuclear agency)
FBR	Fast Breeder Reactor
GE/AEG	General Electric/ Allgemeine Electricitäts-Gesellschaft
HRB	Hochtemperatur Reaktorbau GmbH
IAEA	International Atomic Energy Agency
KWU	Kraftwerk Union
MWe	MegaWatt electrical
NPP	Nuclear Power Plant
OECD/NEA	Organization for Economic Cooperation and Development/Nuclear Energy Agency
PWK	Projektgesellschaft Wiederaufarbeitung von Kernbrennstoffen mbH (Society for reprocessing of nuclear fuel)
PWR	Pressurized Water Reactor
RSK	Reaktor-Sicherheitskommission (Reactor Security Commission)
SNR	Schneller Natriumgekühlter Reaktor
SWR	Siedewasserreaktor (boiling water reactor)
THTR	Thorium-Hochtemperaturreaktor (Thorium High-Temperature Reactor)
VAK	Versuchsatomkraftwerk (experimental atomic power plant)
WAK	Wiederaufarbeitungsanlage (Reprocessing plant)

4.3. Map of nuclear power plants

Figure 1 represents a map of nuclear power sites in Germany.

Figure 1: Nuclear power plants in Germany. Source: WNA 2016.

Currently, there are no operating power plants in East Germany because of the type of reactors built in the German Democratic Republic.

4.4. List of reactors and technical and chronological details

The tables below show the list of reactors, suppliers, operators, and dates.

Table 1: Operational commercial nuclear power reactors. Sources: IAEA 2016, WNA 2016.

No.	Name	Operator	Type	MWe net	Construction date	Grid power	Planned shutdown 2001	Agreed shutdown 2010	March 2011 shutdown & May 2011 closure plan
1	**Biblis A**	RWE	PWR	1167	1970	1975	2008	2016	shutdown
2	**Biblis B**	RWE	PWR	1240	1972	1977	2011	2018	shutdown
3	**Brokdorf**	E.ON	PWR	1370	1976	1986	2019	2033	2021
4	**Brunsbüttel**	Vattenf all	BWR	771	1970	1977	2009	2018	shutdown
5	**Emsland**	RWE	PWR	1329	1982	1988	2021	2035	2022
6	**Grafenrheinfeld**	E.ON	PWR	1275	1975	1982	2014	2028	shutdown June 2015
7	**Grohnde**	E.ON	PWR	1360	1976	1985	2017	2031	2021
8	**Gundremmingen B**	RWE	BWR	1284	1976	1984	2016	2030	end 2017
9	**Gundremmingen C**	RWE	BWR	1288	1976	1985	2016	2030	2021
10	**Isar-1**	E.ON	BWR	878	1972	1979	2011	2019	shutdown
11	**Isar-2**	E.ON	PWR	1400	1982	1988	2020	2034	2022
12	**Krümmel**	Vattenf all	BWR	1260	1974	1984	2016	2030	shutdown
13	**Neckarwestheim-1**	EnBW	PWR	785	1972	1976	2009	2017	shutdown
14	**Neckarwestheim-2**	EnBW	PWR	1305	1982	1989	2022	2036	2022
15	**Philippsburg-1**	EnBW	BWR	890	1970	1980	2012	2026	shutdown
16	**Philippsburg-2**	EnBW	PWR	1392	1977	1985	2018	2032	2019
17	**Unterweser**	E.ON	PWR	1345	1972	1979	2012	2020	shutdown

Before the Fukushima disaster, Germany planned to shut down its reactors as they reach over 30 years of operation. In 2010, the shutdown timetable was agreed upon as presented in Table

1. However, after Fukushima, eight reactors were shut down immediately and the scheduled shutdown time for other reactors was significantly reduced.

Table 2: Reactors in Germany shut down before Fukushima. Sources: IAEA 2016, WNA 2016.

No	Name	Operator	Type	MWe net	Construction date	Grid power	Shutdown	Status
1	**AVR Jülich**	AVR	HTGR	13	1961	1967	1988	
2	**Greifswald-1**	EWN	VVER V-230	408	1970	1973	1990	dismantled
3	**Greifswald-2**	EWN	VVER V-230	408	1970	1974	1990	
4	**Greifswald-3**	EWN	VVER V-230	408	1972	1977	1990	
5	**Greifswald-4**	EWN	VVER V-230	408	1972	1979	1990	
6	**Greifswald-5**	EWN	VVER-V213	408	1977	1989	1989	dismantled
7	**Großwelzheim**	HDR	BWR	25	1965	1969	1971	dismantled
8	**Gundremmingen A**	KRB	BWR	237	1962	1966	1977	dismantled
9	**Kahl**		BWR	15	1958	1961	1985	site unrestric-ted
10	**Kalkar KNK-2**	KfK	FBR	17	1974	1978	1991	
11	**Karlsruhe MZFR**	KBG	PHWR	52	1961	1966	1984	
12	**Lingen**	RWE	BWR	183	1964	1968	1979	safestor
13	**Mülheim-Kärlich**	SCN	PWR	1219	1975	1986	1988	
14	**Niederaichbach**	KfK	HWGC R	100	1966	1973	1974	site unrestric-ted
15	**Obrigheim**	EnBW	PWR	340	1965	1968	2005	
16	**Rheinsberg**	EWN	VVER-V210	62	1960	1966	1990	dismantled
17	**Stade**	E.ON	PWR	640	1967	1972	2003	
18	**THTR**	HKG	HTGR	296	1971	1985	1988	safestor
19	**Würgassen**	PreußenE lektra	BWR	640	1968	1971	1994	

4.5. Data on Electricity Production, Nuclear Development and Companies

Share of electricity in 2013: gas declined 21% from 2012, and coal share rose before declining in 2014.

In the first half of 2014: gas-fired input dropped a further 14% to 16.6 terawatt-hours/TWh, lignite provided 69.7 TWh, hard coal 51.9 TWh, nuclear 45.0 TWh, wind 26.7 TWh, solar 18.3 TWh, biomass 25.6 TWh, and hydro 10.5 TWh. Total for six months: 264.3 TWh, of which 16.1 TWh was exported.

Germany's electricity production in 2014 (preliminary International Energy Agency figures): 615 TWh gross. In 2014 coal provided 275 TWh (more than half being lignite), nuclear 97 TWh (16%), gas 61 TWh, biofuels and waste 57 TWh, wind 56 TWh, solar 35 TWh, and hydro 25 TWh.

Electricity exports: about 34 TWh, compared with 20 TWh in 2012.

Imports: gas, coal, and oil worldwide. Apart from lignite and renewables, Germany has only a few domestic resources. In 2011, Russia provided almost 40% of gas, followed by Norway, the Netherlands, and UK, while 14% was produced domestically.

Annual consumption: about 6400 kWh per capita. Gross consumption was 576 TWh in 2014.

Generating capacity in April 2014: 169.6 gigawatt electrical/GWe.

GWe comprising: 12.1 GWe nuclear, 5.6 GWe hydro, 33.7 GWe wind (0.6 offshore), 36.9 GWe solar, 28.2 GWe gas, 21.2 GWe lignite, 26.3 GWe hard coal, and 5.6 GWe biomass (Fraunhofer Institute). In the first half of 2014 wind and solar PV had capacity factors of 18% and 11% respectively, compared with 85% for nuclear.

Nuclear development:

Until 2010, the 17 nuclear units totalled 20,339 MWe. The last came into commercial operation in 1989. Six units were boiling water reactors (BWR) and eleven were pressurized water reactors (PWR). All were built by Siemens-KWU. A further PWR had not operated since 1988 because of a licensing dispute. This picture changed in 2011, with the operating fleet being reduced to nine reactors with 12,003 MWe capacity, and then to eight reactors with 10,728 MWe. In 2000, two of Germany's biggest utilities, VEBA and VIAG, formed E.ON, which owned or had a stake in 12 of the country's 19 nuclear reactors, which were operating then. From January 2016, E.ON spun off Uniper, which will take over E.ON's global energy trading and power generation in and outside of Europe. E.ON will continue operating and slowly close down its nuclear generating capacity in Germany.

Equities of utility companies operating in Germany:

E.ON has equity in the following nuclear plants (January 2016), which will be managed by its subsidiary PreußenElektra: Isar-1 100%, Unterweser 100%, Krümmel 50%, Brunsbüttel 33.3% (all shut down), Grafenrheinfeld 100%, Gundremmingen B and C 25%, Grohnde 83.3%, Brokdorf 80%, Isar-2 75%, Emsland 12.5%.

RWE has equity in the following nuclear plants: Gundremmingen 75%, Biblis 100%, Emsland 87.5%.

Vattenfall has equity in the following German nuclear plants: Brunsbüttel 66.7%, Krümmel 50%, Brokdorf 20%. It has written off SEK 10.2 billion (€1.2 billion) on Brunsbüttel and Krümmel. Also in Sweden: Ringhals 70%, Forsmark 66%.

EnBW has equity in the following nuclear plants: Neckarwestheim 100%, Philippsburg 100%.

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Manfred Popp, longstanding CEO of the Research Center Karlsruhe, 9 May 2016.

Marco Avena, activist 'Robin Wood' and 'Energiepolitischer Runder Tisch,' 26 May 2016.

Ralf Güldner, president of the German Atomic Forum, 27 May 2016.

Matthias Schuch and Christian Meyer zu Schwabedissen, energy company Areva, 16 June 2016.

Reiner Szepan, physicist and independent expert, 12 December 2016.

Karin Wurzbacher, activist 'Mothers against Atomic Power,' 24 May 2016.

WP2

Greece

Short Country Report

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Ciemat

University of Copenhagen Faculty of Humanities

Deutsches Museum

DIALOGIK

EHU Europos humanitarinis universitetas

TU/e Technische Universiteit Eindhoven University of Technology Where innovation starts

Friedrich-Schiller-Universität Jena

Swedish Defence University

GRE

KTH

LUT Lappeenranta University of Technology

upna

UPMC Sorbonne Universités

The University Of Sheffield.

SCIENCE MUSEUM

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CONTENTS

Executive summary

This report belongs to a collection of 20 short country reports on the History of Nuclear Energy and Society (HoNESt, project Ref.662268). The reports tackle the complex sociotechnical system around nuclear energy. Nuclear developments, notably nuclear energy, are closely intertwined with social, economic, environmental, political and cultural spheres. Nuclear energy is also a globalized system involving transnational transfers of knowledge, materials, technologies, people and products including electrical power, medical elements, toxic wastes and other environmental hazards, materials, capacities and knowledge that must be carefully safeguarded. Nuclear energy is a complex social and technological phenomenon that influences societies but is also shaped by societies.

The short country reports are designed to assemble information and research results on the history of the relations between nuclear energy and society about all the different country cases in an accessible manner, and to document the findings with references.

The purpose of the country reports is threefold, addressing three different audiences:

1. to provide basic elements of narrative and analysis for further historical research by HoNESt researchers;
2. to provide information, context and background for further analysis for HoNESt's social science researchers;
3. to provide accessible information on nuclear-societal relations in the various countries for the purposes of outreach and communication with stakeholders (civil society, industry, associations, policy makers, journalists).

This report focuses on the history of the relations between nuclear energy and society in Greece. It presents the visions and the planning for nuclear power plants in Greece from the early 1960s until the cancellation of such plans in the early 1980s. The report captures the role of various actors during the different phases of the nuclear project.

The initial plans for the construction of nuclear power plants were laid out in the 1960s, mostly by experts. During the years of the Colonels' dictatorial regime (1967-1974) the plans became part of

an overall political project that assumed that energy self-sufficiency and national sovereignty would be served by an extensive nuclear program. At that point the Public Power Corporation (PPC) developed plans for the establishment of nuclear power plants.

After the restoration of democracy in 1974, the nuclear vision was scaled down. The Conservative governments (dates) supported the planning put forward for the construction of a nuclear power station. Amidst contested views about the prospective nuclear plant, a series of critical events led to the cancellation of the project. Public consternation had grown from the late 1970s against the nuclear project, which along with a major earthquake, led the Socialist government to abandon the project in 1981.

The cancellation of the nuclear project was accompanied by the increased use of lignite in power production, the development of transnational interconnections and plans for the introduction of natural gas to the country’s energy mix. These transnational interconnections meant that critical energy flows came from electricity produced in nuclear power plants in Bulgaria. In this manner, Greece became ‘nuclear’ even though it did not have facilities for the extraction of uranium ore deposits or a nuclear power plant.

1. Historical Context (narrative)

This section provides the basic historical context to the interaction between nuclear industry and civil society in Greece. The historical narrative aims at providing relevant context to the events as well as the showcase.

1.1. Introduction to the historical context

The twenty years between the mid-1960s and the mid-1980s was a period of public deliberation, visionary schemes and plans, political antagonisms, competing corporate strategies, political activism and local and national contestation regarding the establishment of nuclear power plants for energy purposes. Proposals for a nuclear power plant were conceptualized and re-conceptualized several times, by several actors and political authorities during these twenty years. Visions of a nuclear future were linked to, informed by and interacted with political order and political strategies. They were informed by the emerging political priorities of the Greek state, and its geopolitical role in the South-East Mediterranean and the Balkans. Moreover, during the militaristic regime of the seven year dictatorship (1967-1974), nuclear energy was linked strongly to a discourse about the political autonomy, sovereignty and energy self-sufficiency of Greece, becoming part and parcel of the broader attempt at political legitimization sought by the leaders of the dictatorship. Governmental strategies and energy policies were influenced also by the general Cold War climate and the priorities set by powerful European countries (Arapostathis et al. 2017).

Supporters of nuclear energy stressed political reasons, including the importance of energy security and the strengthening of Greece's geopolitical position. At the same time, arguments against the establishment of the nuclear plant stressed the cost constructing such a plant, and the issue of technological dependence on the countries which would provide uranium or/and the know-how to construct and operate nuclear reactors. There were also actors who argued that the seismicity of Greece was the main argument against a nuclear plant. They specifically emphasized the risks and the uncertainties in the case of an earthquake in the region near Athens. These concerns were amplified by the accident at Three Mile Island in the USA in 1979 and the strong 6.7 Richter earthquake in the Korinthian Gulf of Greece on 24 February 1981.

These events significantly strengthened, bothpolitically and socially, the civil society movements and activists' groups who were either against nuclear energy in general or against plans for an installation of a nuclear plant at a certain location in particular. A nuclear power plant had been proposed in the area of Karystos, in south Evoia, about 70 km from Athens. It was chosen due to its proximity to Athens and its low seismic potential. However the 6.7 Richter earthquake in 1981 forced the government of PASOK to cancel the project despite the fact that there were ministers who could still have supported it.

The cancellation of the nuclear power plant boosted PPC's reliance on lignite, a strategy for the development of transnational interconnections and plans for the introduction of natural gas into Greece's energy mix. In other words, while the government was cancelling the plan for a nuclear plant in Greece, it boosted transnational electrical interconnectors that would increase critical electricity flows from electricity produced in the Bulgarian nuclear plant of Kozloduy and other nuclear plants in the region. This way Greece became 'nuclear' through its interconnections, even though it has neither a reactor nor uranium ore deposits (Tympas et al. 2013; Arapostathis et al. 2017).

1.2. Contextual narrative

1.2.1. Visions, Ideas and the Politics of the Greek nuclear plant in the 1960s

The initial discussions for the establishment of the nuclear power plant for energy generation started in the early 1960s based on an initiative by the Public Power Corporation (PPC). Yet this was not Greece's first foray into nuclear physics. The 1950s were a decade of developments in the field of atomic and nuclear physics in Greece, including the establishment of the Greek Atomic Energy Commission (1954) and the Nuclear Research Centre 'Demokritos' (initially conceived of in 1954). This was a period through which the USA sought to structure and influence scientific expertise and European epistemic communities according to their interests through reconstruction projects and directed aid programmes In this context and with the support of the USA as well as the political patronage of Queen Frederica and the Greek Palace, the scientific community of nuclear and atomic physicists emerged as an important group of experts. It too promoted atomic and nuclear research for peaceful purposes and positioned itself as a critical group, whose research would contribute to the modernization of the Greek state. State building processes, the diffusion of western values and the formation of scientific institutions around the development of nuclear energy emerged synergistically (Rentetzi 2009a; Krige 2006).

In 1963 public discussion about the construction of a nuclear power plant in Greece began. It was after the initiative of the PPC that Professor Mihail Angelopoulos, an engineer with work experience in the UK Atomic Energy Authority, was asked to give a lecture about the possibility of a nuclear power plant in Greece. M. Angelopoulos was not an optimist. He argued that the cost of construction and operation was too high and that a plant of 150 MW could not compete with thermal units already operated by PPC. On the other hand a larger plant would be unnecessary for the electricity demand in Greece. (Angelopoulos 1963; Tsotsoros 1995; Lemontzoglu 2007). So, M. Angelopoulos argued that as a base station that would have to be in continuous operation there was no requirement for a nuclear power plant in Greece (1963, 23-24). Furthermore, he pointed out that the quest for continuous operation would necessitate its construction close to a large urban and industrial centre like Athens and this would complicate things further with the need for further precautionary measures during the construction and the operation of the plant for health and safety reasons. Also he stressed the lack of technical and scientific expertise to man the power plant,a very important factor for the smooth operation of such a complex technology. He supported the view that PPC should invest in the exploration and exploitation of native resources like lignite and should build its grid and energy mix around those sources and not on the promises and expectations of nuclear power (Angelopoulos 1963, 27-28; Arapostathis et al. 2017).

In 1966, Professor Angelos Th. Angelopoulos (another Angelopoulos), an established authority in economics and editor of the journal *New Economy* (*Νέα Οικονομία*), was arguing in favour of the establishment of a nuclear power plant. For A. Angelopoulos lignite was not a priority. The energy mix of the country should have been structured around the nuclear power. He supported the construction of a nuclear power plant of 280-300 MW at a cost of $ 40-45 million, an amount that ought to be spent by the Greek state in order to secure energy self-sufficiency and development based on nuclear power. He believed that without nuclear power for energy purposes Greece would remain an underdeveloped European country, capable of developing only its tourist industry. In his opinion, the establishment of a nuclear plant would cost less than building two thermal power plants, which would produce less power. He also saw the nuclear power plant as an opportunity to build a strong scientific community of nuclear and atomic physicists (Angelopoulos 1966, 14). A. Angelopoulos argued that the nuclear plant would boost the economic and diplomatic position of Greece. He even insisted that Greece could secure low prices in purchasing uranium by negotiating with Britain, France and even Russia - by playing its cards pragmatically in the Cold War setting (Angelopoulos 1959; 1966, 1; Hatzivassiliou 2006; Wallden 1987, 1991b).His arguments had the support of the leading economic journal, *Economic Postman (Οικονομικός Ταχυδρόμος)* (Kyriazis 1966a, 1966b) as well as of the Industry Minister, I. Toumbas, who publicly supported the construction of the plant (Tsapogas 1966, 5).

The public debate, as well as the strong interest by PPC to study the possibility of integrating nuclear power in the modes of electricity generation triggered the interest of foreign companies in becoming consultants and contractors of machinery. Swiss, Belgian, British and American companies viewed Greece as an emerging nuclear economy and started to lobby PPC and Greek officials in order to promote their engineering services and their technologies (Stratigakis 1967a). The Swiss engineering companies Electrowatt (Stratigakis 1967a, 12-14) and Bonnard-Gardel (Stratigakis 1967a, 9-12), as well as the Belgian Societé de Traction et d'Electricité (Stratigakis 1966), submitted proposals to conduct studies in relation to the construction and operation of a nuclear plant in Greece. From the US, it was Westinghouse that submitted a proposal for a water reactor that would be using enriched uranium and common water for freezing and deceleration purposes (Stratigakis 1967a, 1967b). British interests, through the British Atomic Energy Authority, were mobilized in order to secure the establishment of a British designed and constructed nuclear reactor for Greece. An ad-hoc committee was set by members of the British Atomic Energy Authority, the PPC, the Centre of Economic Planning, Centre of the Ministry of Reconstruction and Energy and the Greek Atomic Energy Commission. The aim was to conduct and complete a study on the locations, the available technologies, the best ways of integrating nuclear energy in the national grid as well as the socio-economic repercussions of that integration (Stratigakis 1967b).

1.2.2. Dictatorial Upscaling: Junta's Atomic Age Ideals

The visions and plans for the establishment of the nuclear power plant continued and were augmented during the years of the colonels' dictatorial regime. The Junta men not only provided the setting for the continuation of the plans and for acquiring momentum but also announced grandiose schemes and long term plans for the transformation of Greece into a hub of nuclear power for energy purposes in the Balkans. The schemes were inscribed in the regime's attempt to secure the militarization of political life by merging nationalist ideals with the ideals of the Atomic Age. The regime attempted to use the Cold War geopolitical setting to diffuse and socially legitimize the idea of a powerful Greece in the Balkans and a country with secure energy self-sufficiency and national sovereignty, through the promotion of an extensive nuclear program (Tsapogas 1966, 5; Arapostathis et al. 2017; Veremis 1999, 108-9). The regime wanted to exercise strong control of the Greek Atomic Energy Commission and the Research Centre 'Demokritos' (Rentetzi 2009a, 2009b, 2010). Plans were set for the upgrade and the upscaling of the experimental nuclear reactor in Demokritos while the Greek Atomic Energy Committee was given funding to promote and diffuse the ideals of the Atomic Age, to organize educational trips and seminars for physicists and engineers abroad (Δελτίον1970a, 13; 1970b, 1-10). During the Junta years, more than 1,000 educational tours were organized for Greek scientists in countries with nuclear facilities (Δελτίον1968c, 1; 1968a, 4; 1969a, 1-11; 1969d, 1-2; 1971a, 1-6; 1974, 1-4). The strong political favouring of nuclear energy by the colonel's regime reinforced the interest of foreign consulting and construction companies. After 1969, collaboration between the British Atomic Energy Authority, the PPC and the Greek Atomic Energy Commission reignited plans (Δελτίον 1968d, 10; 1968b, 3; 1969b, 3; 1969c, 3).

The Colonels' regime also promoted the idea of the existence of uranium ore deposits in Greek territories mostly in Northern Greece. Some explorations were reported in 1968 at the area of Kilkis. They attracted the attention of the United Nations. In 1970, experts from the Development Programs of the UN visited Greece, met with experts from the Greek Atomic Energy Commission and agreed on the need for the expansion of the exploration for uranium ore deposits. The researches were funded by the UN with 500,000 US dollars (Δελτίον 1971b, 14). There were estimations of 1000 tons of uranium that would have sufficed to fuel a nuclear power plan of 600-700 MW for 25 to 30 years ("Πρόγραμμα Ερεύνης" 1972; "Τους 1000 τόνους" 1979).

It was during the dictatorship that, for the first time, PPC officially incorporated the idea for the establishment of a nuclear power station in its five years' development programs. In 1972, the director of PPC, P. Demopoulos, presented the plans for the establishment of a power station by 1980. These plans soon reached a grandiose scale since it was the same year that PPC announced its plans for 8 nuclear power stations by 1991 and 6 more by 2000. So the dictatorial regime was advancing a utopia of 14 stations in less than thirty years. At the same time, further interest in transnational electricity interconnections with Yugoslavia and also with Bulgaria, Turkey and Italy was reported. The Junta aimed at presenting itself as a regime that would secure both the energy interests of the country and its geopolitical position by becoming an electricity exporter, on the grounds of the abundance of electricity that the country would have with the network of nuclear power stations ("Ποσόν 36.000.000.000" 1972; "Επιδεικνύεται εις την Έκθεσιν" 1972). As mentioned above, the Colonels' regime had already started negotiations with the United Kingdom in order to secure the construction of a nuclear station, based on knowledge and technology transfer from this country. The regime proposed to trade 40,000 tons of tobacco for getting the agreement of the British to get involved and construct the relevant infrastructure. The junta pressed for the quickest possible establishment of the plant. This junta initiative failed. Yet, foreign interest in getting involved in a future nuclear program of Greece remained. In addition to capitalist countries like Britain, France and the US, the Soviet Union also expressed an interest (Moissis 2008; Greenpeace 2006).

1.2.3. Politics and the Making of the Nuclear Democracy

The grandiose scheme of Junta did not have any momentum in the period after the restoration of democracy. Yet the idea for the establishment of a nuclear power plant continued to exist and to influence the political life of the country. The plan – in the modest scale of one power station- was discussed and promoted by the governments of the conservative party, New Democracy, both under the leadership of its founder, Konstantinos Karamanlis, and his successor, Georgios Rallis. In 1975 Karamanlis instituted the National Energy Council and asked the MIT Professor Elias Gyftopoulos to chair it (Gyftopoulos 1977). Gyftopoulos supported nuclear power for energy purposes arguing that its integration would reduce the cost of energy production. He also believed that the risks from a nuclear power plant were minimal and could be reduced further due to relevant technological advancements. He sought to deconstruct any argument that supported the view that a nuclear plant would deepen Greece's technological dependence on the countries that had developed the technologies or those with uranium mines (Gyftopoulos 1977). A year later (1976) the plan became part of the PPC ten-year development program. In the program it was specified that the operation would start in 1986 (Arapostathis et al. 2017).

The positive inclination of the conservative government and most importantly of Prime Minister Konstantinos Karamanlis towards Greece's nuclear future triggered the interest of foreign companies and the governments, particularly of Britain, France and Germany. They saw a chance to create a new market for their home companies and also to intervene, once more, in the Southeast Mediterranean and the Balkans. So for geopolitical and business purposes government officials from these countries pressured the Greek government at the highest level (Konstantinos Karamanlis Archive 1977, 3). Karamanlis negotiated the construction of the plant with the political leaders of both France and Germany. In 1979, both the President of France, Valery Giscard d' Estaing, and the Chancellor of Germany, Helmut Schmidt, discussed the issue with Karamanlis, who supported the introduction of nuclear power (Konstantinos Karamanlis Archive 1979; n.d. v.11, 163-164). The French, under the leadership of D'Estaing, were particularly active in promoting nuclear power. Pechiney, the French aluminium company which owned bauxite mines and an aluminium plant in Central Greece, one of the largest customers of PPC that had an interest in securing special status as electricity consumer, had already pushed for the integration of nuclear energy into the electricity production. It had actually pushed a step further by suggesting ten sites for the installation of this nuclear plant (Votsis 2006; Arapostathis et al. 2017).

Finally, it was an American consulting company, EBASCO that provided exclusive advice to the Greek state and the PPC in relation to the suggested power plant, specifically on the possible locations for the erection of a power plant. EBASCO was a well-known consultant of PPC since the end of WWII and the Greek Civil War (1946-9). It was involved in the planning and the reconstruction of the energy sector and more specifically the electricity industry in Greece in the 1950s. The American company provided anew its services in relation to the nuclear power plant after a competition in the late 1970s. It gained a contract for as much as $ 5.3 million. EBASCO conducted research in relation to the location of the power plant and after short listing several sites it pointed to the area around the town of Karystos, in southern Evoia, as the most appropriate place for a plant of 1,000 MW. It was an area with comparatively less seismic activity, only 70 km from the Athens-Piraeus complex, Greece's large urban and industrial centre (Papanikolaou 1980). While it is not clear when exactly EBASCO first became involved, we know that as early as 1976 the southern Evoia town of Karystos was chosen as the most appropriate site for the installation of a 1,000MW nuclear plant. Initially EBASCO selected 5 sites: a. in the island of Evoia in the southern part of the island, along the Strait of Kafireos. This was the site near the town of Karystos; b. in Lakonia, in the Peloponnese, 5 km west of Cape Maleas; c. in Ilia, again in the Peloponnese, about 3 km northwest of the Kendron Reservoir; d. in Arcadia, in the Peloponnese, 3 km southeast of Dafni; e. in the area around Larissa in central Greece. At the request of PPC, two more sites were considered, to replace the ones in Larissa and Ilia. The first was in Lakonia, again in the area around Archangelos, and the second in Evoia, near the town of Mantoudi (PPC Archive 1981, 1.0-1-1.0-2). The site near Karystos was prioritized. It became the centre of public reactions, protestations and conflict (PPC Archive 1981, 1.0-7).

1.2.4. Engagement, Deliberation and Cancellation

After the restoration of democracy, in 1974, a public discussion took place in relation to the energy future of Greece within a context shaped by the oil crisis of 1972. Several actors were involved by organizing workshops, conferences, meetings and public events: The Technical Chamber of Greece (TCG), the Association of Greek Physicists, the Association of Greek Nuclear Scientists, the Greek Atomic Energy Commission, and the Panhellenic Association of Biologists. These were all institutions and professional bodies that contributed to public debates. The competing arguments and the public contestation of the project for a nuclear plant increased the ambivalence regarding the plan of PPC and the Industry and Energy ministries.

The TCG did not reject the project but focused on the uncertainties, and risks that the construction of a nuclear plant would involve for public health as well as for the energy regime of Greece. It argued that a plant of 600 to 1000 MW would be costly and that the energy produced would not be matched by demand. At the same time, due to Greece’s seismicity, it would be difficult –if at all possible- to find a location that would represent an acceptable risk. Furthermore, it argued that the nuclear power plant would increase the technological dependence of Greece from American technologies and certain industrial concerns (Ntaountaki 1977).

In 1977 the TCG became the venue of an important conference on ‘The Present Energy Problem of Greece’ (“Έκθεση συνεδρίου ΤΕΕ” 1978). During the conference, in between several engineering and energy sessions, a roundtable on nuclear energy was organized under the title ‘Hydrocarbons or Nuclear Power’ (“Στρογγυλή Τράπεζα” 1978). Several scientific and professional groups were asked to offer their views. There were supporters as well as opponents to the nuclear future of Greece. The groups that participated were: ‘Physics in the service of man’, the Technical Chamber’s Permanent Committee on the Environment, the Union of Greek Nuclear Scientists as well as the PPC (Κίνηση Φυσικών 1978; Μόνιμη Επιτροπή Περιβάλλοντος 1978a, 1978b; “Συζήτηση” 1978; Nikolinakos 1978, 55-67). The arguments of the ‘Physics in the service of man’ group tried to deconstruct the superiority of nuclear over other ways of producing electricity while, at the same time, they pointed to the inherent risks and dangers that a nuclear power plant would involve for the country. They argued that the cost of the installation would be 30% higher than the cost of thermal power plants. In this cost would be added that for the transfer of know-how, expertise and the education of the personnel. They argued that an economically viable scheme would require a 1,000 MW. That would be more than 15% of the overall energy to be produced in Greece by 1985. The group believed that for a politically unstable region like the Southeast Mediterranean and the Balkans this percentage was too high. They argued that the energy mix of Greece should prioritize investments in alternative technologies and energy sources, like solar and wind power (Κίνηση Φυσικών 1978, 264-65). Actors that were against the power plant stressed the risks that the erection of such a plant would involve in a country with high seismicity. The Technical Chamber’s Permanent Committee on the Environment pointed to ‘the difficulty to find in Greece an area that is non-seismic and is adequately distant from the urban centres’ (Μόνιμη Επιτροπή Περιβάλλοντος 1978a, 277). They noted that the risks from radioactivity in the case of an accident or an earthquake would be extremely high both for the locals and whole country, considering that half of the Greek population would be close to a plant like the one proposed at Karystos (Μόνιμη Επιτροπή Περιβάλλοντος 1978a, 277).

The groups that supported the project were smaller, and mostly formed by nuclear scientists. A leading group was the Union of Greek Nuclear Scientists, a scientific body comprising engineers, biologists, physicists, doctors and agricultural scientists that supported the use of nuclear energy. The Union insisted that the risks of nuclear energy were minimal. It used the Rasmussen report, a well-known and extensively circulated international report on the risks of nuclear energy. According to this report, the chance of involvement in a car accident was, for an individual, 1 per 4,000 whereas in the case of a nuclear accident it was 1 per 5,000,000,000 ("Συζήτηση" 1978, 282, 289; Chrisolouris 1978, 26-34). The Union argued that given that the country was surrounded by countries (Yugoslavia, Bulgaria, Turkey) that had nuclear power plants or had scheduled to build ones, it would be advisable for Greece to build its own for geopolitical purposes and for being stronger and independent energy wise ("Συζήτηση" 1978, 289). Finally, it argued that a plant of 600 MW would be easily integrated into the network, securely and smoothly operating in connection to the grid ("Συζήτηση" 1978, 293).

Several quasi scientific and energy policy oriented meetings followed, organized mostly by the pro-nuclear camp, especially by the Union of Greek Nuclear Scientists. The members of this Union perceived themselves as a key actor in the promotion of the nuclear project and the relevant ideals of Greek society, the circle of professionals and the policy making circles. They thought that the nuclear power plant did not have the political support that it deserved. In response, they organized a public discussion on nuclear reactors in February of 1978 (Arapostathis et al. 2017; Velios 1979). In this discussion, the Union's president, Chr. Markopoulos, suggested that energy policy and energy production should be based on native mineral sources. A new, technologically more advanced, reactor was proposed to reduce the cost of uranium enrichment and thus the total cost (Union of Greek Nuclear Scientists 1978, 443-50).

Two years later, in 1980, the Union organized a new public discussion, with similar aims and scope. This 1980 public discussion took place after the Three Mile Island accident – an accident that had shaken the certainties of those who supported the nuclear power plant and had delivered an initial blow in the social and political legitimization of the Greek project. There were already authoritative experts, like E.L. Bourodimos, Professor of Engineering at Rutgers University, who argued publicly that the accident would and should change state policies, particularly in a highly seismically-exposed country like Greece (Bourodimos 1979; Arapostathis et al. 2017).

There were already strong protests by the local community in Karystos in Evoia against the plans for the establishment of the plant there. The Union wanted to reaffirm the importance of the nuclear power station in the energy policy of the country and to downplay concerns and anxieties about security issues that the project had triggered amongstGreek officials and the public. The anti-nuclear camp was excluded from the meeting; only the cautious attitude of the TCG was represented. Authorities from the scientific world like M. Angelopoulos, Professor of Nuclear Physics at MIT, argued that the nuclear power plant was a necessity for the energy policy and mix of the country while any concerns about the technological dependence of Greece from other countries should be considered as matter of fact and as necessary conditions in achieving energy self-sufficiency and the expansion of the energy mix of the country. Theodore Kouloumbis, then president of the TCG, was more cautious. He stressed that its materialization should comply with a strict legislative and regulatory framework. Furthermore, in a critical note towards PPC, he argued that the power corporation had neglected indigenous scientific and engineering expertise and was bounded on foreign expertise to evaluate sites and make suggestions, thereby neglecting local factors that Greek experts could help with. The Union's president, Markopoulos, agreed about the neglect of the Greek experts while, at the same time, arguing that Greek physicists and engineers had was very little knowledge of the topic. He blamed political and educational authorities for not investing in education on nuclear physics and engineering. He also criticized 'Demokritos', the Centre of Nuclear Physics, for focusing on experimentation and basic science at the cost of neglecting the applied science that could have been more socially relevant ("Με αντεγκλήσεις" 1980).

As mentioned earlier, the late 1970s was the period of public engagement and protestation in relation to the establishment of the power plant in Greece. The contestation increased once the information about the shortlisting of the sites and the possible selection of Karystos in Evoia leaked to the public. It was in this period that local communities also started reacting strongly to the environmental degradation of their region due to the operation of chemical factories, petrochemical plants and fossil fuelled power stations. There was a gradual yet existent environmental activism that emerged from the participation of local communities. In this context, the locals in Karystos reacted very strongly to the plans for the erection of a nuclear power plant in their region (Alexandropoulos, Serdedakis and Botetzagias 2007; Alexandropoulos and Serdedakis 2000, 13-4; Kousis 2007; Boudourides and Kalamaras 2002, 24-6).

The first protest took place in the town centre on May 15th 1977. People from the town, the nearby villages and around the island of Evoia gathered together, along with the local municipal authorities and the local members of parliament from all the political parties. There was a local consensus against the establishment of the plant. The risks and dangers for the locals and the local environment played strongly in the public discourses developed by the local activists. The Mayor of Karystos, Avg. Saravanos, stressed the issue of the technological dependence of the country. In one of the many gatherings that followed until 1981, the project was dubbed as a 'Junta' project. This lowered further the legitimization of the project by linking it to the aspirations of a totalitarian and oppressive regime (Charalampous 1977; Cherouveim 1978). On the 3rd of May of1981, the last public gathering of the Karystians took place. After four years of public disputations they had the support of all the parties at the local level ("Διαμαρτυρία στην Κάρυστο" 1981; "Συγκέντρωση ενάντια" 1981).

While at the local level there was uniform political agreement against the establishment of the nuclear power plant, at the central political stage the situation was much more complicated. On the left of the political spectrum there was a schism. The pro-Soviet Communist Party opposed the transfer of nuclear technologies from the capitalist West while it supported the idea of erecting a nuclear power plant with nuclear technology from the Soviet Union ("Το θέμα" 1977). The Eurocommunist party, a smaller party with a pro-Western agenda that was highly popular among academics and engineers, was opposing the project as a whole by prioritizing environmental and public health arguments and reasons. Several of its members actually pioneered in supporting the development of energy by alternative energy sources. The members of the populist socialist party of Andreas Papandreou (PASOK) were not explicitly against the project. They adopted a rather ambivalent stance that changed after the critical events of the Three Mile accident and the earthquake of 6.7 Richter that took place in Greece on 24 February 1981. The epicentre of the earthquake was near the Halcyon islands, 77 km west of Athens. The conservative party that was in the government continued to support the project even after the earthquake, continuing the well-established nuclear agenda in the energy policy that promoted the nuclear power, along with large scale hydropower and the intensive use of lignite ("Δήλωση Μάνου" 1981). Stephanos Manos, then minister of Industry and Energy, argued that the project ought to continue with no delays since civil engineers would take all the precautionary measures to build a power station secure from an earthquake and other risks. This view had the agreement of EBASCO (Papanikolaou 1981). In the five-year development plans of PPC, a thermonuclear power plant appeared as late as in August of 1981. The situation changed drastically with the win of the populist socialist party of Andreas Papandreou during the elections on 18th of October of 1981. After the earthquake, following the public sentiment and in alignment with the political activism against the nuclear power plant, Papandreou, made it clear that his party would not support any nuclear plans (“Βασική διαφωνία” 1981). After his ascendance to power, his government cancelled the plans for a nuclear plant. The nuclear power plant had no place in the ten years development plans of PPC for the years 1983 to 1992 which was announced in September 1992 (Carydis et al. 1982; Tsotsoros 1995, 95, 102). The abandonment of the plans for a nuclear plant triggered a further shift to lignite for power production, an interest in the integration of natural gas for electricity production, the initiation of a modest experimentation with renewable energy sources and an emphasis on the establishment of transnational interconnections for the transmission of electric power (Tympas et al. 2013; Arapostathis et al. 2017; Angelopoulou 2013; Fotopoulos 2016).

It is ironic that in 1995, due to a blackout in Greece, the electricity grid had to be stabilized by using critical percentages of imported electricity from Bulgaria produced by the nuclear power plant in Kozloduy. The transnational interconnection with Bulgaria and the importation of ‘nuclear’ electricity in Greece was crucial for energy security during the Olympic Games in Athens in 2004. In 2006 the last year of the operation of nuclear reactors 3 and 4 in Kozloduy, Bulgaria was exporting 7.8 TWh to Serbia, Macedonia, Turkey and Greece.[1]

1.2.5. Conclusion

In this report we have reconstructed the history of a nuclear plant which never materialized. We argue that Greece’s nuclearity passed different phases and stages and it was co-produced with political power. Experts played a key role in framing and visioning and thus giving meaning through their public discourses on the nuclear project.

We argue that the 1960s was the period where experts played the most important role in visioning and setting the agenda in relation to plans for nuclear power plants while politicians remained either

[1]See: http://www.world-nuclear.org/information-library/country-profiles/countries-a-f/bulgaria.aspx

cautious or quiet. The years of the dictatorship overlapped with the scaling up of the visions and plans. Nuclear visions became grandiose, acquired the character of a long term program that matched the totalitarian and militaristic regime of Junta. With the restoration of democracy, the nuclear vision was scaled down but remained alive, since conservative Prime Minister Konstantinos Karamanlis viewed energy policy and energy networks as important in order to build his agenda for the Europeanization of Greece and its integration into the European Economic Community. The project was finally cancelled due to critical events, especially the 1981 earthquake and the preceding Three Mile Island accident in the USA. These critical events shook political certainties, eroded the initial ambivalence of the populist socialist party of Andreas Papandreou and gave political legitimacy to the cancellation of the nuclear plans. Once Papandreou became Prime Minister in October 1981, he cancelled the programme.

The 1960s was the period when civil society engagement was expressed through the public intervention of professional and scientific institutions like the Technical Chamber of Greece. In the late 1970s, the engagement of civil society became more pluralistic through the involvement of political activists scientific groups with an agenda of political activism, traditional professional and scientific bodies, local communities and political parties. The voices and the arguments against nuclear power acquired a stronger agency since the engagement became more organized and politicized. While the political movement against the nuclear power plant was strong, it would be a simplification to argue that it was the main reason of the cancellation of the project. On the contrary, we have showed the contingent character of the political decision of the populist socialist government of the period. While this party initially maintained a rather ambivalent stance, it was only the earthquake in 1981 which precipitated a clear decision to cancel the programme. Investing on transnational interconnections became a priority after the cancellation of the Greek nuclear project. This attributed a new meaning in the ‘nuclearity’ of Greece. Critical percentages for the stability of the electricity system in Greece were produced in nuclear power plants in Bulgaria until 2006.

The Greek experience with nuclear energy may be profitably compared to the experiences of western countries that moved forward with the installation of nuclear plants even though they were, like Greece, hit by strong earthquakes. Central here seems to be the case of Japan. This comparison will have, however, to take into account several differences between the two countries. First, Japan was much more developed technologically than Greece. Second, Greece shared land borders with several Cold War enemies. Third, Greece could count on its lignite deposits for an alternative to nuclear energy. Japan did not have such an option. The Greek case may be further compared to that of western countries that share the experience of dictatorial governments. The most appropriate comparisons may be that between Greece and Spain. In both countries, the leaders of the dictatorship appeared eager to move forward with plans for the massive installation of nuclear power plants. Moreover, these plans had to be taken into account by the democratic governments that replaced dictatorships. The Spanish dictatorship was however much longer than the Greek one. This means that the Spanish dictatorial government had much more time to develop nuclear plans than the Greek one. The momentum of dictatorial support for nuclear energy then left a much stronger legacy in favour of nuclear energy in Spain than in Greece.

1.3. Presentation of main actors

Electricity Sector

- PPC, Public Power Corporation

  Demopoulos P., PPC director

  Pantazopoulos G., PPC vice president

  Kasapoglou K., PPC representative

  PPC Union

Science and Research

- National Centre for Scientific Research (NCSR) 'Demokritos' / Nuclear Research Centre 'Demokritos'
- TCG, Technical Chamber of Greece [engineers in Greece register in TCG / official adviser of the State]

  TCG's Permanent Committee on the Environment

  Kouloumbis E., president of the TCG

- Physicists' movement 'Physics in the service of man'
- Union of Greek Nuclear Scientists

  Markopoulos Ch., president

- Angelopoulos M., graduate of the electrical and mechanical engineering department of NTUA with a PhD in engineering at Braunschweig, Germany
- Angelopoulos A., Economist and journal editor

Nuclear industry sector

- Electrowatt, Swiss engineering company
- Bonnard-Gardel, Swiss engineering company
- Societé de Traction et d'Electricité, Belgian engineering company
- General Electric, American manufacturer
- Westinghouse, American manufacturer
- EBASCO, American consulting company

Institutional and Governmental actors

- Queen Frederika
- Toumbas I., minister of industry
- Greek Atomic Energy Commission
- British Atomic Energy Committee
- Junta
- New Democracy, Conservative political party

  Karamanlis K., Prime Minister

  Manos S., Minister of Industry and Energy

- Panhellenic Socialist Movement (PASOK)

  Papandreou A., Prime Minister

  Kouloumbis E., Minister of Energy

- National Energy Council

    Gyftopoulos E., chair

- EEC, European Economic Community

Other actors

Karystians, civilians

2. Showcase: Nuclear interdependencies and an elaboration on the definition of 'nuclearity': the importance of transnational electricity interconnections2

As shown in this report (sections 1.2.4 and 3.6), the seismicity of Greece played a key role in the cancellation of plans for a Greek nuclear plant in the early 1980s, in the aftermath of a strong earthquake near Athens. Yet, the seismicity of Greece was also a factor that was taken into account in advancing transnational interconnections that allowed for the import of critical amounts of electricity that were produced at the nuclear plants of some of Greece's neighbouring countries. We will see, for example, how electricity from countries that relied on nuclear plants was transmitted to the Greek system when this was threatened with a severe blackout, following an earthquake that hit the centre of Greece's electricity generation (the Kozani area in northern Greece). At the same time, we will see how countries with nuclear power could import critical amounts of electricity from countries like Greece in the event of an anomaly. All this can be showcased by reference to three diagrams (Figure 2.1, Figure 2.2, and Figure 2.3). The first comes from a PPC report and shows the international connections in the year 1987 and the purchases and exchanges of electric energy. The second comes from an article of PPC engineers and shows how a 1996 import of electricity from the interconnected Balkan system saved the Bulgarian network during anomalies at Kozloduy that resulted in drop of nuclear power generation. The third comes from the same article and shows how a 1997 drop of frequency at the Greek power network due to anomalies at the Cerna Voda nuclear plant of Romania were offset by positive changes in the exchange of electricity between Greece, Albania, Bulgaria and Yugoslavia.

[2] We have had the opportunity to realize that Greece was a nuclear country without having a nuclear plant, on the grounds of transnational interconnections that supported the import of critical amounts of electricity from nuclear plants of neighboring countries, during pilot research that we undertook under the collaborative project 'EuroCrit' (See: Yiannis Garyfallos, Stathis Arapostathis and Aristotle Tympas, *Transnational Energy Flows and Blackout Risks in a Balkan European Context*, Draft Paper, Presentation in the 2nd EUROCRIT International Workshop "Transnational infrastructures: Coping with scarcity and vulnerability" 21-24 May 2008, Stockholm; Tympas, Aristotle, Stathis Arapostathis, Katerina Vlantoni, and Yiannis Garyfallos. 2013. "Border-Crossing Electrons: Critical Energy Flows to and from Greece." In *The Making of Europe's Critical Infrastructures*, edited by Per Högselius, Anique Hommels, Arne Kaijser, and Erik van der Vleuten, 157-83. Basingstoke and New York: Palgrave Macmillan). The results of further research on this topic, undertaken in the context of the ongoing 'HoNESt' project, will be presented at the conference "ESEH Biennial Conference 2017: Natures in between. Environments in areas of contact among states, economic systems, cultures and religions", Zagreb, Croatia, 28 June to 2 July 2017, session "Crossing the border or not? Towards an environmental history of risks and boundaries" (Authors: Katerina Vlantoni, Stathis Arapostathis and Aristotle Tympas, title of paper presentation: Risks, Borders and the Environment: Between Strong Earthquakes and Nuclear Accidents).

The first diagram (Figure 2.1) can be used to show what took place during a strong (6.6 Richter) 1995 earthquake that hit the centre of Greek electricity generation near the North Greek city of Kozani. As the Greek PPC engineers showed in evaluations that followed the earthquake, the Greek system avoided a blackout with unpredictable consequences by importing electricity from its transnational electricity interconnections (Kampouris et al. 1999, 78-9). In this case, we see how a country without a nuclear reactor was saved by transnational interconnections to other countries, some of which had nuclear power plants. While the electricity that saved the Greek system from a blackout was in this case drawn from the Former Yugoslav Republic Of Macedonia (FYROM), there were many other cases when critical amounts of electricity were imported to Greece during periods of seasonal or other scarcity by countries with nuclear plants, most notably Bulgaria.

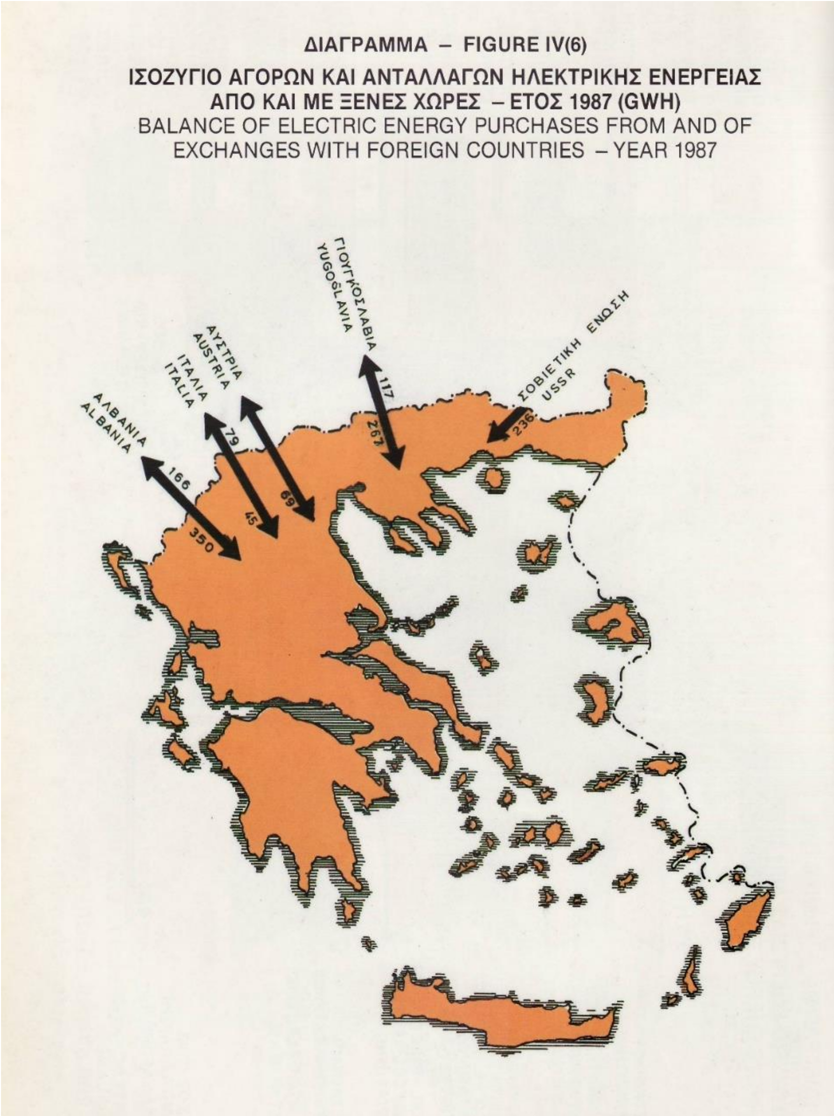


Figure 2.1 – "International Connections in Year 1987, Purchases and Exchanges"

Source: PPC 1989, 40.

The second and the third diagrams (Figure 2.2 and Figure 2.3) refer to the reverse, namely how a country with nuclear power plants could be saved by importing electricity from neighbouring countries that included at least one (Greece) without a nuclear power plant. Figure 2.2 shows what followed after a dramatic fall in the supply of electricity from the Kozloduy nuclear reactor in Bulgaria. As can be clearly seen by the diagram, the Bulgarian electricity system was temporarily saved by imports of electricity from other countries, including Greece. Figure 2.3 offers an elaboration on the same theme by showing what happened to the Greek system in 1997, in the aftermath of problems with a Romanian nuclear power station at Cerna Voda. More specifically, the diagram focuses on how the frequency of the Greek system, which dropped due to the problems in Romania, was restored by imports from Bulgaria, Yugoslavia and Albania. It makes it all the more suggestive that these diagrams refer to problems with nuclear reactors that had to be taken into account and evaluated by PPC engineers, that is engineers of a country without nuclear reactors (Tympas et al. 2013).

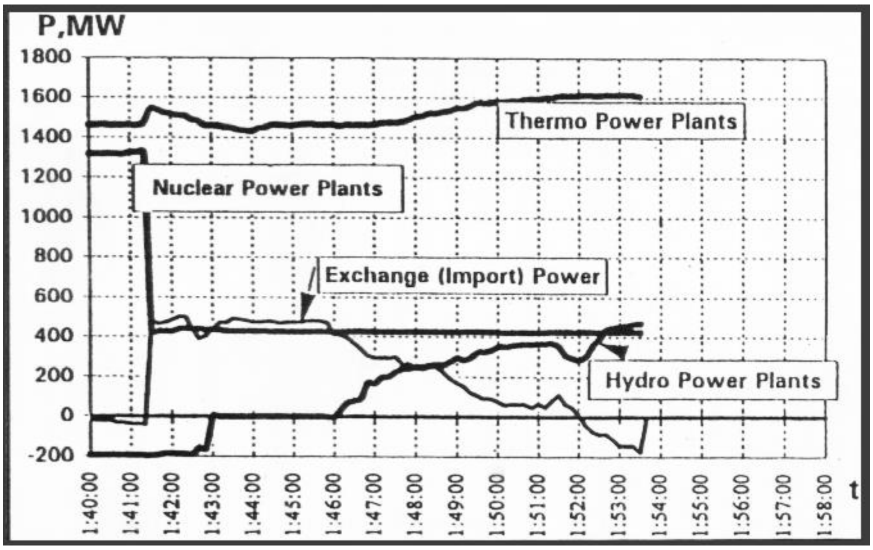


Figure 2.2 – Diagram showing how a 1996 import of electricity from the interconnected Balkan system saved the Bulgarian network during anomalies at Kozloduy that resulted in drop of nuclear power generation.

Source: Kampouris et al. 1999, 80.

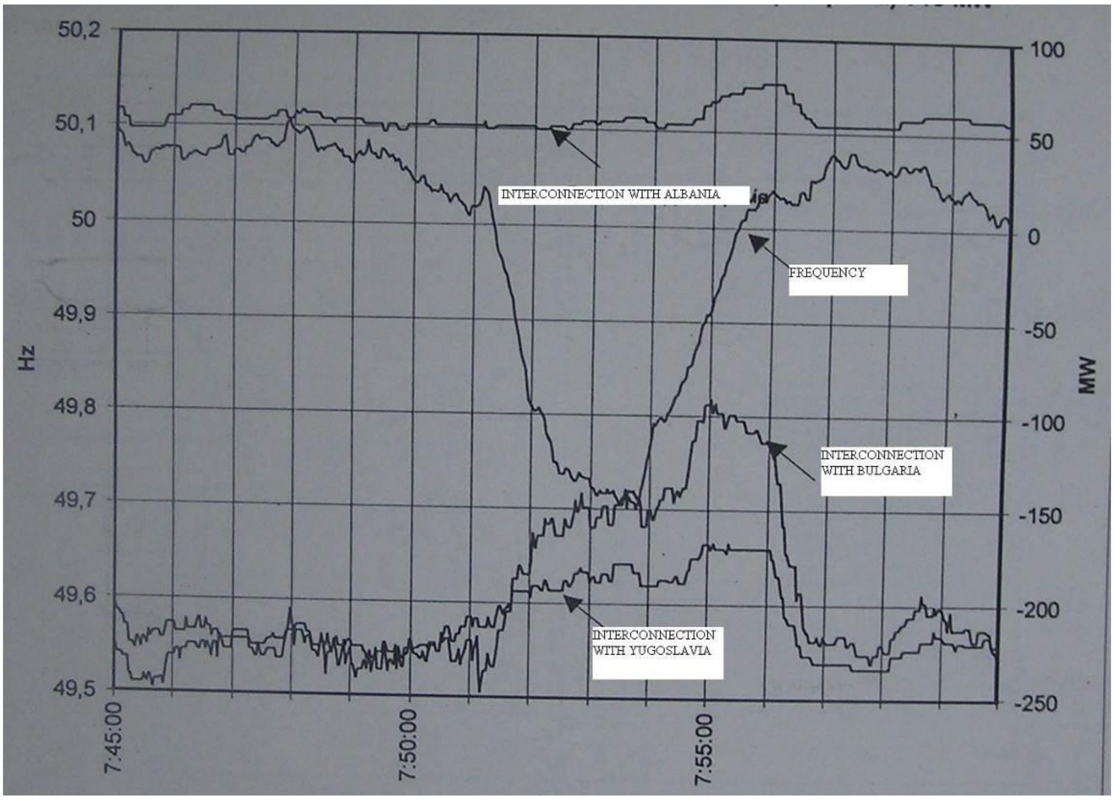


Figure 2.3 – Diagram showing how a 1997 drop of frequency at the Greek power network due to anomalies at the Cerna Voda nuclear plant of Rumania were offset by positive changes in the exchange of electricity between Greece, Albania, Bulgaria and Yugoslavia.

Source: Kampouris et al. 1999, 81.

Noticeably, the amount of electricity imported to Greece in the 1970s and the 1980s through transnational interconnections with countries that had nuclear plants, was of the same order as the amount of electricity that was to be provided by the Greek nuclear plant that was never built. The story showcased here shows that Gabrielle Hecht's (2007) concept of 'nuclearity' as well as the popular perception of a country as nuclear has to open up so as to include not only countries with nuclear plants and/or nuclear fuels, but, also, countries, like Greece, that used transnational interconnections, especially during emergencies, to either import or export electricity to countries with nuclear plants (Tympas et al. 2013, 176-80).

3. Events

In this section we have selected for further analysis five events of relevance to the history of nuclear power in Greece. The first event confirms that interest in the prospect of nuclear energy was generated in Greece from the beginning of 1960s. It was assumed that by entering the Atomic Age, Greece would leave behind the difficulties of a period marked by a Civil War which followed World War II. The second event refers to the expansion of plans for nuclear plants in the country during the years of a military dictatorship. During these years attempts were made to link grandiose plans for nuclear energy development to the nationalistic ideology that the dictatorship depended on. The third event follows the moderate progression of the nuclear plans after the restoration of democracy in Greece. During this period, the planning for the construction of a nuclear plant generated national debates and local anti-nuclear protests. The fourth event captures the scepticism of the engineering community regarding the installation of nuclear plants in Greece in the period covered by the third event. It focuses on a conference organized by the Technical Chamber of Greece in 1977. The fifth event covers the decision making processes that resulted in the cancellation of the planning of a nuclear power plant by the PPC. It shows how the seismicity of Greece, as confirmed by the occurrence of a strong earthquake near Athens, became a key factor in the cancellation of all plans for nuclear plants.

3.1. Event 1: Start of plans to install a nuclear power station in Greece (1963-1966)

This event presents the beginning of the discussions surrounding the construction of a nuclear power plant for electricity generation in Greece. In the early 1960s, the PPC supported such plans in order to integrate nuclear power for electricity production. Various actors were involved in the respective debates either supporting the establishment of a nuclear power station or arguing against it.

In 1963, Professor Mihail Angelopoulos, an engineer with work experience in the UK Atomic Energy Authority, claimed that the cost of construction and operation would be too high and could not compete with thermal units operated by PPC. He also argued that, on the grounds of safety and public health reasons, such a plant should not operate near the capital of Greece (Angelopoulos

1963). On the other hand, Professor Angelos Th. Angelopoulos (another Angelopoulos), an established authority in economics, supported the establishment of a nuclear power plant in order to secure energy self-sufficiency in the country and initiate developmental plans based on nuclear power. The Industry Minister, I. Toumbas, was also on board for the construction of the plant.

Since the PPC began to examine the prospect of the constructing a nuclear power for electricity generation, foreign companies active in the sector of nuclear power became involved in the process. Swiss, Belgian, British and American companies viewed Greece as an emerging nuclear economy and started to lobby PPC and Greek officials in order to promote their engineering services and technologies.

In the following table, we present the positions of the main actors.

Event 1	**Start of plans to install a nuclear plans station in Greece**
Who was involved?	PPC, Angelopoulos M., Angelopoulos A., Queen Frederika, Toumbas I., Electrowatt, Bonnard-Gardel, Societé de Traction et d'Electricité, General Electric (US), Westinghouse
When and where did it take place?	1963- NTUA; 1966-TCG
What type of process was it (communication, consultation or participation)? How did this change over time?	**Communication/Consultation:** Lecturing and conferences in relation nuclear power for energy purposes.
What rationale was given by the party that implemented the engagement (if any)?	PPC started to seek integrating nuclear power for electricity production.

Actor Name	Profile	Actor Category	Reasoning
PPC	Public Power Corporation Sponsor of the event	Supporter	Seek to integrate nuclear power for electricity production. Nuclear power station according to PPC officials view should have been erected by 1975 as a 'basis station'.
Angelopoulos M.	A graduate of the electrical and mechanical engineering department of NTUA with a PhD in engineering at Braunschweig, Germany	Against	Not a viable solution economically. Could not compete with thermal units.
Angelopoulos A.	Economist and Journal editor	Supporter	Reduction of electricity production cost. It would strengthen the geopolitical position of Greece.
Toumbas I.	Minister of Industry	Supporter	State-led policy for energy security and economic development.
Electrowatt	Swiss engineering company	Supporter	Commercialization of engineering expertise on research, planning, construction and operation of nuclear plants.
Bonnard-Gardel	Swiss engineering company	Supporter	Commercialization of engineering expertise on research, planning, construction and operation of nuclear plants.
Societé de Traction et d'Electricité	Belgian engineering company	Supporter	Commercialization of engineering expertise on research, planning, construction and operation of nuclear plants.
General Electric	American manufacturer	Supporter	Agents of a specific type of reactor: a boiling water reactor that would be using enriched uranium and common water for freezing and deceleration purposes.
Westinghouse	American manufacturer	Supporter	Promotion of its technologies.
British Atomic Energy Authority	Institution	Supporter	Promotion of the engineering and commercial interests of British companies as well as the geopolitical interest of Britain.

3.2. Event 2: Dictatorship and its Grandiose Nuclear Plans (1967-1974)

The second event presents the scaling up of the planning for nuclear power plants in Greece during the period of the Colonels' dictatorial regime (1967-1974). During these years, the military regime announced grandiose schemes and long term plans for the transformation of Greece into a nuclear power hub. These schemes aimed at the militarization of Greek political life through the integration of Atomic Age ideals into nationalist ones.

The political actors engaged in these processes the Greek Atomic Energy Commission and the Research Centre 'Demokritos', through educational initiatives. They sought to establish nuclear power plants that reinforced the interest of foreign consulting and construction companies. During these years, explorations also took place to examine the existence of uranium ore deposits in Greek territories.

This planning became part of the programs of PPC. To be specific, in 1972, the director of PPC, P. Demopoulos made public the programming which included the establishment of a nuclear power station by 1980 and additional stations after 1990. This was the momentum of the Greek nuclear power vision and planning, as depicted in the following table.

Event 2	From Junta to Nuclear Democracy
Who was involved?	PPC, Junta, 'Demokritos', Demopoulos P., Pantazopoulos G.
When and where did it take place?	1967-1974
What type of process was it (communication, consultation or participation)? How did this change over time?	**Participation/Consultation:** educational seminars, conferences and educational tours for Greek scientists and engineers in countries with nuclear facilities
What rationale was given by the party that implemented the engagement (if any)?	Emphasis on energy self-sufficiency and energy sovereignty. Also nuclear was envisioned and promoted as necessary for empowering the geopolitical position of Greece.

3.3. Event 3: Public deliberation and conflict (1975-1980)

This event captures the public debates regarding the prospect of constructing nuclear power stations in the years following the restoration of democracy in Greece, in the summer of 1974. Various actors participated in the public discussion that concerned the plans of PPC, with support by the relevant ministries, to put forward the project for a nuclear plant.

On the one hand, the newly established National Energy Council and the PPC took action to advance the nuclear program. On the other hand, those arguing against such a project expressed their views in public. In the table that follows the contested positions are presented.

Event 3	Kick-off public deliberation
Who was involved?	Karamanlis K., Gyftopoulos E., EBASCO, Kouloumbis E.
When and where did it take place?	1975-1980
What type of process was it (communication, consultation or participation)? How did this change over time?	**Participation/Consultation:** International trips, Reports
What rationale was given by the party that implemented the engagement (if any)?	Plans of the conservative government generated interest from foreign countries that sought an opportunity to promote both their geopolitical agendas and their commercial interests.

Actor Name	Profile	Actor Category	Reasoning
Karamanlis K.	Prime Minister	Supporter	Established National Energy Council, and reaffirmed his interest in moving forward with the nuclear program.
Gyftopoulos E.	MIT Professor, chair the Council and advisor on energy issues	Supporter	Believed that nuclear power generation would be 30 to 40 per cent cheaper than that from conventional power plants. Expected that technological advancement would also lower the risks.
EBASCO	American consulting company	Supporter	Engaged by PPC to identify possible sites and provide consulting services.
Karystians	Civilians	Against	Protested against the nuclear plants, sought to discredit the nuclear plant as a “junta plan”.
Papandreou A.	Leading Politician, Prime Minister in 1981	Against	Greece is highly seismically-exposed.
Kouloumbis E.	Leading engineer and president of the TCG	Cautious	Revealed EBASCO secret report plans.

3.4. Event 4: The Technical Chamber of Greece Conference (1977)

This event describes the opinions presented in the conference ‘The Present Energy Problem of Greece’ organised by the TCG. The proceedings of the conference were published the following year, 1978, in the journal of the TCG *Technical Chronicles* (*Τεχνικά Χρονικά).* The program of the conference included a roundtable on nuclear energy under the title ‘Hydrocarbons or Nuclear Power’. Several scientific and professional groups presented their views. Present were those supporting the nuclear future of Greece as well as those who challenged it. Their argumentation is presented in the following tables.

Event 4	Intense deliberation, the Technical Chamber of Greece Conference in 1977
Who was involved (refer to table of potential actors, below)?	TCG, ‘Physics in the service of man’, the Technical Chamber’s Permanent Committee on the Environment, the Union of Greek Nuclear Scientists as well as the PPC
When and where did it take place?	1977, TCG
What type of process was it (communication, consultation or participation)? How did this change over time?	**Participation/Consultation**
What rationale was given by the party that implemented the engagement (if any)?	A period of intense deliberation about the nuclear plant, with engineers and scientists from a variety of specialists participating in public discussions.

Actor Name	Profile	Actor Category	Reasoning
TCG		Neutral	Tried to understand the local conditions that would increase uncertainties and risks in the Greek case.
‘Physics in the service of man’		Against	Based on international experiences of the economic and social risks from nuclear energy. The anti-nuclear group argued that even countries that produced electricity from nuclear power relied even less on nuclear power, and recommended research into alternative energy sources.
Technical Chamber’s Permanent Committee on the Environment		Against	Pointed out the fact that in case of an accident radioactivity could spread easily and quickly into urban centres of close proximity. More specifically for the case of Karystos, it was argued that any failure could result in leakage that would threaten more than a third of the Greek population because of its proximity to the metropolis.
Union of Greek	Scientific body	Supported	Wanted to play a role in shaping

Nuclear Scientists	comprising engineers, biologists, physicists, doctors and agriculture scientists		energy policy and especially in the decision making process about the nuclear plant.
PPC Union		Supported	Deconstructed arguments from the anti-nuclear camp which stressed the possibility of illegal circulation of smuggled nuclear materials should the power station become established.
Kasapoglou K.	PPC represent ative	Supported	Drawing on the argument that countries of the region that are richer than Greece or have comparable resources already have or would have nuclear plants.
Markopoulos Ch.	President of the Union of Greek Nuclear Scientists	Supported	In favour of the establishment of the nuclear reactor complained about the obscure and excessively cautious governmental procedures as well as their own exclusion or marginalization from the decision making process.
Kouloumbis E.	President of the TCG	Cautious	Neither questioned nor criticized the establishment of the plant he insisted that this should only be realized under specific conditions and within a strict legal and institutional setting.
Karystians	Civilians	Against	Protested against the nuclear plants, sought to discredit the nuclear plant as a “junta plan”.
Papandreou A.	Leading Politician, Prime Minister in 1981	Against	Greece is highly seismically-exposed.

3.5. Event 5: Earthquake leading to cancellation of the nuclear project (1981)

This event reconstructs the decision making processes that led to the cancellation of the nuclear project in Greece. In 1980 the public discourse was influenced by the Three Mile Island accident. In addition, local protests against the construction of a nuclear plant in neighbouring areas took place. At the local level there was uniform political agreement against the establishment of the nuclear power plant.

In February 1981, a strong earthquake struck a region close to Athens (see also section 1.2.4). The conservative party that was in the government continued to support the project even after the earthquake. In August 1981, the PPC included in its development plans the construction of a nuclear power plant. The situation changed drastically with the win of the populist socialist party PASOK in the elections that took place on 18th of October of 1981. The government, led by the Prime Minister Andreas Papandreou, made it clear that it would not support any nuclear plans. In 1982, PPC announced its development program that did not include the establishment of a nuclear lplant. Therefore, a nuclear power plant was never constructed in Greece.

Event 5	From politics of expertise to national politics
Who was involved (refer to table of potential actors, above)?	PPC, New Democracy (Conservative Party), Panhellenic Socialist Movement (PASOK), TCG, EEC
When and where did it take place?	24 February 1981, Gulf of Korinthos. 6.7 Richter Earthquake with 50 killed people and more than 200 injured;around 22,000 buildings with severe damage.
What type of process was it (communication, consultation or participation)? How did this change over time?	**Participation/Consultation:** Increased concerns in the technical world and among technical and scientific experts about the vulnerabilities of the nuclear power plants and the seismicity of Greece. Legitimized political activism and local contestation of the plans for nuclear power plant.
What rationale was given by the party that implemented the engagement (if any)?	Seismicity of Greece became the major concern and the major argument against the suggested nuclear power plant.

Actor Name	Profile	Actor Category	Reasoning
TCG		Neutral	Stressing the risks and uncertainties due to seismicity in the case of Greece. In the same time tried to balance between uncertainty
Government of the Conservative Party, New Democracy	Conservative and Liberal	Positive	Insisted even after the earthquake to promote the nuclear power station
PPC		Positive	Energy security is the major concern
EEC	European Economic Community	Positive	Just days before the earthquake the EEC pressed the Greek government to move forward and speed up the procedures for the establishment of the nuclear plant in an attempt to increase the use of coal and nuclear in the electricity production in Europe to 75%.
EBASCO	Consulting company	Positive	Argued that the earthquake should not cancel the project for three main reasons: a. the seismicity of Athens was very low and that the seismicity of the suggested site, Karystos, was even lower; b. the impact of the earthquake was severe only for old and poorly engineered buildings; c. engineering and construction of the nuclear power plant would follow the regulations of the National Regulatory Commission of USA.
Panhellenic Socialist Movement (PASOK)	Political party	Negative	While initially neutral after the earthquake it became negative.
Kouloumbis E.	Minister of Energy after the 1981 elections in the Socialist government	Cautious with an inclination towards a positive response	Neither questioned nor criticized the establishment of the plant he insisted that this should only be realized under specific conditions and within a strict legal and institutional setting.

Papandreou A.	Leading Politician, Prime Minister in 1981	Against	Greece is highly seismically-exposed.

4. Facts & Figures

4.1. Data summary

- There is no reactor in Greece today that is used to generate electricity.
- There is, however, one small research nuclear reactor (in extended shutdown since 2014) and one sub-critical assembly. The 5 MW pool-type research reactor was operated by the Institute of Nuclear and Radiological Sciences and Technology, Energy and Safety of the National Centre for Scientific Research (NCSR) 'Demokritos'. The sub-critical assembly is operated by the Atomic and Nuclear Physics Laboratory of the Aristotle University of Thessaloniki.
- Greece has imported critical electricity amounts that were produced by nuclear reactors through transnational electricity connections.

4.2. Key dates and abbreviations

Key dates:

1963 Start of plans to install a nuclear plant station in Greece.

1972 The Colonels' regime/Junta (a dictatorship that held the power from 1967 to 1974) announced plans for the erection of 14 nuclear power stations by 2000

1976 A proposal for a nuclear reactor plant made its appearance in the official ten-year development plans of the PPC.

1977 Critical discussion of these plans at the Technical Chamber of Greece

1981 Earthquake leading to the definite cancellation of the above plants

1995 Black-out of the Greek system due to earthquake that was avoided due to import of electricity from nuclear plants from outside Greece

1996 The reverse: black-out of a system of another country (Bulgaria), which is based on nuclear production, which was avoided through export of electricity from Greece

Abbreviations:

EBASCO Electric Bond and Share Company

EEAE	Greek Atomic Energy Commission
EEC	European Economic Community
NCSR	National Centre for Scientific Research (NCSR) 'Demokritos'
NTUA	National Technical University of Athens
OECD	Organisation for Economic Co-operation and Development
PPC	Public Power Corporation
TCG	Technical Chamber of Greece
UN	United Nations

4.3. Additional information on main actors of the (nuclear) energy market in Greece

Who was/is responsible for the planned construction/operation of nuclear establishments?

PPC was responsible for the planned construction and operation of the nuclear plants. PPC took the initiative of developing plans and surveys in relation to the integration of the nuclear power generation in the energy of mix of Greece. Yet, in the 1950s, the Centre of Nuclear Studies 'Demokritos' was established under the Greek Atomic Energy Commission (EEAE) to promote research on nuclear physics. The Centre and the Commission were responsible for the establishment and the use of a first nuclear reactor in Greece, for research / experimental purposes. Since 1985 the Centre was rebranded as the National Centre for Scientific Research 'Demokritos' while the Commission was transformed into an independent organization. More recently (2014), on the grounds of a new law (Article 41 of Law 4310/2014), the EEAE was instituted as the independent Regulatory Authority, responsible for the control, regulation and supervision in the fields of nuclear energy, nuclear technology, radiological and nuclear safety, as well as radiation protection. Legislation passed in the preceding years had paved the way, since the Presidential Decrees 60 (2012) and 122 (2013) have defined the EEAE as the regulatory authority in its respective fields: nuclear safety and radioactive waste management. The EEAE's responsibilities, as defined in Article 43 of Law 4310 of 2014, are outlined in Section II. Article 46 of Law 4310 granted the EEAE enforcement power and Article 90 assigned to the EEAE the role of the licensing authority. In 2001 the EEAE was responsible for setting the Radiation Regulatory Framework, which specified all the licensing procedures for the radioactive substances, equipment and the transportation of radioactive materials.

What was (supposed to be) built and who (was supposed to) built it? Is there a gap between plans and what was built? Why?

From the 1960s to the 1980s the proposed power plant was conceptualized, framed and contested by various actors: economists, power engineers, nuclear scientists, politicians, local authorities, engineering institutions and civil society activists. In 1972, the Colonels' regime announced the plans for the erection of 14 nuclear power stations until 2000. No nuclear plant was ever built. The decision to abandon any project for a nuclear plant was became definite after a strong earthquake that occurred in Greece in 1981, which was used to fully deconstruct the political and other social legitimacy of those who supported such project. It also brought into a more powerful position the actors from the civil society who opposed such project. It was the critical event that gave the opportunity to the populist socialist government to postpone, initially, and to cancel, eventually any plans for nuclear plants.

Where the fuel did (could) come from?

In the initial stage of the public discussions in the early 1960s the uranium was to be imported from Britain or France. In the late 1960s and 1970s emphasis was given to the possibility of existence of native uranium ore deposits. Explorations in the area around the city of Kilkis (Greek region of Macedonia) started in 1968. In the 1970s the explorations were intensified with the financial assistance of the United Nations. There were reports about the discovery of 1,000 tons of uranium in the prefecture of Serres, at the Northern border of Greece.

Where does waste go?

There is waste only from the NCSR 'Demokritos', from the research / experimental reactor. There is an interim waste management and storage facility in the centre. (OECD, 2016).

How has electricity supply and demand changed?

Since the late 1960s, there were forecasts for the decisive utilisation of nuclear power in the electricity mix of the country. According to plans, electricity production should by 2000 be based predominantly on nuclear energy. It was predicted that at the turn of the century the country would have 14 plants and 22 nuclear units, producing power of 10,000 MW (see Figure 4.1, Table 4.1, and Table 4.2).

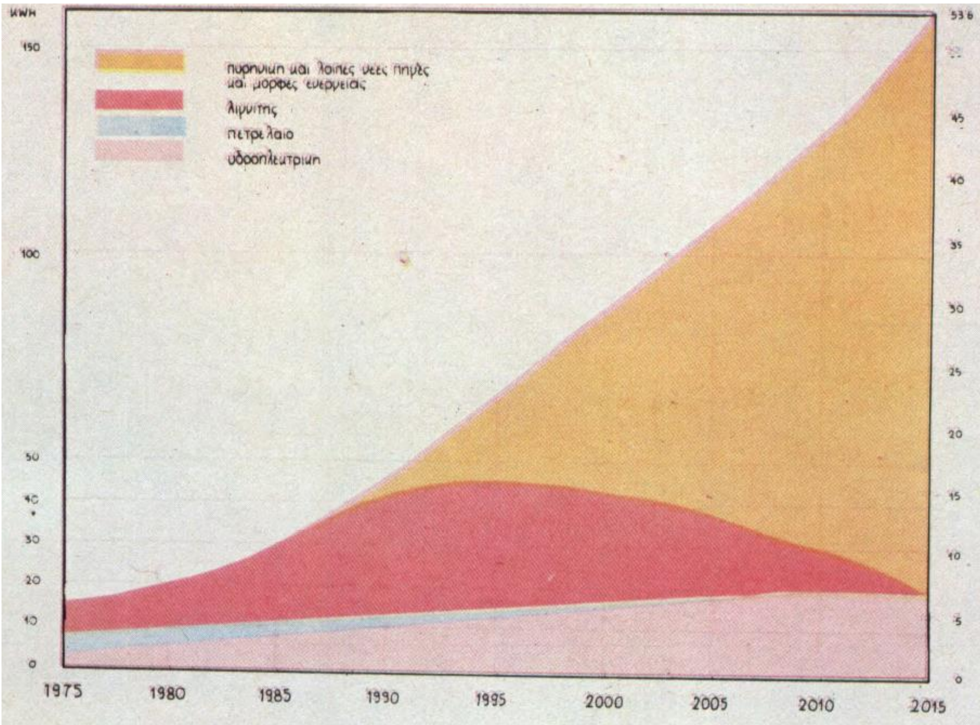
The abandonment of the plan for the construction of a nuclear plan had repercussions in the electricity regime, boosting further the use of lignite extracted from native ore deposits and the reliance on transnational electricity flows from neighbouring countries in case of seasonal shortages or emergencies. Furthermore, the PPC started to play prominent role in introduction of natural gas in the country’s energy mix predominantly for electricity production.

Who was / is in charge of safety/security?

PPC was also in charge of safety and security issues. Since 2014, with Law 4310, the EEAE became the regulatory authority responsible for the regulation of nuclear science, technologies and radioactive materials in Greece.

4.4. Forecasts of nuclear energy development

Billion kWh



Million TEC

Years

Nuclear energy
Lignite
Oil
Hydroelectric

Figure 4.1 – "PPC programme: development on energy mix during the period 1975-2015".

A PPC diagram depicting the anticipated introduction of nuclear energy to the energy mix. According to this diagram, PPC expected that electricity production from nuclear plants and hydroelectric units to eliminate the need for power production by lignite and oil by 2015. The first nuclear plant was to operate in 1986.

Source: "Έκθεση συνεδρίου ΤΕΕ" 1978, 94.

Planning the installation of nuclear units in the PPC System				
Year	**Number of units**	**Unit capacity (MW)**	**Capacity to be installed (MW)**	**Total capacity (MW)**
1976	1	300	300	300
	1	300	300	600
1980	2	400	800	1400
1985	3	400		
	1	500	1700	3100
1990	4	500		
	2	600	3200	6300
1995	4	600		
	2	750	3900	10200
2000				

Table 4.1 – "Planning the installation of nuclear units in the PPC System".

The table presents plans for the installation of nuclear units in the period from 1976 to 2000. It has been reconstructed after Papamathaiakis and Xynopoulos 1968, 285.

Power production from the various System units														
Year	**Maximum Demand MW**	**Installed capacity MW**	**Units: Available power (MW)**											
			Reserve / storage	(%)	Hydro-electric	(%)	Oil	(%)	Lignite	(%)	Nuclear	(%)
1965	884	925			256	(28)	266	(29)	403	(43)		
1970	1860	2153			1029	(48)	676	(31)	448	(21)		
1975	2880	3353			1598	(39)	825	(25)	930	(27)		
1980	4400	5300	350	(7)	2100	(24)	650	(12)	1600	(30)	600	(12)
1990	10500	11600	850	(7)	3600	(31)	1600	(14)	2650	(22)	3100	(26)
2000	23000	25500	1900	(7)	6000	(24)	4000	(16)	3400	(13)	10200	(50)

Table 4.2 – "Power production from the various System units".

A 1968 forecasting of energy demand and supply between 1965 and 2000. According to this forecasting, by year 2000 50% of the electricity would come from nuclear power plants. The table has been reconstructed after Papamathaiakis and Xynopoulos 1968, 285.

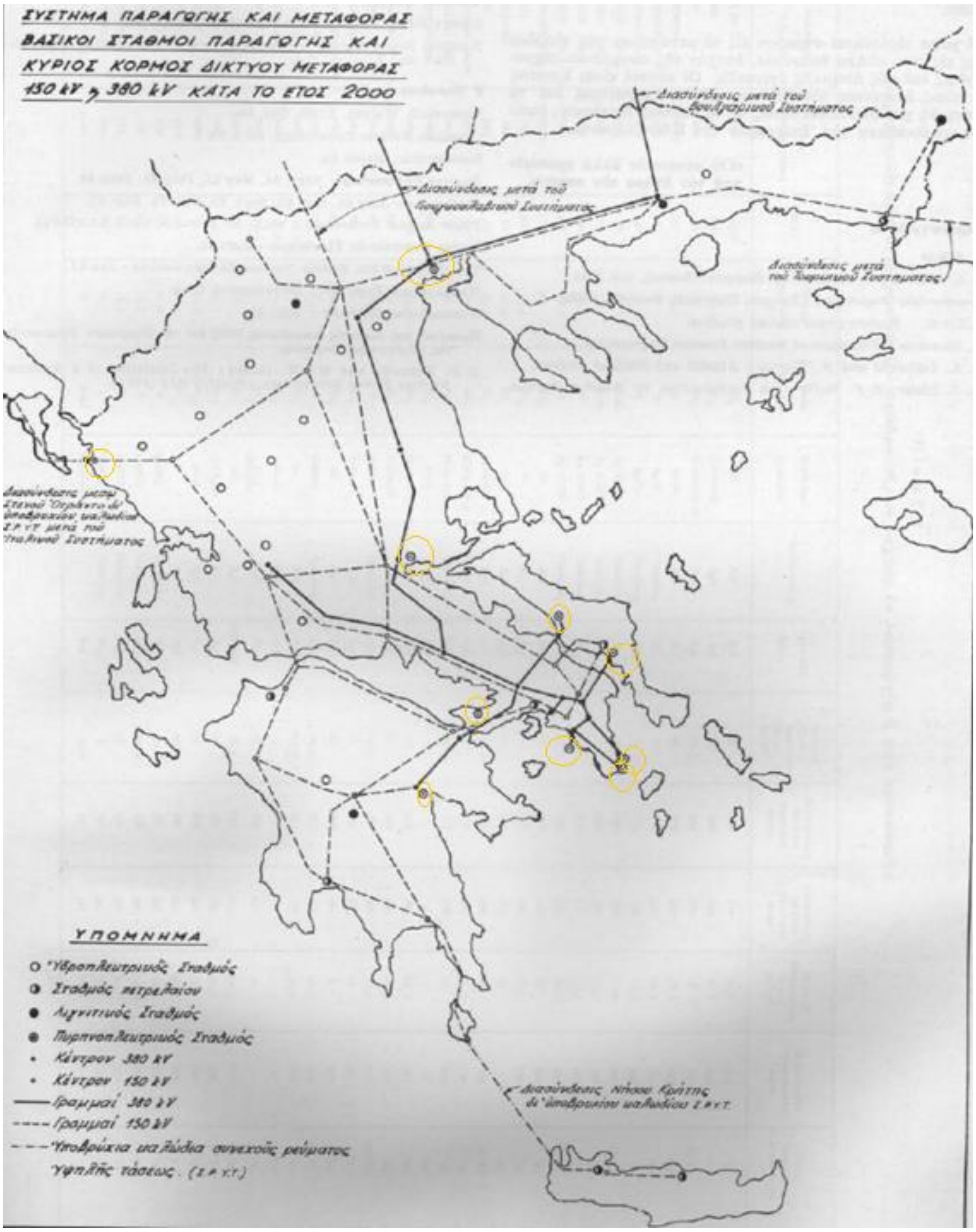


Figure 4.2 – Map's heading: "System of production and distribution: Main production stations and basic 150kV & 380 kV grid by year 2000".

In this map of Greece the grid and the production stations are depicted. The possible locations of the nuclear plants are in yellow circles (the sign  indicates the nuclear power plants).

Source: Papamathaiakis and Xynopoulos 1968, 291.

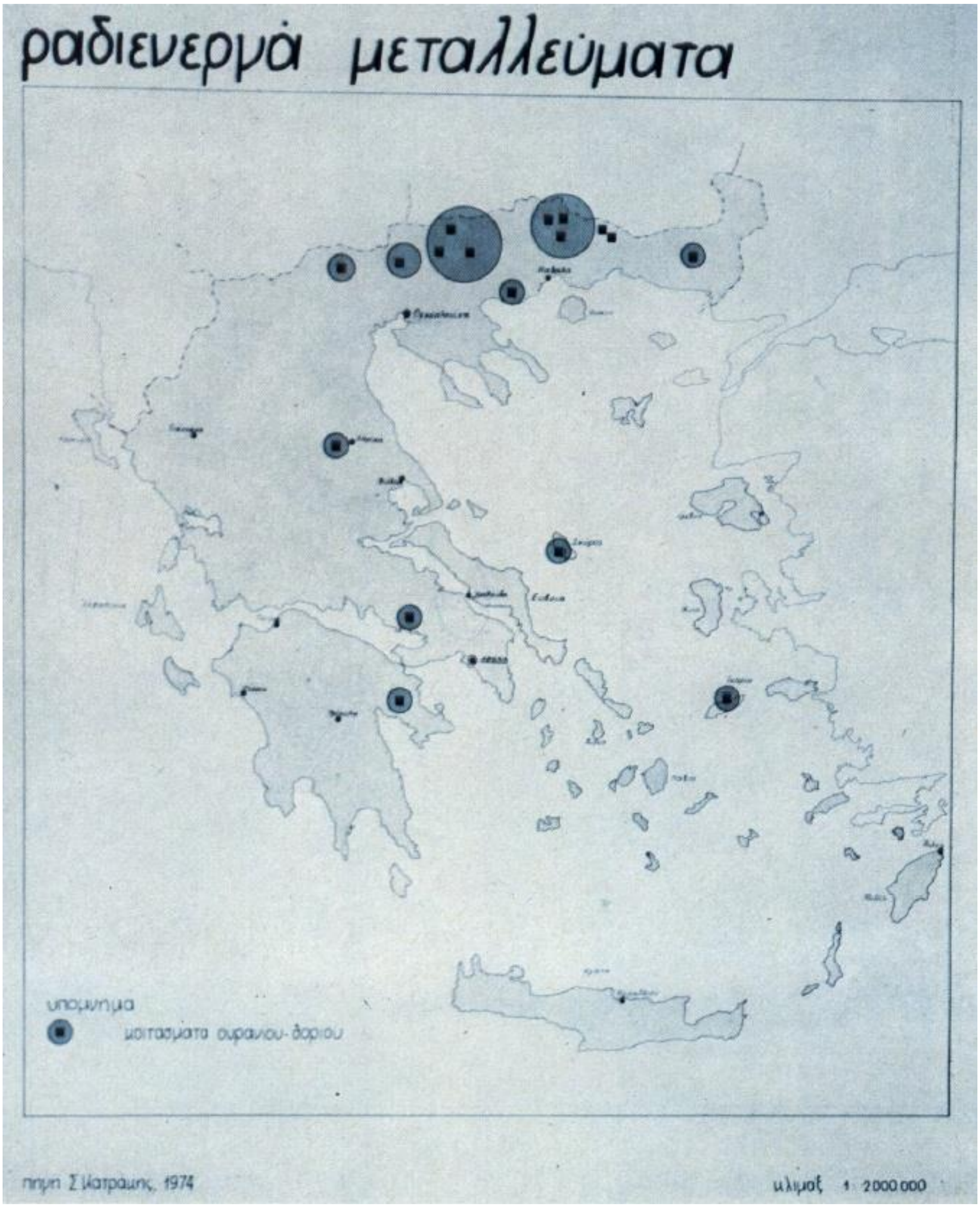


Figure 4.3 – Map's heading: "Radioactive ores".

In this map of Greece, the sign  indicates the possible location of uranium - thorium ore deposits.

Source: "Έκθεση συνεδρίου ΤΕΕ" 1978, 78.

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WP2

Hungary

Short Country Report

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CONTENTS

Executive summary

This report belongs to a collection of 20 short country reports on the History of Nuclear Energy and Society (HoNESt, project Ref.662268). The reports tackle the complex sociotechnical system around nuclear energy. Nuclear developments, notably nuclear energy, are closely intertwined with social, economic, environmental, political and cultural spheres. Nuclear energy is also a globalized system involving transnational transfers of knowledge, materials, technologies, people and products including electrical power, medical elements, toxic wastes and other environmental hazards, materials, capacities and knowledge that must be carefully safeguarded. Nuclear energy is a complex social and technological phenomenon that influences societies but is also shaped by societies.

The short country reports are designed to assemble information and research results on the history of the relations between nuclear energy and society about all the different country cases in an accessible manner, and to document the findings with references.

The purpose of the country reports is threefold, addressing three different audiences:

1. to provide basic elements of narrative and analysis for further historical research by HoNESt researchers,
2. to provide information, context and background for further analysis for HoNESt's social science researchers,
3. to provide accessible information on nuclear-societal relations in the various countries for the purposes of outreach and communication with stakeholders (civil society, industry, associations, policy makers, journalists).

1. Historical Context (narrative)

This section provides the basic historical context to the interaction between nuclear industry and civil society in Hungary. The historical narrative aims at providing relevant context to the events as well as the showcase.

1.1. Introduction to the historical context

Compiled for the History of Nuclear Energy and Society project, this report is a short summary of the historical developments and decision-making processes that resulted in the production of nuclear energy in Hungary. It is not a unified history propelled by a single argument; rather, it stems from a number of fundamental questions generated by the HoNESt research group and therefore engages several topics. Nevertheless, it can serve as a starting point for anyone interested in the origin of Hungary's operating nuclear reactors.

In Hungary there is one nuclear power station consisting of four reactor blocks. Their particulars according to the World Nuclear Association are as follows:[1]

Reactor	Model	Net MWe	First power	Scheduled close
Paks 1	VVER-440/V-213	470	1982	2032
Paks 2	VVER-440/V-213	473	1984	2034
Paks 3	VVER-440/V-213	473	1986	2016
Paks 4	VVER-440/V-213	473	1987	2017
Total (4)		**1889 MWe (2000 MWe gross)**		

In 2013, total electricity generation in Hungary from 9.4 GWe of capacity was 30.3 billion kWh (gross), of which nuclear accounted for 15.4 billion kWh (51%). The site of the nuclear station is Paks, a town in southern Hungary on the Danube River.

The study of Hungary's nuclear history offers scholars a fine opportunity to examine how scientific

1http://www.world-nuclear.org/information-library/country-profiles/countries-g-n/hungary.aspx and technocratic decision-making took place in the former socialist states of Eastern Europe. Civil society was highly restricted, under the control of state authorities, and therefore did not have a role in the decision-making process that led to the introduction of nuclear power. Rather, this process took place within the government and bureaucracy of the Socialist State, where influence came not from the building of coalitions of citizens who voiced their opinions in public, but instead from the assembly of constellations of interest and power consisting of important figures in the State government, administration, and bureaucracy. This process was transnational, happening amid and because of the hegemony of the USSR in Eastern Europe. Negotiation between the Hungarian and Soviet governments was vital to this history; in addition, there were exchanges of personnel and technologies between various Eastern European countries, evidenced in the history of nuclear energy in Hungary.

The five events recommended as representative of the process explained above are:

a) decision to construct a research reactor (1955)
b) decision to construction a training reactor (1962)
c) decision to construct nuclear power plant (1966)
d) halt to the planning and construction of the power plant (1969)
e) definitive restart to the construction of the power plant (1973)

More will be said about all below.

1.2. Contextual narrative

The history of nuclear reactors in Hungary comprises a long period of time with very different political regimes. These regimes bring different contexts to nuclear history. The most radical change came around 1990, when Hungary went from being in the Soviet sphere, to being part of a cluster of newly democratic states as the Soviet Union collapsed. By that time the electricity-generating nuclear plants were built and in operation. In other words, the four Paks reactors were built and began operation during the latter stages of Socialist-era Hungarian history. What has happened after 1990 can best be described as a kind of epilogue with fewer historical sources and only an emerging historical perspective, something more akin to contemporary daily politics than to history.

Historical periods in Socialist Hungary largely conform to those of the conventional Soviet periodization. Hungary's nuclear energy project began in 1955, during the Khrushchev era (1953-64), yet preserved many features of the preceding Stalinist era (1945-1953). The most decisive years in Hungarian nuclear history came during the Brezhnev era (1964-82).

The periodization of Hungarian nuclear history might be best thought of as follows:

- Period 1 (1955-1959): planning, construction, and use of a research reactor;
- Period 2 (1966-1987): planning and construction of the four reactors of Hungary's nuclear power plant;
- Period 3 (1982-1990): regular operation of the nuclear plant and contribution of its output to the national grid;
- Period 4 (1990-present): continued regular operation of the nuclear plant in a new political regime, ongoing debate and decision-making concerning construction of new reactors.

Nuclear decision-making

There were five major nuclear decisions to speak of leading to the construction of Hungary's nuclear plant. Almost all of them resulted from the same process. The Political Committee of the Hungarian Communist Party, the most important decision-making body in Socialist Hungary, was decisive. Consisting of 10-15 members, including the prime minister, the Political Committee reported its decisions on the most important questions of the day to the government, who executed the decisions. The government carried out concrete studies and delegated the tasks of execution to ministries and other governmental agencies.

In its decisions the Political Committee relied on its bureaucratic apparatus. This involved sections (e.g. cultural, economic, etc. sections) and committees. The sections and committees relied partly on their own staffs and partly on the opinions of politically reliable experts. The sections and committees prepared proposals for the Political Committee to consider.

Justification for nuclear reactor construction

The decisions were made in different historical periods and concerned three different types of reactors. Unsurprisingly, the reasons, arguments and ultimate justifications were different in each case.

a) The first decisions were made in 1955, and do not appear to have been difficult to arrive at. They stemmed from the Soviet Union's offer to build research reactors and accelerators in its Eastern European satellites and China (in response to the American Atoms for Peace initiative).

The exact date of the Hungarian decision is telling. As noted, the suggestion to construct a nuclear reactor came from the Soviet Union—the Superpower who led the geopolitical alliance Hungary was a part of.

However, Hungary was not among the first cluster of countries invited to do so. The USSR Council of Ministers declared in January 18, 1955 its intention to aid its allies in the development of nuclear technoscience for peaceful purposes. It sent just such a proposal to the Chinese People's Republic, the Polish People's Republic, the Czechoslovak Republic, the Romanian People's Republic and the German Democratic Republic. Delegates consisting of physicists and engineers from these countries attended a meeting held in early April to discuss the details, and only then agreed to extend the proposal to Hungary and Bulgaria. The treaty between Hungary and the USSR was signed on June 13, 1955. Like all such treaties, it was bilateral.

What is remarkable is that the Council of Ministers in Hungary ordered that an experimental reactor be built in a decision made on March 10, 1955—three months *before* the bilateral agreement. In fact, even before this, the Political Committee of the Hungarian Communist party (officially at the time: the Political Committee of the Party of Hungarian Workers) declared it necessary to construct a research reactor, and specified institutions responsible for the project. Therefore, we see a visible interest in nuclear power in Hungary that predates the Soviet-led decision to permit Hungary to build a nuclear reactor.

b) The second decision, to construct a training reactor at the Technical University of Budapest, was made by the Hungarian government in 1962, late in the Khrushchev era. The goal was to train nuclear engineers for the promising future field of nuclear technology.

The process leading to this decision began in 1955, with the establishment of the Országos Atomenergia Bizottság, the OAB (the National Commission of Atomic Energy). Until 1970, the OAB was the highest level of government authority on nuclear issues, headed by a deputy prime minister. The commission entrusted experts working with the research reactor to elaborate plans for a training reactor. The Hungarian Academy of Sciences and the Committee of Education of the Party decided in favor of the plans. The head of the Section of Energetics of the Ministry of Heavy Industry signed the contract with Mihály Kökény, the secretary of the OAB, in 1962. The construction was financed by the OAB. Soviet experts acting as referees gave positive opinions on the plans for the reactor design. The design process lasted until 1966.

c) The third decision, to build power-producing nuclear reactors, was much more complex and took much longer time than the first two. The process leading to the decision started in 1964. It was initiated and made by the Hungarian authorities, including the Party leaders and the government. All this happened in the Brezhnev era. The factors most influencing the decisional process were as follows:

i.) There was an ideological, philosophical component, tracing back to the Stalinist period or even earlier, that cannot be ignored. According to this ideology, science was the main driver of communist development. The mode of production is inextricably linked to production power—and production power increases via technological innovation. Hence, for arrival at a communist mode of production, technology must be modernized. Nuclear technology seemed to be a decisive component of modern technology; hence it should have widely been used.

ii.) Another component consisted of the USSR's relative advance in atomic technology, and its and others countries' displays of this technology at international forums. The Soviet Union had an advanced nuclear technology which impressed observers at the International Conferences on the Peaceful Uses of Atomic Energy held in Geneva the first time in August 1955. This series of conferences was one result of American President Eisenhower's Atoms for Peace speech, delivered to the United Nations in December, 1953. The conferences can be considered both a forum for international rivalry and an early step of détente. Hungarians attending these conferences were inspired to suggest to the Party that Hungary make preparations for the atomic age.

iii.) Yet another component consisted of institutional support for nuclear power development among the countries that made up the Socialist bloc of states. The Permanent Commission on Utilization of Atomic Energy for Peaceful Purposes was set up in CMEA in 1960. By 1964 Hungarian authorities began to believe that the CMEA member states might cooperate multilaterally in using nuclear power stations for enhancing energy supply, especially in light of the promisingly good performance and apparent relative affordability of the newest Soviet reactors.

iv.) A final component was domestic, though not unique to Hungary. Rapid industrial growth required more energy in the CMEA countries, Hungary included. Energy provision tripled between 1950 and 1960, and the 3rd (1966-1970) and 4th (1971-1975) Five Year Plans also prescribed fast increase of energy supply in a country previously rather energy poor. The question became, of course, which type of energy could secure the increase: coal, hydroelectric, oil and gas, nuclear energy, and/or some sort of electricity import. Most of the existing power stations were coal-fired. However, the scarcity and the low quality of Hungarian coal led the country to import large amounts of coal. Hungary's flat topography precluded hydroelectric energy. Oil appeared quite promising, given that the Soviet Union could provide it at a favorable price. Next to it, atomic energy appeared rather fantastic—however, it, too, might furnish the megawatts Hungary would need.

The Soviet proposal to provide a nuclear power plant arrived in 1965 in the framework of the CMEA cooperation mentioned above. As usual, following the suggestion of the Political Committee of the Party, the government made their decision, in favor of constructing a nuclear plant. The representatives of the Hungarian and the Soviet government signed an agreement to construct a nuclear power plant on December 28, 1966.

d) The fourth decision, to halt the planning and construction of the nuclear power plant, was made again by the highest body of the party and the governmental authorities. They decided in January 1970 to postpone the construction of the nuclear power station for several years. This very fact shows that after the mid-1960s the Hungarian regime had departed from the previous Stalinist rigidity and became more flexible, accepting elements of market-driven decision-making and considering various stakeholder interests. From this period of the Brezhnev era, negotiation and bargaining became particularly important activities in economics and politics, both domestically and internationally. We see that in a note provided at that time to Soviet authorities, reference is made to a reappraisal of the coming energy needs of the country in the period of the next five year plan, casting the need for the nuclear plant in enough doubt that planning for it was halted. Considering that no definite time for restarting the project (the note alludes only vaguely to sometime in the 1980s), the step represented by the note can be considered a de facto cancellation of the original agreement—and it was, in fact, accepted by the Soviets.

e) The final and last decision in this brief historical review—the decision to resume planning and construction of the nuclear plant—was made definitively in 1975. The reconsideration of the 1970 decision to halt construction began in the spring of 1972. Hungarian energy experts' consultation with their Soviet analogues concerning the fifth Five-Year Plan led to a return to the view that nuclear energy would become indispensable. Speculation that oil prices would rise was soon met with the hard reality of just that. Hungarian Prime Minister Jenő Fock signed the final document in April 1975. All the decisive elements of the construction were agreed to and described by this time.

To summarize: in the Hungarian case, arguments both for and against nuclear power were framed in economic terms.

1.3. Presentation of main actors

The main actors were stakeholder groups involved in the construction of a nuclear power station in Hungary. Groups that would prove either for or against nuclear power were formed in the long process of developing nuclear culture in a country where something like advanced nuclear technoscience, much less a nuclear power station, was virtually nonexistent. Various groups in a rather consistent fashion served as advocates for nuclear energy.

In Period 1 (1955-1959), the supporting group was the political establishment. The Soviets made a recommendation and the Hungarian party complied. This is how decision a) (the decision to build the research reactor) was made. We have no information about any opposition or debates to this decision. This happened at the beginning of the post-Stalin era.

Decision b) (the decision to build the training reactor) was made in 1962, in an entirely different period: the late Khrushchev period, years after the 20th congress of the Soviet Communist Party and the Hungarian revolt in 1956 but before political consolidation and economic reform in Hungary. This latter started in 1966 and led to a gradual softening of the dictatorship. These significant political changes account for why the construction of the training reactor lasted so long. The reactor went critical only in 1971.

To the best of our knowledge, there was no opposition in this case either. Difficulties were due mostly to the complicated bureaucracy that was in confusion during these years of transition. Supporters can, however, be identified. They were leading scientific and engineering professionals belonging partly to the academy and partly to the political leadership and technocracy. In addition, due partly to the research reactor, a small high-level community of nuclear experts was born. Three support groups can easily be discerned, and represented by three particular individuals. These support groups were crucial to the ultimate adoption of nuclear energy in Hungary, and the leading figures who represent these groups merit closer examination.

András Lévai

András Lévai (1908-2003) was an effective mover. He was a mechanical engineer trained in Austria. Lévai settled in Hungary in 1940 after leaving Romania. He became a high expert of energy policy, technology, and economics, occupying high, politically crucial positions in his field. He was director of ERŐTERV, the central office of power plant design. He was professor at the Technical University (where the training reactor was built), a member of the Academy of Sciences, and in an important period (1962-67) he was deputy minister in the Ministry of Heavy Industry, where he worked in various positions before and after. In spite of his high positions, he was not a member of the Party.

Lévai introduced nuclear technology into the curriculum at the Technical University. From 1956, after the First Geneva Conference, with his colleague Károly Simonyi he taught an optional course entitled *Atomic Plants* for regular students and, separately, to postgraduate students. They published lecture notes to help the students and advised on theses related to nuclear technology. Levai wrote a long study on the role of nuclear energy in the future Hungarian economy and sent it to high-level political and party leaders. In so doing, he was likely the first individual to draw the authorities' attention to the possibility of nuclear energy. He initiated development of the training reactor.

Lévai's students joined him in supporting nuclear energy. He organized a team consisting of six people to study applications of nuclear energy. One of them, Gyula Csom, became the first director of the training reactor, and Gergely Büki also remained active in the field. This was one of the nuclei of the Hungarian nuclear community.

Lévai established an office for designing power stations (called ERŐTERV) in 1950. He was its director until 1962. This company produced designs both for new power stations and for developing the electric network. The small staff at ERŐTERV worked on the preliminary designs that provided the basis for the Soviet-Hungarian negotiations. These experts supported all the steps of the nuclear power project, and overall this small but growing group had a stake in the nuclear future of the country.

Lénárd Pál

Another high ranking supporter of nuclear energy in Hungary was Lénárd Pál (b. 1925), a physicist. He graduated in Budapest and continued his postgraduate studies in Lomonosov University, Moscow. After his return from the USSR in 1953, he became a leading researcher in the Central Research Institute for Physics, the most important center of science then. The research reactor was placed in this institute. In 1956, Pál became head of the organization that operated the reactor and carried out various research programs, produced isotopes, and manufactured instruments for nuclear measurements and experiments. In 1970-1978, he was the director of the entire institute. Meanwhile, Pál became a very influential politician: in 1975-1989 he was a member of the Central Committee of the Party, and from 1985 to 1989 secretary of the Central Committee. In addition, he was member in committee of science of the Council of Ministers in 1978-1989.

In the institute, in particular in the section housing the research reactor, significant expertise in reactor physics was accumulated by a growing staff. They constructed critical assemblies (ZR-1, ZR-2, etc.) to study and prove the experimental and calculation methods of the field. They also designed the training reactor at the Technical University. Among them, nuclear professionals like

Ferenc Szabó and Zoltán Gyimesi became important authorities. They expressed their support for nuclear power in various committees and meetings.

Benjamin Szabo

Benjamin Szabo (b. 1932) was the political and organizational manager of the construction of the Paks nuclear plant. He graduated from electric engineering in the Soviet Union in 1958 and in 1961 he became director of an important power plant in Ajka. Two years later he became the referent of electric energy industry in the Party administration. Subsequently, he worked as head of the Atomic Energy Secretariat in the Ministry of Heavy Industry and became a main actor of the nuclear plant construction, first as general manager of Paks Nuclear Power Plant Ltd established in 1976, and then as Government Commissioner of its development.

Szabo was in the arena in which politicians, economic policy makers, and companies fought. He negotiated compromises between participants. He had to look for allies who sometimes changed according the shifting political climate. While he often relied on nuclear experts, it was ministers and deputy ministers, in particular Ferenc Lévárdi (deputy minister and later minister of heavy industry) and Gyula Szekér (also deputy minister and then minister of heavy industry, and later deputy prime minister), who proved incomparably more effective. They had to convince state planners of the importance and inevitability of nuclear energy.

The opposition to nuclear power is more difficult to represent with names. In the 1960s, there was a large, rather undefined group of skeptics who thought that nuclear energy amounted to science fiction. Faced with the undeniable advance of nuclear technology in the Soviet Union, they claimed that construction of nuclear reactors for Hungary was too complicated, the task too big. Unfortunately, we have not as of yet found protocols of the meetings in which they expressed their opinions. In the memoirs we have, we could not identify names or groups because they are mentioned only in general terms.

The National Planning Office opposed nuclear energy as well. It had the task of estimating energy demand and recommending the mix of energy resources (coal, hydrocarbons, hydroelectric, and imports) for the country. The price of a nuclear power plant was undefined but it was guessed to be very high and the price of the energy produced by the plant was also unknown but similarly estimated. Hence, energy planning became uncertain. In addition, Hungary energy mix was undergoing a significant change with the diminishing weight of coal and the increasing weight of hydrocarbons. (The Office planned to increase the ratio of hydrocarbons from 18% in 1958 to 37 % by 1970.) This process required large investments.

Given this situation, the interest groups in opposition to nuclear power can be identified. These were the managers and employers of companies that had every reason to oppose the development of a nuclear plant. There were two sorts of such enterprises: energy production enterprises and plant development enterprises. The growing energy demand necessitated the development of new power stations and enlargement of old ones (e.g., the Gagarin and Bánhidai, Tiszapalkonya, and Dunamenti thermal power stations, and the Tiszai oil refinery). The stakeholders of these companies had a vested interest in the enlargement or development of these plants and feared a competing enterprise. They defended their interests in various meetings on state planning. In addition, the construction companies and companies that produced the technological instruments for the energy companies received enough orders, and were simply uninterested in new tasks and, in particular, in such huge and technologically complicated tasks that required unusually high quality products such as the nuclear industry required.

These groups opposing nuclear energy were influential enough to bring the planning and construction of the nuclear plant in Hungary to a halt. But the oil crisis and the limitation of Soviets energy imports left their opposition untenable in the early 1970s.

The actual characteristics of the three Hungarian reactors/reactor complexes are as follows.

The research reactor

The research reactor was a light water moderated 2 MW thermal power VVR-S reactor. Its fuel was low enriched uranium (10%). It was not designed to generate energy but was used for production of isotopes and for research. The reactor was designed by Soviet experts; Hungarians designed only the building housing the reactor.

The training reactor

The training reactor was a light-water moderated 10 kW thermal power reactor, increased to 100 kW in 1980. The experts involved in the construction and use of the research reactor built the training reactor's active zone and control system, while the building and its equipment were designed by ERŐTERV. Notably, a Hungarian company (Kiskunfélegyháza Machine Factory) produced and installed the reactor and its technological appliances.

The nuclear power plant

The nuclear power station's characteristics are found above. The construction was by far the greatest achievement in the history of technology in Hungary. It was built by a number of Hungarian and non-Hungarian companies. They cooperated at several levels. At the top was ERBE (full name: Erőmű Beruházási Vállalat, Power Station Establishing Company) with the task of organizing the construction of power stations. The government entrusted ERBE with developing the nuclear power station described in the Hungarian-Soviet agreement signed after the third decision (1964). ERBE began to organize the project and took important preliminary steps (e.g., finding the most suitable location, securing transportation routes to the site, etc.) With low intensity it continued this activity even after decision four to halt construction.

Following the decision in the early 1970s to resume construction, the Government transferred money into a bank at ERBE's disposal for making contracts with companies. (The Paks Nuclear Power Plant Ltd was responsible for the operation of the would-be-reactor, but not for its construction.) An important principle was to include as many Hungarian firms as possible, because the Hungarian users wanted to understand all of the technological details of the reactor and be assured that they could find experts within easy reach in case of malfunction.

ERBE, like ERŐTERV, was established in 1950. Its task was to provide various services in constructing and operating a wide range of energy stations, including design, quality control, making contracts, etc. ERBE made contracts with ERŐTERV, building companies, service companies and, in 1973, the Soviet foreign trade company, Atomenergoexport. Another crucial partner was the aforementioned ERŐTERV (nickname of Erőmű Tervező Iroda, Power Plant and Network Designing Company). ERŐTERV set up a General Department of Atomic Energy responsible for a considerable part of the nuclear plant's development, including finding a suitable site and making the general design. ERBE and ERŐTERV had vested interest in developing a nuclear plant throughout the various political periods described above.

Other Hungarian companies were assigned by the Government to particular tasks. An appendix to the government decision (Nr. 3296/1976) lists them, specifying their duties. The list turned out to be incomplete, as in the course of development other companies were also included. The appendix mentions only one Soviet Company, Teploenergoprojekt, as general executor of the assignment. The other Soviet participants remained unknown for obvious secrecy reasons. The list also mentions Intransmas, a Bulgarian-Hungarian company, as a contributor without specified duties.

Despite the lack of details, we know that the development of the nuclear power plant in Hungary was a transnational project. Skoda, the famous Czechoslovak firm, produced the reactor containment vessel. A Polish company, Budostahl, sent workers to carry out special welding and construction jobs that Hungarians were unable to manage. The sole device coming from the West was a French industrial tower-crane. In addition, many exchanges of experts were organized with Soviet, German, Czechoslovak, Bulgarian and Finish colleagues, in different specialties.

It is to be noted that the complexity, quality requirements, the large number of participants, the new technology and the structure of economic and technological administration in State socialism made the construction extremely difficult to achieve. Four blocks were built in sequence and much was learned in the process of their construction. It is a wonder that it was successfully done.

It should be noted that cost was in many respects the most mysterious part of the nuclear plant construction process in Hungary. The basic contracts contained nothing about the costs because the Soviets were not willing to disclose this information. Hence, in their planning the Hungarians relied on an estimated price. This was a fiction, no one took it seriously but they had no choice. The long bargaining procedure could not be based on anything other than qualitative and estimated factors, excepting the power output of the future nuclear station.

None the less, we found an interesting estimate. According to this, in the third decision (1964) the planers calculated 10 billion Forints as the price of the whole project all the while knowing that it was not real. After the final decision (1972), their prognosticated total was 59 billion Forints, plus 10 billion Forints in reserve. In 1986, seeing all the changes in deadlines, organization difficulties, new technologies, changes of the financial system, and so on, a new financial plan was conceived. At that point, the estimated total was 72 billion Forints. When the project was financially closed in

1990, this estimation proved more or less correct, but some elements of the plant were still to be built. (Inflation is disregarded in the sums.)

It is to be noted that the financial account was by then extremely complicated. Hungary needed credit for the construction, and an important agenda in the bargaining process was the sum of credits the Soviets would provide. The account settlements were also linked to complicated multilateral CMEA agreements. In addition, the prices had little to do with the prices known in Western markets, not to speak of the exchange rates between Forint and Ruble, and Forint and Dollar. These procedures were matters of negotiations.

The fuel cycle

An important part of the history of the Hungarian (and any) reactors involves not the reactors themselves, but the origin of their fuel elements and the fate of the wastes removed from them. In Hungary, the history of fuel cycle problem embraces all indicated periods and the problem of closing the cycle is still present.

The front end, the production of fuel, was carried out in the Soviet Union throughout the periods covered. In Hungary there was in fact a uranium mine in the Mecsek Montains, near the city of Pécs. The associated uranium deposits were discovered in period 1, and the mine opened in 1955 under the name of Bauxitbánya Vállalat (Bauxite Mine Company), near the village of Kővágószőlös. The company was a Soviet-Hungarian one owned originally by the Soviet Union. It had a Hungarian director but all other higher level positions were filled by Soviets. The uranium content of the ore was 0.1%. In 1957 Hungarian state took over the mine, renamed the Pécsi Uránércbánya Vállalat (Pécs Uranium Ore Company) and in 1958 made a contract with the Soviet Union for twenty years, prolonged for another fifteen years in 1979. In this same contract, the Soviet party undertook to provide Hungarian reactors with nuclear fuel.

In 1964 (already period 2) Hungarians started to concentrate to a higher grade the ore in Hungary, making subsequent shipment to Chepetsk Mechanical Works in Glazov City, Udmurt Republic (the Soviet processing company) cheaper. The product of the renamed company (Mecseki Ércbányászati Vállalat, Mecsek Ore Mining Company) contained 50% uranium metal. In exchange, Hungarians received the ready-to-use uranium fuel elements, called ‘cassettes’.

In the new regime following the collapse of communism 1990 (period 4), uranium mining entered a deep crisis in Hungary from which it never recovered. By 1997, the whole uranium industry was shut down.

As for the back end of the nuclear fuel cycle, it was first tackled during period 2, when the first nuclear waste storage was opened in Solymár, near Budapest in 1960. A portion of the waste coming from the research and training reactors was stored there, while another portion was transported to the Soviet Union. As the Solymár site reached the limits of its capacity, and in addition seemed to pose a danger to nearby Budapest, a new repository was built in Püspökszilágy, about fifty kilometers NNW of Budapest. The repository was named the Radioactive Waste Treatment and Disposal Facility (RWTDF), designed in the early 1970s in harmony with the international standards of the time. It was completed in 1976 and the first items of waste arrived in 1977.

The nuclear waste produced by the Paks plant were to be transported back to the Soviet Union, according to the agreements related to decisions 3 and 4. However, by the time this aspect of the agreements would have come into effect, the Soviet Union asked for its modification. Originally, the burnt cassettes with spent fuel had to be stored for three years in a decay pool before return to the Soviet Union, where they were reprocessed and the residues stored. Later the Soviets asked for a five-year storage in the decay pool in Hungary. In 1986 a contract was signed about handling nuclear waste; it contained a paragraph saying that the Soviets take back spent fuel free of charge. The Hungarians themselves had to store low and intermediate level radioactive wastes. For a while, they again used Püspökszilágy for this.

What happened after this might be considered an epilogue to our history. After the collapse of state socialism all the former agreements and reasoning became entirely invalid. Five year plans, CMEA, Socialist friendship, insulation from the West, ignoring financial aspects—all this disappeared with the dissolution of the Soviet Union. Consequently, the Hungarians found themselves facing a new partner: Russia. Waste handling was one of the subjects that had to be radically rethought in the new regime. Bargaining had to be continued on monetary basis. Indeed Russia charged increasingly high prices for the return of nuclear waste. As a result, the Hungarians searched for less expensive solutions, i.e. storage of high-level nuclear waste in Hungary.

This search resulted in the first and only notable popular anti-nuclear action in Hungary's history, against the plan for a new repository for low and intermediate level radioactive wastes in Ofalu, in southwestern Hungary. In 1990, its population voted against storing radioactive waste in spite of all the efforts of politicians and experts to lobby otherwise. They had to abandon their campaign to create a repository in Ofalu and instead open a storage facility in Bátaapáti, to the east of Ofalu. The National Radiactive Waste Repository (NRWR) in Bátaapáti was opened in October 2008.

The situation grew more confusing in the early 1990s, and not only because of the collapse of the USSR. Domestically, the democratic Hungarian parliament was compelled to pass a law on the handling of nuclear energy issues, including nuclear waste management, in 1996. (1996/CXVI. Law). A financial fund was established (Központi Nukleáris Pénzügyi Alap) in 1998 and the National Commission of Atomic Energy was reorganized under the new name of Országos Atomenergia Hivatal (Hungarian Atomic Energy Authority) with new mandates. The law ordered this institution to establish a Public Agency for Radioactive Waste Management, a non-profit company, which was transformed to the Public Limited Company for Radioactive Waste Management (PURAM) in 2008. PURAM is responsible for all of the steps of the back end of the fuel cycle.

In this institutional framework a group of experts decided to construct a new system for storing, reprocessing and disposing various kinds of nuclear waste in Paks. They opted for Interim Spent Fuel Storage Facility technology (ISFSF). As a consequence, the renamed company, the Paks Nuclear Power Plant (not the Hungarian state) made a contract with British-French GEC Alsthom to construct a Modular Vault Dry Storage System (MVDS) in 1992. In spite of some protest from the local community, since its completion in 1997 the system has been working and growing in accordance with the requirements.

Siting

Another important context to the development of nuclear energy in Hungary is siting—how sites for reactors were selected, and, just as importantly, what influence those reactors had on the localities. The siting of the research reactor and the training reactor had no real influence on the neighborhood. The research reactor was built in the campus of the large Central Research Institute for Physics, in Csillebérc, located in the Buda Hills, in Budapest far from the city center. The training reactor is located on the campus of Budapest Technical University also in Buda. Both reactors are virtually invisible to the general population of Budapest.

In contrast, Hungary's nuclear plant brought radical changes in the life of the town of Paks. The site of the plant was determined by the Hungarian government in 1967 on the basis of research done by a team of Soviet and Hungarian experts of geology, meteorology, geography, and others, including urban planners. Political aspects were also considered, as the plant provided an important means of development to Tolna County. Bogyiszló, another township, was a competitor to Paks but from the technical point of view Paks appeared more suitable. The local population was not consulted about the decision.

For the construction block apartment houses were built for the workers (instead of barracks as was suggested by some) and new shops and other facilities were established for the fast growing number of workers coming from various parts of the country. Paks, a sleepy town, abruptly doubled in size, with around ten thousand migrants arriving with their urban styles and needs. Hence, Paks developed very fast, received new medical, cultural, sport, commercial, and other facilities as well as well-paid jobs, and career opportunities. As a result, an unprecedented interest in engineering studies took root in the population.

Nevertheless, the integration of the newcomers by the traditional population was very difficult. Fear of atomic energy was present in Paks but was only expressed in private conversation. After 1990, the tension between the old and new inhabitants received political form in the shape of contested local government elections. Anti-nuclear plant groups were organized, loud marches coursed through the streets, and fervent debates broke out in local government meetings. The situation gradually eased as the number of employees at the nuclear plant coming from Paks and the surrounding vicinity grew, as the first generation staff gradually retired.

For the larger area, Tolna County, the nuclear power station was extremely important. Tolna was relatively backward compared to neighboring counties, and the huge industrial plant provided more weight to Tolna in national politics. The new highways, railway lines, bus stations, and big houses contributed to the development of nearby Szekszárd as well, the county seat.

Media and nuclear energy

Due to the lack of civil society in state socialist countries, neither pro- nor anti-nuclear civil movements existed in Hungary in the early Brezhnev era. Forbidden Samizdat movements started in the early 1970s. The national media spoke of the agreement in an unequivocal supportive tone. Actually, it normally handled the nuclear plant construction as a triumph of Socialism, and a sign of Soviet-Hungarian friendship.

The developers of the project were not very interested in informing society about the progress of their work, and gave little attention to public relations. Nevertheless, national radio and television broadcasted reports on the Paks project every two to three month, and two TV reporters, János Bán and Marietta Szabó, became well-known for their reports. The local newspaper in Tolna County reported almost every step of the construction work. Some of the articles were later republished in a thick retrospecive book.

Chernobyl was reported somewhat belatedly in a comforting tone. Hungary’s leadership at the time wished to calm the worries of the public and defend the Soviet Union. By 1986, however, the disaster at Chernobyl did not influence the ongoing project in Paks, where three reactors were already operating.

An analysis of the media’s portrayal of nuclear power in Hungary would require a great deal more research. In the period of state socialism the public learned to read between the lines. It was a period when the number of newspapers, radio and TV channels was very limited. After 1990, however, the media became extremely complicated, branching and sub-branching and growing very complex. With Internet, the situation has become even more complicated, and confusing for the researcher.

2. Showcase

Research has revealed the most surprising historical case to be the fourth decision mentioned above, to postpone indefinitely planning and construction of the NPP. This event—what turned out to be a long pause in construction—was in itself revealing for the way in which a nuclear opposition within the state bureaucracy manifested itself (see the Section 4: Events), and very influential in terms of the final shape of the NPP and its components.

It should be understood that one of the major subjects of the long bargaining process between the Soviets and Hungarians that began in the 1960s was the power of the would-be plant. In the process of the mid-1960s negotiation, Hungarians expressed their interest for a plant of 800 MW. This was the type that was offered in the framework of CMEA and the Soviets provided the outlines of the design of this in 1965. By 1968 the power of the planned plant had grown to 860 MW, and some other parameters also improved.

The letter of cancellation or postponement that was the culmination of event four brought a great rethinking to the 1968 plan. The Hungarians expressed their intention to buy a more advanced nuclear plant later. They referred to the plant of 1000 MW that was under construction in Leningrad called RBMK (Reaktor Bolsoj Mosnosztyi Kanalnij). This upset the Soviets because by that time they had sold a 440 MW VVER plant in Finland which was proving very good in operation. In any case, the Hungarians were inclined to think in terms of 1000 MW reactors and by 1969 they corresponded with the Soviet partners on constructing two RBMK blocks in the future. With this, the Hungarians significantly increased their demand for nuclear energy to 4000 MW and in their long term plan (1991-2000) they spoke about a 14-16,000 MW need for nuclear energy.

When Hungarians renewed their nuclear energy project in 1972, they assumed between 1760-4000 MW nuclear energy in their energy mix by 1980. But in negotiations they soon understood that the Soviets would not undertake to provide a plant of 4000 MW. The realistic demand could only be 1760 MW, four VVER 440 reactor blocks. The final decision and documents signed then contained this, and this was what was ultimately constructed by the early 1980s.

The other major element of change was the new Soviet safety policy. Already in 1973, before the prime mister signed the final agreement, ERBE was assigned to make a contract with a Soviet foreign trade company to plan for the nuclear reactor assuming that it would be very similar to the one described in the agreement of the third decision. However, in a CMEA meeting, the Hungarian participants were informed about a new safety policy conforming to Western requirements.

The starting point for the new safety policy was preparation for a worst-case scenario. The Soviets assumed the break of the largest diameter tube in the cooling system and, simultaneously, a break in the supply of electricity. For this they had to construct a containment building, a 1.5 meter thick building made of concrete around the primary circuit. This massive hermetic box was intended to prevent release of radioactivity from the reactor. At the same time, a backup electric supply was installed.

These elements as well as others had serious consequences for the whole project. The task was twice as big as they calculated on the basis of the earlier contract and the product of construction became a prototype—an identical plant had never before been built.

This episode—the opposition to nuclear power in the Hungarian Socialist administration in the late 1960s, the pause in construction, the dramatic revision of plans, and, ultimately, the building of a prototype powerplants with four units still in operation—stands out as the outstanding event in the history of Hungarian nuclear power. The limits of what the archives can divulge and the sensitivities and discretion of historical actors still living prevent the present authors from stating more about individual identities of those who comprised the nuclear opposition, as well as other fascinating details of this event. Therefore, more stands to be learned about the nature of the adoption and opposition to nuclear power in Hungary and in the Socialist-era Eastern European context. What can be said here is that for Hungary the whole episode ends with an ironic twist: when the halt to build a nuclear power station in Hungary was lifted, and planning and construction was resumed, a renewed plan was put forth more than doubling the amount of electric power provided by the station, influencing Hungarian energy policy for more than a generation.

3. Events

The five major nuclear decisions leading to the construction of Hungary's nuclear plant, which comprise the events detailed in this country report, resulted from similar processes. The Political Committee of the Hungarian Communist Party, the most important decision-making body in Socialist Hungary, was decisive. Consisting of 10-15 members, including the prime minister, the Political Committee reported its decisions on the most important questions of the day to the government, who executed the decisions. The government carried out concrete studies and delegated the tasks of execution to ministries and other governmental agencies.

In its decisions, the Political Committee relied on its bureaucratic apparatus. This involved sections (e.g. cultural, economic, etc. sections) and committees. The sections and committees relied partly on their own staffs and partly on the opinions of politically reliable experts. The sections and committees prepared proposals for the Political Committee to consider. In the case of nuclear power as in other matters of the day, these bodies provided information and opinions feeding the decision-making process.

These decisions, made in different historical periods and concerning three different types of reactors, varied in terms of the reasons, arguments and ultimate justifications for each case.

3.1. Event 1: The decision to construct a research reactor (1955)

The first decisions were made in 1955, and do not appear to have been difficult to arrive at. They stemmed from the Soviet Union's offer to build research reactors and accelerators in its Eastern European satellites and China (in response to the American Atoms for Peace initiative). The exact date of the Hungarian decision is telling. As noted, the suggestion to construct a nuclear reactor came from the Soviet Union—the Superpower who led the geopolitical alliance Hungary was a part of.

However, Hungary was not among the first cluster of countries invited to do so. The USSR Council of Ministers declared in January 18, 1955 its intention to aid its allies in the development of nuclear technoscience for peaceful purposes. It sent just such a proposal to the Chinese People's Republic, the Polish People's Republic, the Czechoslovak Republic, the Romanian People's Republic and the German Democratic Republic. Delegates consisting of physicists and engineers from these countries attended a meeting held in early April to discuss the details, and only then agreed to extend the proposal to Hungary and Bulgaria. The treaty between Hungary and the USSR was signed on June 13, 1955. Like all such treaties, it was bilateral.

What is remarkable is that the Council of Ministers in Hungary ordered that an experimental reactor be built in a decision made on March 10, 1955—three months before the bilateral agreement. In fact, even before this, the Political Committee of the Hungarian Communist party (officially at the time: the Political Committee of the Party of Hungarian Workers) declared it necessary to construct a research reactor, and specified institutions responsible for the project. Therefore, we see a visible interest in nuclear power in Hungary that predates the Soviet-led decision to permit Hungary to build a nuclear reactor.

3.2. Event 2: decision to construct a training reactor (1962)

The second decision, to construct a training reactor at the Technical University of Budapest, was made by the Hungarian government in 1962, late in the Khrushchev era. The goal was to train nuclear engineers for the promising future field of nuclear technology.

The process leading to this decision began in 1955, with the establishment of the Országos Atomenergia Bizottság, the OAB (the National Commission of Atomic Energy). Until 1970, the OAB was the highest level of government authority on nuclear issues, headed by a deputy prime minister. The commission entrusted experts working with the research reactor to elaborate plans for a training reactor. The Hungarian Academy of Sciences and the Committee of Education of the Party decided in favor of the plans. The head of the Section of Energetics of the Ministry of Heavy Industry signed the contract with Mihály Kökény, the secretary of the OAB, in 1962. The construction was financed by the OAB. Soviet experts acting as referees gave positive opinions on the plans for the reactor design. The design process lasted until 1966.

3.3. Event 3: decision to construct nuclear power plant (1966)

The third decision, to build power-producing nuclear reactors, was much more complex and took much longer time than the first two. The process leading to the decision started in 1964. It was initiated and made by the Hungarian authorities, including the Party leaders and the government. All this happened in the Brezhnev era. The factors most influencing the decisional process were as follows:

i.) There was an ideological, philosophical component, tracing back to the Stalinist period or even earlier, that cannot be ignored. According to this ideology, science was the main driver of communist development. The mode of production is inextricably linked to production power—and production power increases via technological innovation. Hence, for arrival at a communist mode of production, technology must be modernized. Nuclear technology seemed to be a decisive component of modern technology; hence it should have widely been used.

ii.) Another component consisted of the USSR's relative advance in atomic technology, and its and others countries' displays of this technology at international forums. The Soviet Union had an advanced nuclear technology which impressed observers at the International Conferences on the Peaceful Uses of Atomic Energy held in Geneva the first time in August 1955. This series of conferences was one result of American President Eisenhower's Atoms for Peace speech, delivered to the United Nations in December, 1953. The conferences can be considered both a forum for international rivalry and an early step of détente. Hungarians attending these conferences were inspired to suggest to the Party that Hungary make preparations for the atomic age.

iii.) Yet another component consisted of institutional support for nuclear power development among the countries that made up the Socialist bloc of states. The Permanent Commission on Utilization of Atomic Energy for Peaceful Purposes was set up in CMEA in 1960. By 1964 Hungarian authorities began to believe that the CMEA member states might cooperate multilaterally in using nuclear power stations for enhancing energy supply, especially in light of the promisingly good performance and apparent relative affordability of the newest Soviet reactors.

iv.) A final component was domestic, though not unique to Hungary. Rapid industrial growth required more energy in the CMEA countries, Hungary included. Energy provision tripled between 1950 and 1960, and the 3rd (1966-1970) and 4th (1971-1975) Five Year Plans also prescribed fast increase of energy supply in a country previously rather energy poor. The question became, of course, which type of energy could secure the increase: coal, hydroelectric, oil and gas, nuclear energy, and/or some sort of electricity import. Most of the existing power stations were coal-fired. However, the scarcity and the low quality of Hungarian coal led the country to import large amounts of coal. Hungary's flat topography precluded hydroelectric energy. Oil appeared quite promising, given that the Soviet Union could provide it at a favorable price. Next to it, atomic energy appeared rather fantastic—however, it, too, might furnish the megawatts Hungary would need.

The Soviet proposal to provide a nuclear power plant arrived in 1965 in the framework of the CMEA cooperation mentioned above. As usual, following the suggestion of the Political Committee of the Party, the government made their decision, in favor of constructing a nuclear plant. The representatives of the Hungarian and the Soviet government signed an agreement to construct a nuclear power plant on December 28, 1966.

3.4. Event 4: halt to the planning and construction of the power plant (1969)

The fourth decision, to halt the planning and construction of the nuclear power plant, was made again by the highest body of the party and the governmental authorities. They decided in January 1970 to postpone the construction of the nuclear power station for several years. This very fact shows that after the mid-1960s the Hungarian regime had departed from the previous Stalinist rigidity and became more flexible, accepting elements of market-driven decision-making and considering various stakeholder interests. From this period of the Brezhnev era, negotiation and bargaining became particularly important activities in economics and politics, both domestically and internationally. We see that in a note provided at that time to Soviet authorities, reference is made to a reappraisal of the coming energy needs of the country in the period of the next five year plan, casting the need for the nuclear plant in enough doubt that planning for it was halted. Considering that no definite time for restarting the project (the note alludes only vaguely to sometime in the 1980s), the step represented by the note can be considered a de facto cancellation of the original agreement—and it was, in fact, accepted by the Soviets.

3.5. Event 5: definitive restart to the construction of the power plant (1973)

The final and last decision in this brief historical review—the decision to resume planning and construction of the nuclear plant—was made definitively in 1975. The reconsideration of the 1970 decision to halt construction began in the spring of 1972. Hungarian energy experts' consultation with their Soviet analogues concerning the fifth Five-Year Plan led to a return to the view that nuclear energy would become indispensable. Speculation that oil prices would rise was soon met with the hard reality of just that. Hungarian Prime Minister Jenő Fock signed the final document in April 1975. All the decisive elements of the construction were agreed to and described by this time.

To summarize: in the Hungarian case, arguments both for and against nuclear power were framed in economic terms. .

3.6. A word about the present

In the last few years, nuclear energy has occupied the center of Hungarian national politics for the first time in history. In 2012 the Hungarian government decided to build new blocks in Paks, called Paks II. They reached an agreement with Russia. Neither the technological nor the economic arguments are published. The opposition heatedly attacks the agreement because the details of the contract are as unknown as the justification of the project. The European Union has launched an investigation of the contract as to whether it meets the European legal requirements. The Hungarian opposition suspects corruption and also criticizes the present government's possible commitment to Putin's Russia.

So, by now, more than half a century after Hungary's first nuclear reactor, nuclear energy has come to the fore of both civil life and party politics.

4. Facts & Figures

The purpose of this section is to give an overview of nuclear power in Hungary. This section contains such data as number of reactors, reactors' locations, technical and chronological details of reactors' construction as well as statistics on electricity production, periodization and social connections to nuclear constructions. This data can be used as a supportive material to the following sections of the country report and in order to understand the overall country's situation. Key dates and abbreviations used in this report are presented in the beginning of this section.

The authors would like to thank Aisulu Harjula (Lappeenranta University of Technology) for her valuable contribution in the preparation of this section.

4.1. Data summary

- Four nuclear reactors are operating in Hungary, they generate about 1/3 of total electricity production in the country.
- The government of Hungary is at present strongly for nuclear power development and building of two more NPPs..

4.2. Key dates and abbreviations

Key dates:

1950	Establishment of the ERŐTERV ('powerplan') office for design of powerplants
1955	After several years of prospection, uranium mine opened near Pécs
1955	Establishment of the OAB (*Országos Atomenergia Bizottság*—the National Commission of Atomic Energy)
1955	Agreement reached with the USSR to construct research reactor
1959	Research reactor goes critical
1964	Upgrade in uranium mining industry to a higher refining capacity
1966	Agreement with Soviet Union to build a nuclear power station
1967	Paks site was chosen for the first NPP, 100 km south of Budapest
1969	Hungary became a party to the Nuclear Non-Proliferation Treaty (NPT)

1969	Halt to planning and construction of nuclear power station
1973	Definitive resumption of construction of nuclear power station
1976	Paks Nuclear Power Plant Ltd established, to operate the future power station
1982	First electricity-producing VVER (PWR) reactor goes critical at Paks
1987	Last of the four reactors at Paks goes critical, bringing the total output of the station to over 1800MWe
1980s	Plan to construct two other blocks (two VVER-1000 units), ultimately abandoned
1990	A local referendum in the town of Ofalu rejects a proposal to store nuclear waste there
1996	Democratically elected Hungarian parliament passes legislation (1996/CXVU, Law) on nuclear issues, including nuclear waste management
1997	Hungarian uranium mining operation shut down
2000	Study on extension of operational lifetime of NPP
2000	The Additional Protocol signed in relation to its safeguards agreements with the International Atomic Energy Agency

Abbreviations:

BUTE	The Technical University of Budapest
HAEA	Hungarian Atomic Energy Authority
KFK AEKI	The Atomic Energy Research Institute
Mwe	MegaWatt electrical
MVM	State-owned company Hungarian Electricity Ltd (Magyar Villamos Művek). MVM Paks Nuclear Power Plant Ltd is a subsidiary of MVM.
NPT	Nuclear Non-Proliferation Treaty
OAB	National Atomic Energy Committee
WNA	World Nuclear Organization
BSSR	Belorussian Soviet Socialist Republic
EBRD	European Bank for Reconstruction and Development
EIA	Environmental Impact Assessment

IAEA	International Atomic Energy Agency
IRT	Research nuclear reactor
mSv	Sievert, micro Sievert
MWe	Megawatt electrical
NGO	Non-Governmental Organization
NPP	Nuclear Power Plant
NTPP	Nuclear Thermal Power Plant
RBMK	High-power channel reactor - Chernobyl type (*reaktor bolshoy moshchnosty kanalny)*
Rem	roentgen equivalent man
SredMash	Ministry of Medium Machine Building
USSR	Union of Soviet Socialist Republics
VVER	Water-Water Energetic Reactor
WNA	World Nuclear Association

4.3. Map of nuclear power plants

Figure 1 - Nuclear power plants in Hungary. Source: WNA 2016.

Figure 2 - All nuclear sites in Hungary.

List of sites in Hungarian nuclear history

Number on map	Location name	Significance
1	Paks	Site of 4-block Hungarian nuclear powerplant.
2	Csillebérc	Site of Hungary's 10MWe research reactor, operated by the Central
3.	BME	Site of Hungary's 150kWe training reactor.
4.	Kővágószőlös	Site of Hungary's principal uranium deposit, mined along with others in the immediate area until 1997.
5.	Solymár	Site of first repository of waste generated by the KFKI research reactor.
6.	Püspökszilágy	Site of second repository of waste generated by the KFKI research reactor, as well as other low and intermediate level waste.
7.	Ofalu	Site of 1990 local referendum against creation of nuclear waste depository.
8.	Bátaapáti	Site of the National Radiactive Waste Repository, which opened in 2008.

4.4. List of reactors and technical, chronological details

Tables below shows the list of reactors, suppliers, operators as well as date details.

Table 1 - Operational and projected nuclear power reactors

No	Name	Operator	Supplier	Type	Mwe net	Construction began	Grid power	30-years operations shutdown	Scheduled shutdown
1	**Paks-1**	MVM	Atomenergo-export	VVER-440/V-213	470	1974	1982	2012	2032
2	**Paks-2**	MVM	Atomenergo-export	VVER-440/V-213	473	1974	1984	2014	2034
3	**Paks-3**	MVM	-	VVER-440/V-213	473	1979	1986	2016	2016
4	**Paks-4**	MVM	-	VVER-440/V-213	473	1979	1987	2017	2017

5	**Paks-5**	-	-	AES2006/VVER-1200	1200 (gross)	2018?	2023-2024	-	-
6	**Paks-6**	-	-	AES2006/VVER-1200	1200 (gross)	-	2025	-	-

4.5. Periodization of nuclear developments

The history of nuclear reactors in Hungary comprises a long period of time with very different political regimes. These regimes bring radically different contexts to nuclear history. The most radical change came around 1990, when Hungary went from being in the Soviet sphere, to being part of a cluster of newly democratic states as the Soviet Union collapsed. By that time the electricity-generating nuclear plants were built and in operation. In other words, the four Paks reactors were built and began operation during the latter stages of Socialist-era Hungarian history. What has happened after 1990 can best be described as a kind of epilogue with fewer historical sources and only an emerging historical perspective, something more akin to contemporary daily politics than to history.

Historical periods in Socialist Hungary largely conform to those of the conventional Soviet periodization. Hungary's nuclear energy project began in 1955, during the Khrushchev era (1953-64), yet preserved many features of the preceding Stalinist era (1945-1953). The most decisive years in Hungarian nuclear history came during the Brezhnev era (1964-82).

The periodization of Hungarian nuclear history might be best thought of as follows:

1) Period 1 (1955-1959): planning, construction, and use of a research reactor;
2) Period 2 (1966-1987): planning and construction of the four reactors of Hungary's nuclear power plant;
3) Period 3 (1982-1990): regular operation of the nuclear plant and contribution of its output to the national grid;
4) Period 4 (1990-present): continued regular operation of the nuclear plant in a new political regime, ongoing debate and decision-making concerning construction of new reactors.

5. References

The historical study of nuclear energy in Hungary is barely started. Virtually nothing of a scholarly nature on the topic exists in English. Even in Hungarian, published sources at this point are limited in large part to the recollection of historical actors and historical summaries encouraged by state and parastatal institutions. Archival sources include folders in the National Archives of Hungary, especially in the boxes of the collection of the State Atomic Energy Committee (Országos Atomergia Bizottság, OAB). Outside the National Archives, one finds sources in the Archives of the Hungarian Academy of Science, and the Archives of the IAEA. The present authors also found sources in the Archives of the Foreign Ministry of the Republic of France, and no doubt similar sources can be found in the archives of other European countries.

As for memoirs that provide insight into the development of Hungary's research and training reactors as well as the Paks nuclear power station, one should consult:

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Szabó, Benjamin. *Atom Korkép* [Atomic Portrait] Budapest. Új Platinusz Könyvesház, 2004.

Szabó, Imre. "Az Upponyi- és a Bükk hegységi sugárzóanyag-kutatások története" [The history of radioactive substance research in the Uppony and Bükk hills]. *Érckutatások Magyarországon a 20 században*. (Sándor Szakáll and Gusztáv Morvai, eds). Miskolc—Rudabanya. 2002: 217-234.

WP2

Italy

Short Country Report

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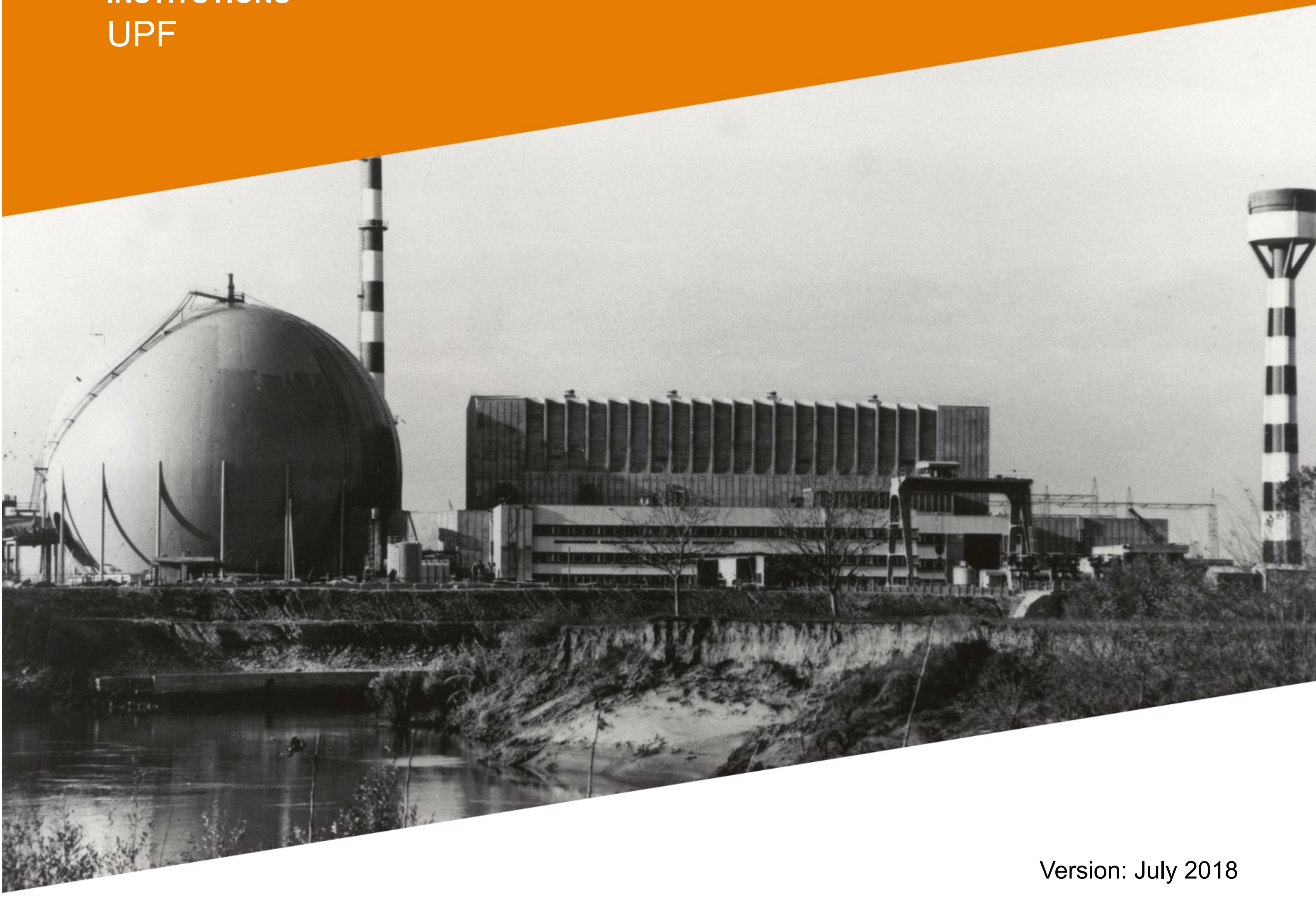

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HoNESt History of Nuclear Energy and Society

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EXECUTIVE SUMMARY

This report belongs to a collection of 21 short country reports on the History of Nuclear Energy and Society (HoNESt, project Ref.662268). The reports tackle the complex sociotechnical system around nuclear energy. Nuclear developments, notably nuclear energy, are closely intertwined with social, economic, environmental, political and cultural spheres. Nuclear energy is also a globalized system involving transnational transfers of knowledge, materials, technologies, people and products including electrical power, medical elements, toxic wastes and other environmental hazards, materials, capacities and knowledge that must be carefully safeguarded. Nuclear energy is a complex social and technological phenomenon that influences societies but is also shaped by societies.

The short country reports are designed to assemble information and research results on the history of the relations between nuclear energy and society about all the different country cases in an accessible manner, and to document the findings with references.

The purpose of the country reports is threefold, addressing three different audiences:

1. to provide basic elements of narrative and analysis for further historical research by HoNESt researchers,

2. to provide information, context and background for further analysis for HoNESt's social science researchers,

3. to provide accessible information on nuclear-societal relations in the various countries for the purposes of outreach and communication with stakeholders (civil society, industry, associations, policy makers, journalists).

This report focuses on the history of the relations between nuclear energy and society in Italy. The main findings are the large investments in the nuclear sector by the oligopoly of power production and by the State before the nationalization of electric power, among the biggest in the world; the flexion on the investment after the nationalization, because of the costs on the public utility of the expropriation of private companies; the development of an Italian prototype reactor as a national kind of power reactor; the political parties unwillingness as a cause of the dropping out of nuclear energy by the Italian system.

1. Historical context (narrative)

1.1. Introduction to the historical context

In Italy the course of nuclear energy started under the Fascist regime, and then stepped across the war and the reconstruction, finally following the changes occurring during the long post-war period, until the so-called second Cold War. The search for an Italian nuclear weaponry finally ceased when Italy adhered to the treaty for non-proliferation, signed on January 28, 1969, and ratified on May 2, 1975. All the electronuclear projects faded away in a public debate where the promoters of nuclear energy ended up being a minority, as a result of the referendum that took place on November 8 and 9, 1987. The same position was confirmed in the 2011 referendum on the same subject.

The context within which the Italian nuclear history was set includes, at its early beginning, the solid school of nuclear scientists founded by Enrico Fermi, strongly colliding with Fascism after the promulgation of the racial laws in 1938. In the perspective of the world history of nuclear energy, these outstanding scientists marked the application of the discoveries of nuclear physics and the debate that followed. In 1945, the war over, Italy experienced the deepest transformation in its history, marked by the end of the monarchy and the ensuing Republic, decided after the institutional referendum of June 2, 1946. The Italian economy was obviously at its lowest, and the political parties, lifeblood of the new Republic, had the overriding task of reconstructing the nation.

The political choice for the reconstruction was a problem involving the international system within which the new republic was to find its position. The debate on the participation in the European Recovery Program (ERP), launched by the United States in 1947, was part of the strategy of alignment in the Western domain carried out by the pro-tempore head of State, the Christian Democrat Alcide De Gasperi, against the left and the neutralist components of De Gasperi's party. In April 1948, the first election in the republic marked the victory of the Christian Democrats over Socialists and Communists, thus speeding up the process that found its crucial moment in the adherence of the Republic of Italy to the North Atlantic Treaty Organization in 1949. Christian Democrats remained the governing party during the whole so-called First Republic, at first by itself, and later flanked by other parties in several coalitions.

The potentials of nuclear energy fell within the process of reconstruction of the country in the frame of the western block: those were the years when electronuclear production was considered a promising supplement to traditional energy providers. Investing in this sector mirrored the historical question of the lack of coal resources that had forced the Italian industry to tap the hydroelectric production instead of coal, which had to be purchased from abroad. Likewise, although the *Ente Nazionale Idrocarburi* (ENI) [National Hydrocarbon Company] was carrying out a courageous policy with the countries producing oil, electronuclear production seemed to offer a higher degree of autonomy. On the other hand, the military applications of nuclear energy were especially enticing but hard to reach for part of the armed forces and for the government. Technical limits as well as problems linked to the reconstruction of the defence after the defeat, prevented Italy from acquiring nuclear weaponry. Completely rebuilt in the frame of the Atlantic Treaty, the Italian armed forces followed the lead of the government in supporting the non-proliferation policy of the United States, also favoured by the Italian nuclear scientists, by a significant part of the public opinion, and by the left in particular.

Both Socialists and Communists would have favoured the development of the electronuclear program in Italy, although the general political and economic frame in Italy trusted the large electric companies that had first brought electricity to the country. Conversely, the right parties considered the Italian nuclear program as one of the items on the list of the country's energy requirements, without necessarily being more important than other projects of industrial development. Christian Democrats kept an unprejudiced attitude towards the question.

At first, the private sector, led by the main electric companies, fostered electronuclear programs. Later, the public sector started to carve out a role similar to the other countries' that had started a nuclear program, in a process that intertwined with the debate over the nationalization of electric power. When Law No. 933 of August 11, 1960 created the body called *Comitato Nazionale per l'Energia Nucleare* (CNEN) [National Committee for Nuclear Energy], corresponding to the commissions for nuclear energy in the other countries of the western block, Italy was on the eve of the endorsement of the law nationalizing electric energy, approved in November 1962 by the first centre-left government.

The life of the new nuclear body was very hard; to begin with, a scandal hit its management in 1964 when the secretary Felice Ippolito was arrested, and in the later years it never reached the apical role on the great decisions relevant to the development of nuclear energy in Italy. Therefore, in the following period governed by the centre left, this time with the participation of the Socialists, Italian nuclear programs could hardly be connected to an underlying political strategy. The trend remained steady well beyond the crisis of the centre-left, reaching the five-party coalition government period, the so called *pentapartito*, started in 1981 with the further scaling down of the weight of the Christian Democrats who renounced the chairmanship of the Council of Ministers. Nevertheless, those were the years when the Italian nuclear system, despite its polymorphism, carried out significant improvements: to name one, the international cooperation in the field of breeder reactors.

When the conservation movements of the 1980's formed an alliance with the peace movements that marked the crisis of the Euromissiles, a significant moment in the so-called Second Cold War, the public opinion was already pondering a final shift towards positions opposing the electronuclear development. The nuclear accident at Chernobyl completed the picture, and when the following year a referendum on nuclear energy was held, the majority voted for the abrogation of the regulations that allowed the development of the sector. The government interpreted this shift as the end of the whole electronuclear department, thus influencing also the research in the nuclear field.

The following year that in 1992-94 brought to the uncertain end of the first republic, never resumed the debate whether or not it was worthwhile going back to electronuclear production, until the fourth government chaired by Silvio Berlusconi, first Prime Minister of the post-party system, which reintroduced some elements of energy planning aiming at reinstating the sector. A second referendum held on June 12-13, 2011, abrogated the government decrees, leaving the situation unaltered until now.

1.2. Contextual narrative

Origins of the nuclear applied sciences in Italy

The historical premises of the civil nuclear programs in Italy may be traced back in the creation of nuclear physics in 1926 when the young, brilliant physicist Enrico Fermi was appointed with the first chair of theoretical physics at the Sapienza University in Rome. A former student at the Scuola Normale in Pisa and a Free Mason, Fermi created a group of brilliant researchers who provided a crucial contribution to the foundation of nuclear physics. Although Fermi had been appointed member of the Royal Academy by Benito Mussolini, in 1938 the fascist regime denied the funds required for the research, promulgating at the same time racial laws, therefore Fermi had to take a long-pondered decision: his wife Laura Capon was Jewish and the family had to flee abroad. The opportunity arose when the scientist was awarded the Nobel Prize in 1938: from Stockholm, they reached the United States and Fermi started working in American laboratories, developing the first nuclear pile, which offered a pivotal contribution to the Manhattan project which would later create the nuclear bomb. (Paoloni 2009: 14-22; Battimelli, De Maria 1997: 63)

The news of the Hiroshima bombing stirred up the already lively debate in Italy on the use of the enormous energy freed by the fission of the core. (Severini, 1941) In Milan, on December 19, 1946, the private company *Centro Informazioni Studi Esperienze* (CISE) [Research and Experimentation Information Centre], was created by a group of technicians and scientists coming from the Academy and from the largest Italian company of electric power, Edison. (Zaninelli, 1996: passim) The engineer Vittorio De Biasi, managing director of Edison, had charged the young engineer Mario Silvestri with the nuclear program with Giorgio Bolla, professor of physics at the University of Milan, and his assistants Giorgio Salvini and Carlo Salvetti. They were supported by Edoardo Amaldi, who had been a student with Fermi; the latter had stayed in Italy during the war and was the main Italian nuclear physicist of the post-war period: he had successfully gathered the top Italian industrial groups such as *Fabbrica italiana automobili Torino* (FIAT) [Italian cars factory of Turin], Cogne, Montecatini, and *Società adriatica di elettricità* (SADE) [Adriatic electric company], as funders. (Silvestri, 1968:42-67) Led by Bolla, they went to Paris where the peace treaty with Italy was being negotiated, to obtain from Alcide De Gasperi reassurances on the absence of clauses that would deny Italy the opportunity to use nuclear energy for civil purposes. From 1946 to 1952, CISE promoted an autonomous three-fold nuclear program for Italy. The first step would be the creation of a group of experts, the second the making of a zero-power pile similar to the one Fermi built in Chicago; and the third step was the building of a 10MW heavy-water national reactor, entirely designed by Italy, powered by natural uranium. (Amaldi, 1979: 186-225)

To support the research on nuclear physics, in 1949 the mathematician and engineer Gustavo Colonnetti, president of the *Consiglio nazionale delle ricerche* (CNR) [National Council for Research], wrote to De Gasperi asking for an increase in the resources destined to this sector. Through Amaldi, Colonnetti obtained Fermi's interest and after the elections of April 18, the latter wrote to De Gasperi guaranteeing the value of the results promised by the studies on nuclear physics. (Battimelli, 2003)

In 1949, the concerted pressures of the nuclear physicists and the industrialists of CISE finally started affecting the government, which planned an Italian centre for atomic studies funded by the government and the involved industrial groups such as the arms industry Terni, which suggested to CISE an agreement with the ministry of defence and the army to promote civil nuclear research. CISE was wary of the entrance of the army in the electronuclear research when in March 1950 the Ministry of Defence called the Ministers of Education, Industry and Commerce, and International Commerce to create a commission that would deal with problems relevant to atomic energy. The initiative was not backed up by Amaldi, who was acting upon the advice of the Minister of Industry Mario Alberto Rollier, both active supporters of the European Federalist Movement. But although the clash between nuclear physicists and the army arose, they were able to reach an agreement with CISE in October 1950. Nevertheless, the army's plans were subject to the evolution of the NATO, to which Italy had adhered in 1949. (Nuti, 2007:53-70)

At the end of 1951 CISE had reached a significant target, realizing a pilot plant for the production of heavy water by electrolysis, and an experimental plant for uranium metallurgy. Its laboratories, equipped with state-of-the-art electronic instruments, had taken noteworthy steps towards the fission of uranium, but the most significant ones had been reached in the training of qualified personnel: the CISE laboratories trained the experts who would play a central role in the Italian research in the nuclear field in later years. (Zaninelli, 1996: 43-88) That year saw substantial stepping stones: the funds Colonnetti had required in 1948 were granted; the budget allocated for CNR was doubles; most of the resources were invested in the basic nuclear physics; and

INFN, national institute for nuclear physics was created, with the task of coordinating the CNR branches dealing with nuclear research. (Battimelli, De Maria, Paoloni, 2001: passim)

On June 26, 1952, a decree constituted the *Comitato nazionale ricerche nucleari* (CNRN) [national committee for nuclear research], and the State entered the nuclear scenario. The body had no legal personality of its own; it was a mere counsellor for CNR although it was not subject to it, under its direct relation with the Ministry of Industry. The Board included Francesco Giordani, president of CNRN and professor of electrochemistry at the University of Naples; the secretary Felice Ippolito, professor of applied geology in the same university; and Amaldi, a member of the committee. (Curli, 2000:32-4) Most of the dedicated literature acknowledges the conflict between CISE and CNRN, which ended favouring the state committee in 1955, when a public finance company formed by the *Istituto per la ricostruzione industriale* (IRI) [Institute of Industrial Reconstruction] and the Municipality of Milan, acquired 50% of the shares. From 1939 to 1943, Giordani had chaired IRI, the public body of fascist industrial politics, later prime subject of the economic intervention of the state in the years of the first republic. (Castronovo, 2012: passim)

In Paris, in July 1953, an Italian delegation participated in a meeting with other representatives of the European countries to discuss the common interest in creating a European nuclear body, under the acronym of EURATOM. In its activity in the emerging process of European integration, CNRN started favouring the acquisition of US technology, due to the new attitude the US had shown towards the access to information relevant to civil use of nuclear energy. The change was marked by the speech the President of the United States, Dwight Dee Eisenhower gave at the UN on December 8, 1953, where he introduced the Atoms for Peace projects, creating a market for the US nuclear industry, a market that was already enticing to the Italian industrialists. In 1955 CNRN promoted a cooperation agreement between the US and Italy including the following: 1) Italy would buy a supply of heavy water; 2) Italy would also buy the first power reactor as pilot plant; 3) the building of industrial-scale plants, made cheaper by the expensive power of the Italian market and the lack of resources of the production of electric power. The CISE researchers felt that with its choice, CNRN was giving up the development of the national reactor, although the strategy of CNRN was in fact the same pursued by the other nations defeated in WWII, namely Germany and Japan, who entered in similar agreements with the United States. We must read the choice made by CNRN within the context of 1955, marked by the UN great conference on atomic energy in Geneva, when the Soviet Union was the only nation with a running power reactor. At the time, it was acceptable for a country with the industrial structure Italy had, to want to seize the opportunity offered by the other superpower. Nevertheless, the United States did not find appropriate to sell a reactor similar to the one still under construction in Rowe, Massachusetts, to a nation that did not possess a running experimental reactor. (Paoloni, 1992: 5-43)

While the negotiations were still under way in December 1955, Edison created the *Società elettronucleare italiana* (SELNI) [Italian Electronuclear Society], with other public and private companies and manufacturing companies from the centre and north of Italy, aiming at building their own power reactor. Again, this initiative started by the largest private power company, turned to the US market, evaluating the following year the offers made by Westinghouse and General Electric. Those months were critical for the supporters of nuclear power in Italy: in April 1956 the public companies owned by Finelettrica and controlled by IRI left SELNI; from the end of 1955 to July 1956 CNRN negotiated with CISE for the installation and the running of a research reactor purchased from the American Machine and Foundry, similar to the CP-5 of the Argonne Laboratories, to be built in Ispra, on the shores of Lake Maggiore. Once the contracts had been approved, Giordani left the chairmanship of CNRN: the committee had suffered severe losses and was a focal point of clash between those who wanted to strengthen it, and those who wanted to downscale it, as it was a significant piece in the checkerboard of the debate on the nationalization of electric power, progressively unrelenting in those years. Ippolito was charged with the administration, while waiting for a new decision of the government on the nature of CNRN, which occurred on August 14, 1956. (Curli, 2000:43-4) CNRN became an organization with autonomous headquarters and hired personnel, chaired by Basilio Focaccia, professor of electrotechnology at the University of Rome. Italy was accepting all the safeguard clauses provided for by the USA, as the International Agency of Atomic Energy (IAEA) did not have its own at the time. Very active in Europe as well, they invested quite some energy in the creating of EURATOM, whose founding treaty was developed in a technical conference in Venice in May 1956, signed in Rome in March 1956 together with the treaty of the European Economic Community.

Nuclear power in Italy at the height of the electric oligopoly

The Suez crisis in 1956, occurred between the conference in Venice and the signing of the treaty, had some relations with the Italian nuclear power matter. The Egyptian nationalist government had asked the World Bank for a loan to build a second dam on the Nile, but the funds were denied, and in retaliation Egypt nationalized the canal; the ensuing war witnessed Egypt loose against Israel, Great Britain and France. Although the coalition was soon to be politically defeated, the canal was closed from October 1956 to March 1957, complicating matters for the oil tankers traveling from the Gulf to the European countries, therefore showing the frailness of the supplying pipes for the electro-production of fuel. The Italian government had presented a project to build a power reactor in the South of Italy, competing with the Egyptian one.

In December 1956 SELNI opted for Westinghouse's offer, for an enriched-uranium pressurized water reactor. Its initial 134-MW power would be destined to increase several times to reach 270, since before the agreement was signed, long institutional and technical steps needed to be taken. The main hindrances were the scouting of the site and finding the funds to build it. SELNI had asked for a loan to Eximbank, which would have granted it through *Istituto mobiliare italiano* (IMI) [Italian Real Estate Institute], a public bank that had run the funding of ERP. Nevertheless, Eximbank demanded a guarantee against the floating of the Lira-Dollar exchange, and IMI asked the Italian government to provide that. The fund was stalemated because the governor of the Bank of Italy, the Minister of the treasury budget and Economic Planning, and other bodies, including CNRN, did not favour the proposal. Therefore, although SELNI had been the first to plan the choice of the reactor, it was not the first to implement it. (De paoli in Castronovo, 1994: 109-142) During that same year, FIAT and Montecatini had founded the *Società ricerche impianti nucleari* [Society for research on nuclear plants] (SORIN), that owned a research centre in Saluggia, in the province of Vercelli, where they were planning to carry out a large industrial investment using American technology. In March 1957 the companies that had left SELNI, with other companies controlled by IRI, founded the *Società elettronucleare nazionale* (SENN) [National Electronuclear Society], with the aim of building a power reactor in the South of Italy. As the economic backwardness of Southern Italy had been a critical element in the economic history of Italy since the creation of the Kingdom of Italy in 1861, the purpose of a public intervention for the development of the south was obviously contrasting the private initiative of the industrialized North. In the same month, the state-owned *Ente nazionale idrocarburi* (ENI) [National Hydrocarbon Trust], main economic subject of the oil sector, participated in the project. Only seemingly in the wake of the Suez crisis, but actually with a much more complex strategic choice, ENI created the *Società italiana meridionale per l'energia atomica* (SIMEA) [Southern Italian Society for Atomic Energy] through AGIP Nucleare under its control and one fourth of stakes of IRI. In London in May that same year, Enrico Mattei, president of ENI, met the representatives of the British nuclear industry, checking the assessments of the offers for the reactor that SIMEA would soon build, therefore opting for the British technology and thus for the natural-uranium graphite moderator. (Rigano, 2002: 11-21)

At the instance of the Ministry of Industry, in June 1957 CNRN advised for the SELNI project; nevertheless, the consent recommended that the Italian government should subject its approval to a safety plan and a feasibility study of the site provided by SELNI. And it was exactly the choice of the site that made the decision hard: the site of Trino Vercellese, in Piedmont was chosen only in 1960. (Paoloni, 2009: 70)

Finding sites for the state-owned companies promoting nuclear plants, and realizing them, was an easier task. In July 1957 the World Bank drew up an agreement with the Italian government to build a nuclear plant in Southern Italy; its funding would occur through a loan of the World Bank to the Cassa del Mezzogiorno, a public body created in 1950 to fund infrastructural works in the South of the nation. The project was called *Energia nucleare sud Italia* [Southern Italy Nuclear Energy] (ENSI), and it was the first feasibility study to build a nuclear plant in the South of Italy carried out by CNRN and the BIRS experts; SENN obtained the task to build the plant. (Rigano, 2002: 21-40)

The final showdown between the public and private sectors in the Italian nuclear programs occurred in the following months, marked in September 1957 by the breach between CISE and CNRN regarding the agreement for the site in Ispra. Increasingly dominated by Ippolito, CNRN had acquired the personnel it lacked before, despite the fact that it did not have legal status and had to act through the NUCLIT corporation. The CNRN technicians, who had started flanking those of CISE, started clashing with the management of the site, and CNRN had NUCLIT hire CISE technicians. CNRN thus became the main subject of the Italian nuclear programs, asserting itself not only in the private sector, but also over ENI, thus solving the internecine conflict within the government about nuclear energy. (Paoloni, 2009: 67-68) As a reaction to SIMEA's choice on the offer of the British Nuclear power plant company (NPCC), SENN addressed exclusively the US market. CNRN approved the SIMEA project only in June 1958, and in October that same year in the province of Latina, the building of the SIMEA plant started: the plant was to house the 200-MW reactor Magnox. (Elli, 2011: passim)

During 1957 CISE designed the *CISE reattore a nebbia* (CIRENE) [CISE fog reactor] project, a prototype of a heavy-water natural-uranium reactor and refrigerated with light water resulting in steam during the shifting phase, hence the name fog. The project was funded by EURATOM, and later entrusted *Ansaldo meccanico nucleare* (ANM) [Ansaldo nuclear mechanic]; the entire operation would be carried out in Italy, thus meeting CISE's crucial target.

In September 1958 SENN chose General Electric's offer for a 160-MW boiling water reactor fuelled with enriched uranium. The construction started more than a year later in the Garigliano area in the province of Caserta. And it was only in July 1961 that the construction of SELNI reactor started.

The peculiarity of these investments that were supposed to include Italy among the countries with the largest installed power, was the difference between the systems of the three reactors. The historical and political opinions on this unique situation are not even. On the one hand, there is the dispute on the diseconomy that the three different systems entailed, enhanced by the fact that two reactors belonged to the state industry, and the third one belonged to private and public shareholding. Moreover, the two state-owned reactors were very close to each other, which made the project to develop southern Italy debatable, and a sign of the lack of coordination of the government in the strategic sector, and the inadequate power CNRN had in determining political choices. (Lombardi in Zanetti, 1996: 589-644) On the other hand, once the three kinds had been experimented there was the opportunity to choose where investments should go, as in those years, there was no previous experience in the functioning of the reactors. Also, according to

CNRN, the three different systems would allow the training of Italian technicians who would thus be able to manage directly all the main reactors the market was offering. (Paoloni 2009: 73)

At the end of 1957, CNRN joined all the works of its commission in a white paper that was supposed to be the basis for a much sought-after 5-year development plan of the Italian nuclear power. The paper included the building of a large particle accelerator in Frascati, in the province of Rome, entrusted to INFN. The committee had started working on a national research centre in Lazio that would not be a copy of the one in Ispra, as the project of the latter had changed. To understand the changed strategy in Ispra we need to take into consideration other elements: once the personnel were trained, CNRN's next target was to create industrial capacities able to build all the parts needed in nuclear plants directly in Italy. This national industrial strategy matched the strategy that hoped to acquire the competences to manage and control the cycle of nuclear fuel. Therefore, a project to build another prototype of national power reactor was launched. CNRN chose an even more innovative system, an enriched uranium reactor moderated and cooled with a mixture of dyphenil and terphenyl, therefore an organic liquid. The building of this reactor involved all the parties of the Italian nuclear power: ENI, FIAT, and Montecatini, which through SORIN and AGIP nucleare would be contacted by CNRN. The project was named *Progetto reattore organico* (PRO) [Organic Reactor Project], and for the first charge of the reactor it would recourse to the collaboration with Baltimore's Martin Marietta Corporation; another collaboration with the US for the PRO was addressed to Atomic International, which was working on a similar plant. The following fuel charges would be produced in Italy, relying on the successful progress of the various projects in the sectors of fuel cycles the Italian parties were participating in. Both CNRN and SORIN were members of the Eurochemic, created under the initiative of the Agency for atomic energy (NEA) of the OECD, which had created a plant for isotropic separation in Mol, Belgium. (Lombardi in Zanetti, 1994: 589-644) CNRN gave the research reactor located in Ispra, called Ispra-1 and finished in March 1959, to EURATOM; the latter had its first real address there, as it started the Joint nuclear research centre, it operational site, right there. The donation marked Italy's large share of participation in the European plan: it was met by protests in Italy but it was also CNRN's not merely political investment towards the European nuclear integration: as a matter of fact, EURATOM immediately started the project called *Organique Eau Lourde* (ORGEL) to build two prototype heavy-water reactors cooled with organic liquid that were supposed to simplify the Italian system of PRO. (Geiss, 2011:17-22; 40-5) The first reactor was the ORGEL critical experiment (ECO), whose building started in 1962; the following year the building of the second reactor, *Essai ORGEL* (ESSOR), was entrusted to a pool gathering the *Groupement Atomique Alsacienne Atlantique* (GAAA), the German Interatom and the Italian Montecatini. (Leny, Orlowski, 1971: 27-31)

In November 1959 CNRN invested in researches on the Uranium-Thorium cycle in a project later named *Programma ciclo Uranio-Torio* (PCUT) [Uranium-Thorium cycle program], perfected with the research in reprocessing, for which the building of the pilot plant Enriched Uranium Extraction (EUREX) in Saluggia, in the province of Vercelli, was arranged. The building of EUREX started only in 1965, when Eurochemic expanded its action to fuel reprocessing, thus depriving EUREX of the purpose of its existence. PRO was abandoned too, in favour of the research in FBRs that led to the project *Prova elementi combustibile* (PEC) [Fuel Element Trial], aiming at building a reactor in the same site as PRO, on lake Brasimone. PCUT was abandoned as well, leaving only PEC and CIRENE as top projects in applied research. (Lombardi in Zanetti, 1994: 589-644)

CNRN had become a public body with a considerable budget and about 1,700 employees; in August 1960 it was converted into the *Comitato nazionale energia nucleare* (CNEN) [National Committee for Nuclear Energy], which took over NUCLIT and the Real Estate Company Ispra. CNEN was chaired by the Minister of Industry and governed by a board of directors. Ippolito was confirmed secretary-general, therefore he was managing an actual body, similar to other nations. Nevertheless, CNEN did not fall within the frame of a nuclear law, which Italy would only approve two years later in a scenario that would prove very different from the earlier Italian nuclear euphoria. (Paoloni, 1992: passim)

The building of the SELNI plant in Trino Vercellese finally began in July 1961: the first plant to have been planned was in fact the last one to be built.

The nuclear power in Italy after the nationalization of electric power

The notion that electric power could be nationalized took shape in that period. Besides the mere opponents of the nationalization, the debate and the clash were heating up also within the promoters of the nationalization, regarding the measure of the control the state would have over it. Amintore Fanfani, the Christian Democrat premier and promoter of the nationalization, suggested the creation of a national electric body connected with ENI. IRI opposed this idea because its subsidiary company Finelettrica was already significantly involved in the Italian power industry. The Christian Democrat economist Pasquale Saraceno claimed that Finelettrica would have purchased the private power companies, placing them under public control. The option of creating an autonomous body prevailed instead: the body would not be subject to ENI, and it would expropriate the private electric companies, compensating their owners. The *Ente nazionale energia elettrica* (ENEL) [National Trust for Electric Power] was created on July 26, 1962; the body expropriated and compensated the power companies with more economic advantages than IRI would offer, and therefore larger mortgage for the new body. (Castronovo, 2012: 281-297) The engineer Arnaldo Maria Angelini, president of Finelettrica, and vice-president of CNEN, was appointed CEO of ENEL, while also Felice Ippolito would participate in the management of the new body.

In October that same year, Enrico Mattei, CEO of ENI, died in a plane crash and the role of the company was limited and dimensioned. (Colitti, 1979: passim)

Once electric power was nationalized, the parliament was able to work on the nuclear law that was quickly approved in December 1962. The law on the civil use of nuclear energy defined CNEN's field of action, applied and fundamental research, and the controls on the nuclear plants, integrating the law of the nationalization of power in the allotment of competences relevant to nuclear power. CNEN was given the task of developing applied research on every type of reactor and all the activities connected to research. It was also in charge of reactor safety, and expressed previous and binding opinions on the projects and location of future reactors. ENEL would instead develop electronuclear production deciding the building of new plants, assessing industrial offers and signing contracts for plants and fuel; moreover, ENEL was in charge of the functioning of the reactors. As a matter of fact, with the nationalization, ENEL took over both the private shares of the reactors still under way, and the management of public-owned power reactors.

At the end of that same month, SIMEA reactor went critical: the Magnox reactor in the plant in Latina was the first reactor activated in Italy; it came from the one in Bradwell-on-Sea, in England. The first parallel connection occurred in May 1963; in December that year it reached full power, and in January 1964 it started its commercial production. The electrode Rome-Latina-Garigliano-Napoli, linking the two metropolis to the axis of the two nuclear plants, had been built the year before by the ENI-IRI holding. The reactor of the SENN plant of Garigliano, built following the model of the Dresden plant in Illinois, went critical in June 1963, and its commercial production started in May 1964. The following month the reactor in SELNI plant in Trino Vercellese went critical, and the first parallel connection occurred in October, while the commercial production started in December 1965. The reactor prototype was the same as the Yankee plant in Rowe, Massachusetts. (Lombardi in Zanetti, 1994: 589-644) All the private companies participating in SELNI had been nationalized, and in actual facts, also CISE. The difference between SELNI and the other nationalized companies was the fact that *Electricité de France* (EDF), a foreign public body, participated in the company. The French power body was interested in learning to manage a 270-MW PWR reactor. As a matter of fact, the reactor in Trino Vercellese was one of the most powerful in the world and the most competitive among the Italian reactors. (Paoloni, 2009: 93-100)

In August 1963 the Social-Democrat Giuseppe Saragat started his press campaign against the management of CNEN and against the significant funding dedicated to the electronuclear sector. The attack concentrated on Ippolito and his allegedly bad management of the funds. The press appreciative of private industry supported the campaign, while the left party press defended Ippolito. The Christian-Democrats split in two, possibly because of the clash between, two different understandings of the centre-left, and therefore of nationalizations, as Saragat claimed in an interview in the same month. Presumptions of guilt surfaced against Ippolito connected both with the management of CNEN and with the companies linked to his family, which brought Ippolito's lawyers to intervene with due caution. His participation in the management of ENEL was questioned first, then his position as secretary at CNEN, from which he was suspended at the end of August that year. In the month of September, the public prosecutor of Rome took legal proceedings against Ippolito, who was suspended immediately from his position at ENEL. (Curli, 2000: 91-105) The investigation strongly downsized CNEN's leeway in the decisive moment for nuclear power in Italy, in particular in planning future investments. Italy was at the height of the debate on the competitiveness of nuclear power, whose cost per KWh was much higher than hydrocarbon thermoelectricity, against which Ippolito was suggesting a substantial project of public investment in the sector. His suggestion contrasted with ENEL budget problems, as it had to remunerate the compensation for the oligopolistic companies expropriated; therefore, both because of the CNEN crisis and the management of the nationalization, the investments in the nuclear sector were not economically adequate to its competitiveness. (Castonovo, Paoloni, 2012: passim)

The US nuclear reactors of Garigliano and Trino Vercellese were the ones who posed more functional problems. Trino underwent two long interruptions, while Garigliano was definitively closed down in 1981. The Magnox did not undergo significant interruptions, but due to the corrosion of several part of the reactor, its power decreased by 20%. Both the interruptions and the power losses affected negatively the competitiveness of electronuclear production against hydrocarbon thermoelectricity. We must consider the economy coming from the state electric monopole, completely realized in 1966, which gave to the electric body an installed nuclear power of over 600 MW; this had allowed Italy to become the third nation in the world in terms of electronuclear production, at least during the Geneva conference on nuclear energy in 1964. (Paoloni, 2009: passim)

In March of the same year the investigations ended, and Ippolito was arrested and committed for trial; the Italian and foreign press disapproved the investigative magistrate's attitude, and the sentence to 11 years issued at the end of the process was considered excessive by most. Ippolito filed an appeal and was actually released in 1968. (Curli, 2000:107)

In 1967, ten years after its drafting, CIRENE found its physical address in the Latina site where the Magnox was located, a 130-MW prototype. According to some sources, Italy became competitive in the sector of electronuclear power in that same year, on the basis of the increase of orders for nuclear plants in the United States after the black-out that paralyzed New York in 1966. (Lombardi in Zanetti, 1996:589-644) Nevertheless, in the five years after the nationalization, not many projects had been drafted in the nuclear section: the priority for ENEL was to electrify the nation and develop the network. Only in 1967 did ENEL draft the building of a fourth nuclear plant, as part of a large development project in the electronuclear sector, based on the projections of power demand in the future. In 1969 the offers of ANM and of the General electric technical services company (GETSCO) were chosen for the building of a 850-MW boiling water reactor.

The Italian nuclear law allowed the rapid selection of Caorso, in the province of Piacenza, as the location destined to host the plant. In that same period, ENEL was evaluating the building of a fifth plant, but in December 1969 the Court of Audits sent a report to the parliament describing ENEL's indebtedness, which caused the temporary halt of the project. The building in the location of Caorso started in October 1970, and ended in June 1976; the first parallel connection occurred only in May 1978, much later compared to the earlier plants, and the full power and commercialization only in March and April 1980, respectively. The delay was also due to the new safety criteria provided for by the US government in the late 1970's, as they obviously influenced the procedures of the making and charging of the reactor, and therefore on the building of the plants. Still, the project of the fifth plant was resumed during the works for the Caorso plant, after Agelini's decision in April 1972 to involve ENEL in the building of two plants in 1973 and another two in 1974. The call for tender opened in December 1972, and in November of the following year ENEL was able to assess the proposals for a 100-MW plant, to which, upon ENEL's suggestion, a second power unit would be added, built by the winning party, doubling the reactor installed in the same plant. ENEL required a natural uranium and heavy water system, since, like France before, it had decided to abandon the gas-graphite system of the Magnox. The contenders were Westinghouse, General Electric, but most of all Atomic energy of Canada limited, who had built the Canadian deuterium uranium (CANDU) reactor. In February 1973 ENEL had selected all the locations in Italy destined to host the reactors, as evidence of the actual resumption of the project of nuclear development. General Electric obtained the job, as the company was considered more competitive, also because the issues at the Garigliano plant had not fully manifested themselves yet; the US company also obtained the order of what would be the fifth and sixth plants. Paoloni, 2009: 100-8) In December of the same year, the corporation of advanced Italian nuclear reactors NIRA was founded, with ANM holding the majority stake; the latter would build the CIRENE and the PEC. Curli in Castronovo, 2002: 109-42)

From 1969 to 1975 the course of the military nuclear energy in Italy took place with the signing of the non-proliferation treaty in January 1969, added with a protocol of 12 reservations, and eventually ratified six years later, in May 1975. (Nuti, 2007: 287-345)

From the 1973 crisis to nowadays

The oil crisis of 1973 and the economic crisis in Italy led the parliament to grant ENEL the amendment of the utility tariffs and a state guarantee on the obligations issued by the body. For the first time after WWII, inflation, had reached 2-figure numbers, and the 250-billion lira five-year fund did not leave resources for investments adequate to the planning. Nuclear power had nevertheless acquired new popularity due to the decrease in fuel stocks, therefore the project to develop a national reactor was resumed despite the financial straits. From the point of view of the regulations, the parliament approved a law that allowed ENEL to invest in international consortia, thus the Italian utility was able to participate, together with EDF and RWE, in the NERSA, the company that would build the FBR Superphénix reactor, and in the ESK, that was supposed to build the FBR SNR-2 in Germany. In the summer of 1974, AMN received the order to double the fifth and sixth plant, and therefore build a seventh and eight plant. The location of the fifth plant was supposed to be in Molise, and the sixth in Lazio, each with two reactors; to hasten the building paperwork the parliament approved a law in August 1975 simplifying the process, confirming the tool that the State could use against possible objections of the local bodies. In December that same year, for the first time the government issued a document that would mark the path of the Italian energy policy, the *Piano energetico nazionale* (PEN) [National Energy Plan]. Grounded on the estimates of the request for electric power, the document included the possibility to reach the number of 20 1000-MW plants by 1985, the so called “nuclear islands”. (Lombardi in Zanetti, 1996: 589-644)

In June 1976 ENEL and CNEN signed an agreement to build the CIRENE, in a renovated effort to build a national reactor.

In 1977 the parliament approved the arrangement of a project to locate the 8 1000-MW nuclear plants decided by ENEL, and in December the same year the *Comitato interministeriale di programmazione economica* (CIPE) [Interministerial Committee for Economic Programming], amended the PEN, lowering to 6000 MW the electronuclear quote for 1985. The data on the decrease of demand for electric power counted, of course: when Italy was first electrified, the doubling of the demand every 10 years was confirmed by experience, but the 1970’s were different. The Italian nuclear industry was now firmly established and able to meet the needs, but what halted the realization of the nuclear plants was the objection of the local bodies that in the second half of the 1970's stopped the building of the plant in Molise, the nuclear island that was supposed to host the fifth and sixth reactors. The local bodies approved the plant in Alto Lazio, and in particular in the site of Montalto di Castro, although part of the population started opposing it by slowing down the start of the works until 1982. This nuclear island was supposed to have two 982-MW BWR, and would be built by the ANM. (Lombardi in Zanetti, 1996: 589-644) The construction of the CIRENE began in 1980, and finished in 1986; the reactor had attracted the interest of the kingdom of Iran and the governments of Kuwait and Indonesia. The tests started immediately and closed successfully in 1989.

In 1981 the Italian government revised the PEN, this time confirming only three new plants to be built according to a unified nuclear project (PUN) that established the standards for all the new BWR plants. ENEL would order and manage the plants, AGIP nucleare would supply the fuel, ANM would be the main manufacturer and pivot of the industrial consortia gathered for several needs, CNEN-ENEA was in charge of controls and safety. As a matter of fact, in 1982 CNEN was turned into the *Comitato nazionale per la ricerca e lo sviluppo dell'energia nucleare e delle energie alternative* (ENEA) [national committee for research and development of nuclear energy and alternative energies]. In March that same year the reactor of Garigliano was closed down definitively. In November 1986 the reactor in Latina was closed down as well, and the parliament approved the new PEN, providing for the doubling of the reactor in Trino and the installation of another 4000 MW in Veneto, Sicily, Campania and Basilicata. (Paoloni, 2009:118-24)

In the meantime, the anti-nuclear movement of the environmentalists and local communities was now strongly connected to the pacifist movement, against the deployment of the Euro missiles in Italy, a choice that the parliament had voted for in December 1979 but carried out in the mid 1980's. The actual institutional shift of the opponents to nuclear power occurred after the Chernobyl disaster: among the abrogative referenda of November 1987, three were proposed by the Radical Party that promoted the instances of the anti-nuclear movements. The first one asked for the elimination of the prerogative of the CIPE as regarded the location of the plants, should the local bodies fail to reply within the deadlines provided for by the procedure. The second one asked for the abrogation of the compensations to the local bodies that hosted the nuclear or carbon (not hydrocarbon) plants in their territories. He third one asked for ENEL's withdrawal from the participation in international consortia for the building and management of nuclear plants abroad. (Gerlini 2012: passim)

The referenda were successful, and although they basically blocked the location of new plants and ENEL's participation in the FBR project, politicians interpreted them as an exit from the nuclear project. As a matter of fact, the referendum blocked the building of the plant in Montalto di Castro, but in 1988 the government formed by the five parties chaired by the Christian Democrat Giovanni Goria ordered the reopening of the works; nevertheless, the downfall of the government that same year, due to the vote of no confidence of the Socialist party, caused the plant to be converted into a thermoelectric plant in 1989. The CIRENE, technically ready to start working, was kept on hold until 1994, when the government closed the plant. The plant in Trino Vercellese was stopped in July 1990; the last fuel charge was sold in March 1987. (Lombardi in Zanetti, 1996: 589-644) In 1991 ENEA was converted once again; under the same acronym, it changed its name into *Ente per le nuove tecnologie, l'energia e l'ambiente* (ENEA) [Trust for new technologies, energy and environment]. In 1999 all the Italian nuclear plants closed down were forwarded to the public company *Società gestione impianti nucleari* (SOGIN) [Company for the management of nuclear plants]. In 2003 the Italian and Russian governments drew up an agreement to entrust the decommissioning of nuclear submarines to SOGIN. The embarrassing heirloom of a group of reactors under decommissioning seemed to disappear in 2009, with a law that seemed to open to the resumption of the nuclear adventure in Italy and with a subsequent law of 2011 that occurred at the eve of a second referendum called by committees for the environment and the common heritage. Among the questions, only one addressed the abrogation of the chapters of the law relevant to the resumption of nuclear plants, and the opposition won once again. Neither in 1987 nor in 2011 there were significant stances favouring nuclear power, and neither from the mass parties of the First Republic, nor from the lighter parties of the Second Republic. The left parties were mostly against nuclear power in both plebiscites, despite they had favoured it during Ippolito's times, while the right parties were mostly tepidly indifferent.

1.3. Presentation of main actors

CISE: *Centro Informazioni Studi Esperienze* [Research and Experimentation Information Centre], founded in Milan, on December 19, 1946, this private company gathered a group of technicians and scientists coming from the Academy and from the largest Italian company of electric power, Edison. It was financed initially by, other than Edison, *Fabbrica italiana automobili Torino* (FIAT) [Italian cars factory of Turin], Cogne, Montecatini, and *Società adriatica di elettricità* (SADE) [Adriatic electric company].

CNRN: *Comitato nazionale ricerche nucleari* [national committee for nuclear research] The first State's body had no legal personality of its own; it was a mere counsellor for CNR although it was not subject to it, under its direct relation with the Ministry of Industry.

CNEN: *Comitato nazionale energia nucleare* [National Committee for Nuclear Energy], CNRN was converted in CNEN in August 1960. CNEN was chaired by the Minister of Industry and governed by a board of directors. Felice Ippolito was its secretary-general, as it was an actual state body, similar to other nations.

ENEA: *Comitato nazionale per la ricerca e lo sviluppo dell'energia nucleare e delle energie alternative* [national committee for research and development of nuclear energy and alternative energies]. In 1982, CNEN was changed in ENEA, a public body which inherited the former CNEN role more other research fields in alternative energies.

IRI: *Istituto per la ricostruzione industriale* [Institute of Industrial Reconstruction] founded in 1933, wanted by Benito Mussolini and planned by Alberto Beneduce, with the intent to avoid bankruptcy of the main banks and Italian companies and so the collapse of the economy, already suffering by the global crisis that erupted in 1929. After the war, the Institute was the protagonist of the reconstruction and then of the economic miracle.

ENI: *Ente nazionale idrocarburi* [National Hydrocarbon company], founded in 1953 was the State company and the main Italian player for oil and gas. The company invested abroad in oil and gas reserves, as well as in the nuclear sector. It was from the Seventies in charge for nuclear fuel management.

ENEL: *Ente nazionale energia elettrica* [National Trust for Electric Power] was created on July 26, 1962, with the nationalization of electric power. It expropriated and compensated the power companies, becoming the owner of all the Italian nuclear power reactors.

CIPE: *Comitato interministeriale di programmazione economica* [Committee of economic program] was the governmental body established in the 1967 to steer the political economy of the State. It gathers the chief of the government, the ministers of economy, of foreign affairs, of economic development, of agriculture, of infrastructure and transports, of the welfare.

DC: *Democrazia Cristiana* [Christian democratic party] was the majority party of Italian First republic. It was the centrist catholic party which was gathered various groups, sometimes conflicting, of different economic and political attitudes. Also, regarding nuclear power, the party had staunch supporters and cautious opponents.

PCI: *Partito comunista italiano* [Italian communist party] was the main party of the opposition and the biggest of the left parties of the First Republic. Pro nuclear from the Ippolito trial up to the Euromissiles crisis, it moved against the nuclear power for the referendum of 1987 under the pressure of pacifist, ecologist and NIMBY movements.

PSI: *Partito socialista italiano* [Italian socialist party] was the older Italian leftist party. It had various political shifting during the First republic, from the losing popular front with the Communists in the first political elections of 1948, to the two centre-left coalitions with the DC, and to the Five-Party coalitions of the Eighties.

PSDI: *Partito socialdemocratico italiano* [Italian social-democratic party] was a right-wing scission of the PSI, occurred before the 1948 elections. Its leader Giuseppe Saragat, was the main accuser of CNEN chairman Felice Ippolito.

PR: *Partito radicale* [Radical party] was a right-wing scission of the liberal party, which during the years of the protests endorsed the civil rights struggle, as divorce or abortion. It promoted the referendum against nuclear power.

2. Showcase

2.1. The tricolour reactor

The most significant part of the history of Italian nuclear power is undoubtedly the search for a national reactor, which was considered the most advanced technology on the experience gained with the three reactors' types. The technology would allow for a gradual separation of uranium enrichment, and possibly even make up for the shortage of uraniferous resources in the area. Consequently, the researches focused on the control of the fuel cycle, in its various aspects. This brought the Italian nuclear complex to become an international player and not just a technology importer and a client for the largest foreign industry.

The first actual project in chronological order was the CISE *Reattore a Nebbia* (CIRENE) [CISE Mist Reactor]. Since its inception the *Centro informazioni studi esperienze* (CISE) [Centre Information Studies Experiences] had devoted special attention to the use heavy water as a moderator. Obviously, the interest of the CISE for heavy water derived from the possibility to use it for the realization of a natural uranium power reactor. The CIRENE program became a reality with the feasibility study, carried out at the end of the fifties, of a reactor fuelled with natural uranium, moderated by heavy water and cooled by boiling water, i.e. steam and therefore fog, in honour of the Milanese climate. It was at that time a very innovative solution, which preceded similar heavy water research of the Canadians, the British and the Japanese. (Maiocchi in Zaninelli, 1996: 43-88)

The first sponsor of the project CIRENE was EURATOM, and it remained substantially alone for the first part of the sixties, since the *Comitato Nazionale per l'energia atomica* (CNEN) [National Committee for Atomic Energy] did not consider this the first project in which to invest resources to a national reactor, preferring the research on fast breeder reactors (FBRs) and thus on cycle Uranium-Plutonium and Uranium-Thorium, more promising. Therefore, CNEN invested another project of national reactor, the *Prova elementi combustibile* (PEC) [Fuel elements test] project, namely the creation of an FBR at the site of the lake Brasimone, which supplanted the former *Progetto reattore organico* (PRO) [Organic Reactor's Project]. (Silvestri, 1968: 237-54; Ippolito, Simen, 1974: passim)

It is rather difficult to date precisely the circumstances in which the PEC took its final form; instead the bibliographical sources agree mostly in recognizing a progressive co-operation with the French research in the FBR, given the success scored by the *Commissariat à l'Energie Atomique* (CEA) with the entry into operation in 1967 of the first experimental sodium-cooled FBR, RAPSODIE. (Gerlini, 2017: passim) In the same year 1967, the ENEL signed the first agreement with the CNEN for CIRENE project, defining the objective of the program in the construction of a reactor already prototypical, albeit from 40 MW, because in this way would have experienced the chain to an average reactor power. (Lombardi in Zanetti, 1994:589-644)

Both projects progressed slowly, compared to the speed of construction of the three plants already operating in the area, but since 1972 a series of events put things in motion. In the face of a change in the regime of fuel sales by US operators, and after the failure of construction of the EURATOM enrichment, the CNEN and nuclear AGIP participated with 22.5% of shares to the Eurodif consortium, promoted by CEA. The action showed the impatience with the monopoly of the US uranium enrichment complex, even if the subsequent performance of the enriched uranium market crowded-out the consortium Eurodif, whose participation ENEL became uneconomical for Italian needs. (Lombardi in Zanetti, 1994:589-644)

In the same year, the ANM was appointed head of the consortium for the construction of CIRENE in the Latina site. The order process was closed in 1973, a position that was later made structural architecture of the Italian nuclear complex. The acquisition of this position was compensated in 1974 with the sale of the entire ANM sector fuel at the ENI, with the passage of nuclear Manufactures companies (FN) of Bosco Marengo, in the Alessandria area, at AGIP nucleare. The company's fuel nuclear reactors (COREN) FIAT properties, followed suit at this concentration, dealing to FIAT a guarantee of exclusive supply of mechanics of processing plants for fuel elements. In this way the Italian nuclear complex is predisposed to both of the single chain selected from those then present on the market, both innovation and execution of the National reactor. There were not FBR in commerce, French Phénix prototype was commissioned in 1969 and the works for the CIRENE were uninitiated. (Gerlini, 2017: passim; Puri, 1975: passim)

2.2. On the international scene

The ability to invest capital in international consortia the Parliament attributed to ENEL was required to participate in the so-called "pact of the utilities". In December 1973, three big power utilities as ENEL, *Electricité de France* (EDF) and *Rheinischwestfälisches Elektrizitätswerk* (RWE), urged the integration of the European aggregates FBR programs, around the French and the German nuclear complexes. In fact, if the Italians had established cooperation with the French, the Germans had created a similar business combination with the Belgians and the Dutch, with the company *Schnell Brüter Kernkraftwerksgesellschaft mbH* (SBK).

So, the next year were formed two companies: the central *Groupmement nucleaire européenne à neutrons rapides* (NERSA), which would build the Superpénix-1 reactor in Creys-Malville site, and *Europäische Schnell Brüter Kernkraftwerk* (ESK), for the construction SNR-2 reactor in Kalkar site. ENEL held 33% of the shares for both the companies, but it was with the French part of the program that Italian nuclear complex was integrated. In fact in 1974 the CNEN squeezed an agreement with CEA for which he established the PEC testing of elements for Superphénix, thus abandoning not only the purpose of making the PEC the prototype of Italian power reactor, but to have an independent national FBR program. But it would be wrong to consider the choice of the CNEN as a waiver autonomy or a choice of submission of plan led by the CEA. Firstly, because after the pact of the utilities, French and Italians had rationalized efforts, effectively creating an integrated European research. Secondly, because the Italian nuclear complex was encountering great difficulties in completing the PEC, which at the height of these agreements was still under construction, with growing costs respect the planned ones. Thirdly, because the Nucleare italiana reattori avanzati (NIRA) [Italian advanced nuclear reactors], the company that worked both the PEC that the CIRENE, drew up with his French counterpart Novatome an agreement for the joint provision to NERSA the boiler of Superphénix-1. This was the first of a series of agreements to which the Italian industry benefited; they followed an agreement of NIRA with CEA for the transmission of knowledge in systems engineering of the FBR, an agreement of AGIP Nucleare with CEA for the transmission of knowledge on fuel, and various other components "agreements" between the Italian and French industries for components, precisely, the reactor block and of refrigeration circuits. (Lombardi in Zanetti, 1994:589-644)

The agreements certainly worked, as the Italian companies furnished the agreed components and Superphénix-1 started commercial production in 1986, as scheduled. What suffered fatal delays was the PEC, which on December 31 of that year was 70% completed and the work had cost 1.56 trillion liras of that time. In those ten years, however, the fate of the European FBR program was sealed, and as well the fate of the reactors heavy water-natural uranium, with an international framework that influenced the choices of governments and industry consortia. (Lombardi in Zanetti, 1994:589-644)

On the one hand, there was the strengthening of non-proliferation policies by the superpowers, following the Indian nuclear tests of 1974. Since the bomb was made with plutonium produced by a CANDU, the entire chain-heavy water natural uranium was the subject of special political attention, which of course will translate into a reduction of appeal on the international market. For the European FBR program the proliferating risk was inherent in its fuel cycle, based on the economy of plutonium, and then both efforts received a serious disincentive by the process of the International Nuclear Fuel Cycle Evaluation (INFCE), strongly backed in 1977 by the president of the United States Jimmy Carter. (Gerlini, 2017:passim)

On the other hand, thermal reactor as BWR and PWR especially remained the cheapest type, winning the competition against the gas-graphite chain and especially with a very economic enriched uranium market, which hardly gave incentives for alternative solutions, such as the use of natural uranium. These reasons concurred to the PWR choice for the single reactor type for future Italian power plants, a decision formalized with the *Progetto unificato nucleare* (PUN)

[Unified nuclear plan] in 1981, but destined not to be practiced. Indeed, the majority of Italian reactors remained the BWR, because those were the two reactors planned for the nuclear island of Montalto di Castro, as well as those of Caorso and Garigliano. But the choice of the PUN makes sense as well, as PWR had imposed on the international market thanks to the performance achieved in nuclear propulsion, and France and the United Kingdom had already directed their industry towards the PWR. (Paoloni, 2009:118-23)

2.3. The dark implosion of the Italian nuclear

These elements combined with the crisis of the national reactor project. If the PEC had been subsumed in the European program, outweighing the costs, the CIRENE was still supposed to be the reactor of Italian design, in fact, the ANM was continuing its work with a minimum contribution to Canadian industry. The changed international context disincentive the commercialization of a new type of natural uranium reactor, and therefore the government in 1982 appointed a special commission to evaluate whether to continue or not the program CIRENE. The commission considered uneconomic the interruption of the works, now being enough progressed, but from that moment on, the CIRENE was considered an Italian nuclear "national exercise" without potential commercial value. The whole project then lost motivation, and when in 1987 the reactor was ready for operation and absolve "exercise" that had been conferred, the entire program was stopped by the referendum, leaving him fully and completely unused, epitome of the end of the Italian nuclear power. (Lombardi in Zanetti, 1994:589-644)

An end, or an exit from nuclear power, of which historiography hasn’t yet to produce relevant studies. The story of the National reactor is exemplary of the divisions within the Italian nuclear complex, where competition between centres and consortia was very marked, and the analysis can no longer be considered resolved by attributing his failure to insufficient Italy's nuclear industry development because since 1975 the Italian industry was now fully competitive on an international scale. (Puri, 1975: passim) The same competition between the various groups, which manifested itself in an antagonism between sectors and between programs, cannot be considered an Italian specificity. In addition, the internal competition, through the various steps that the nuclear law led to the unique supply chain, was very limited and channelled into a national system.

Empirically, it is possible to note that the attitude of the mass parties to the Nuclear radically changed, just the simple comparison of the positions expressed by the parties during the case Ippolito and during the referendum campaign of 1987, especially those of socialists and communists. It is precisely on this plane the lack of historical research based on primary sources. If it is empirically clear that the three major accidents of history have had Italian public opinion effect, these are not enough to explain the course of events. The Three Mile Island accident significantly increased the concern and protests of local communities, but in 1979 the government had already got the legislative instrument to compel local administrations. It is equally clear that accidents at Chernobyl and Fukushima have moved the vote of the referendum to the rejection of nuclear power, as polls published prove. We have not in the bibliographies an historical study on the change of position of the parties to the first referendum, which may help explain the actual effects that the referendum had on the Italian nuclear power, as the non-entry into operation of CIRENE.

At the moment, it is only possible to advance a reconstruction that establishes some logical connections, however, based on a nuclear-wheel definition covering both the civilian use of that military ones. The PCI had always been opposed to the Italian military nuclear projects, while he had always supported the civilian ones, as the most significant exponents of nuclear physics, Amaldi for everyone. The same Ippolito, ended the sentence and pardoned by Saragat, meanwhile became president of the republic, was elected in 1979 to the European Parliament in the PCI lists. But in the same 1979 it was approved by the Italian Parliament the dual-track decision, that is, the ability to deploy in Italy the new missile carriers, the so-called Euromissiles. The PCI opposed the deployment, and when the protest movement against missiles grew in the early eighties to become a national reality, the leadership of the party endorsed the issues raised by the movement. (Nuti, 2007: 347-93) The protests, however, had the characteristic of not focusing solely on large national demonstrations in the capital, but also to develop on sites that would host the missiles, far from the big city circuit. A relocation compared to large urban centres like that of nuclear islands, so this common grammar of protest facilitated the osmosis between the peace movement and the local demonstrations against nuclear reactors, promoted by most of the Green movement. Environmentalism and pacifism had thus created a synergy against the two main uses of nuclear energy, weapons and electroproduction, while for example the medical uses were not disputed.

Both the PEC that CIRENE could have been of great use to a national military program, but the troubled NPT ratification process had foreclosed that possibility, then, both projects were exposed to complex domestic and foreign elements were acting on Italian electroproduction. In addition to PCI also the DC shifted rapidly its positions, dropping the pro-nuclear stance toward the 1987 referendum. PSI for the change in position was somewhat less abrupt but equally significant being the third largest socialist mass party, and having been the party which had allowed the victory of the parliamentary motion on dual-track decision. In fact, only the PSI in 1979 took side on an issue that had put in great difficulty the other European social democratic parties, most notably the German one, approving the deployment of the missiles after a hard, internal debate. So, the PSI was favourable to nuclear weapons, not as a national acquisition but as an element of international relations, while it was against Italian nuclear power. It should not seem a stretch to define the political parties "against" the Italian nuclear power, because this is, today, the only explanation to understand why after the 1987 referendum all nuclear programs, including research in the field, were substantially closed. (Gerlini, 2012: passim)

The object of the referendum questions did not legally close the nuclear power tout court, but it made it more difficult, perhaps almost impossible, the location of new plants: did not touch existing or already approved, which explains the attempt made by the Christian Democrat government of Giovanni Goria to complete and activate the nuclear island of Montalto di Castro. Certainly, the denial of the possibility for ENEL to participate in new international investments hit hard the PEC, weakened both by the realization that he had encountered problems, and from the missed commercialization of European FBR. In both cases, there were no legal grounds to close all programs, if not a lack of interest of political leaders; this disinterest complicated the exit process from nuclear, both in the renegotiation of international commitments on fuel supplies, and for the management of the decommissioning of reactors and waste.

3. Events

3.1. Critical view to the selection process of the five events

These five events were selected based on their relevance in the full history of Italian nuclear complex. They are putted in their wide historical context, to avoid the *événementialité* which could affect an extrapolation of a single event. **All the text of the events here below are tailored mix of quotations by three bibliographic sources:** Gerlini, 2012; Paoloni, 2009; Gerlini, 2016.

3.2. Event 1

The private sector as primal move of nuclear applied research

The inception of applied nuclear research in Italy was marked by the foundation of the *Centro Informazioni Studi Esperienze* (CISE) [Research and Experimentation Information Centre]. The organization had already been mooted before it was officially created in Milan on 19 November 1946: the idea had first been aired in August 1945, in the aftermath of news about the atomic bomb. Following a big conference held in Como in November 1945 on the suggestion of Luigi Morandi, an antifascist chemist and the man who was appointed to run the Montecatini firm after the liberation of Italy, Edoardo Amaldi drafted a report entitled *La fisica in Italia* (Physics in Italy), in which he stated his opinion about what needed to be done to develop peaceful applications of nuclear physics. Amaldi, who went on to become an exceptionally high profile figure in post-war

Italian physics, was part of Enrico Fermi's group. By the end of the war he not only had undeniable personal leadership in the scientific community, especially among physicists, he held a prominent position among Italian and international scientific policymakers.

CISE actually was a partnership between by one side the full professor of advanced physics in the Milan' State University, Giuseppe Bolla and his assistants Carlo Salvetti and Giorgio Salvini, and by the other side the Edison electric company manager Guido Molteni, the executive officer Vittorio De Biasi and his young engineer Mario Silvestri.

A series of six-man meetings commenced, at which academia was represented by Bolla, Salvetti and Salvini, and the Edison company by De Biasi, Silvestri and his boss, who was Manager of the company's Technical Office. In early 1946, Salvetti and Silvestri drafted a three stages plan. Stage one was simply to assemble a group of specialists who could research and work on the topic; stage two required setting off a very low-power nuclear chain reaction; stage three consisted of building an experimental nuclear reactor of a certain size. Funding requirements were estimated at 10 million lire for stage one, 100 million lire for stage two, and 1 billion lire for stage three. To give some sense of scale to these figures, Silvestri recalls that at the time he was earning 18,000 lire per month, a sum that was considered a good wage.(Silvestri, 1968:39)

Bolla suggested that the project – an enormously ambitious project considering the circumstances at the time – could be achieved by persuading potentially interested industrial enterprises to set up an ad hoc company. To get the project off the ground, they approached the largest industrial groups in northern Italy: the big car company Fabbrica Italiana Automobili Torino (FIAT), the steel company Cogne, the chemical company Montecatini and Società Adriatica di Elettricità (SADE), which was Italy's second largest private electricity trading company after Edison.

This long series of events unfolded prior to 19 November 1946, when a deed was signed at the offices of a Milan notary that marked the beginning of the CISE. The signatories that day were Vittorio De Biasi of electric power company Edison, Teresio Guglielmone of Cogne, and Antonio

Cavinato of FIAT. The founding partners paid up 40,000 lire each in share capital. De Biasi was appointed chairman of the new company, and Cavinato was offered the post of sole administrator. The CISE took the form of a limited liability non-profit-making company. The funding parties each pledged to pay 6 million lire annually, and to personnel free of charge. The company's declared purpose was, according to the articles of association, "study, research and scientific experimentation in any field, for the acquisition and exploitation of patents". The company was initially set up to continue until 1951. Not long afterwards, the SADE and Montecatini companies also signed up. The number of shareholders was destined to grow in later years, as other major Italian industrial groups joined: in 1949, it was Falck, Pirelli and Olivetti; in 1950, Terni. Within a short space of time, Vittorio Valletta joined the board as a representative of FIAT, bringing more weight than Cavinato could provide. Also in 1947, Gustavo Colonnetti, the Chairman of Italian national council of researches (CNR), joined the CISE board.

CISE was established to build a nuclear reactor for electricity generation purposes. It is worthy to remark CISE wasn't a public body or agency as the ones were established in the US, the UK, France and obviously the USSR.

Back in 1946, CISE had to rely on designing and building a reactor under its own steam. After long discussions, it was decided to work on a 10 MW heavy water natural uranium reactor. A vast number of issues still needed to be resolved, however, not least where to obtain a supply of uranium and heavy water. Each of these items required brand new solutions to theoretical and technological issues, since Italy did not have access to information or results obtained by others, and was not eligible to license foreign patents. One of the most pressing problems for the development of nuclear research in Italy was the lack of qualified personnel, something that Amaldi had already pinpointed in his January 1946 report, in which, among other things, he set out a plan for properly training a sufficient number of staff. This issue was one of CISE's stage one objectives in Salvetti and Silvestri's planning document. During its earliest years, more than anything else CISE served as a school for researchers. Nevertheless, the main problem for CISE remained definition of the overarching plan, owing to the scarcity of detailed scientific and technical information available on progress in the most advanced nations, particularly the United States: all such information was shrouded in the utmost secrecy. The most important thing was to gather all available information and undertake theoretical and experimental studies to understand the principles of how a reactor worked. The theoretical unit, headed by Salvetti, was responsible for this area of research, with the assistance of two laboratories, one for neutrons and one for ion sources, directed respectively by Ugo Facchini and Emilio Gatti.

By the end of 1951, CISE had achieved a number of important results. It had built a pilot plant to make heavy water through electrolysis, and created an experimental uranium metallurgy plant. Important measurements had been undertaken in its laboratories of uranium fission, and it had developed leading-edge electronic instruments. Bolla was venting feelings and frustrations that were percolating through CISE, not least the financial problems that were emerging as certain shareholders began to become impatient. Cogne had fallen behind in its payments; Falck was threatening to pull out altogether; and the Pirelli representative had gone on record to say that the CISE had been "working on a vastly ambitious project, given the means at its disposal".

The State enters in the nuclear applications

By this time, the government was being lobbied on three separate fronts: by industrialists, who were seeking appropriate public funding for CISE's activities; by physicists, who wanted to stay abreast of international scientific developments; and by the military, who were asking a lot of questions about the consequences to Italy's defence of these new weapons and the emerging international scenario. With progress in other countries, all the parties concerned hoped that adequate State funding would accelerate development and restructure industrial and academic nuclear research in Italy. However, each of these parties was also jockeying for the lead in the putative new structure, rather than combining their efforts to press the political authorities. Thus, the government continued to postpone deciding, and consequently continued to be lobbied on all sides. At the beginning of 1949, Edison Chairman De Biasi reiterated the company's opposition to seeking public funding because they wanted to keep the CISE beyond the reach of government meddling and control. However, on that occasion he came up against the opposition of Antonello Vittore, who represented SADE, the other large private electricity trading company involved in CISE, and Bartolomeo Orsoni of Montecatini. Edison had long been concerned that nuclear research could potentially become part of the debate about nationalizing the Italian electricity industry. However, De Biasi acknowledged how his fellow board members felt and agreed to go down this new path, despite his scepticism about its chances of success. To implement this resolution, CNR Chairman Colonnetti joined the CISE Board as a sitting member, and put himself forward as a mediator in relations with the government in order to obtain the funding they sought.

We have to consider that the first, actual attempt of military application for the nuclear energy begun in these years, as it met the staunch opposition of nuclear physicists, Amaldi above all, and also the suspicious opposition of the electric companies.

In the while the long hoped-for increase in the State funding finally materialized in the 1950/1951 budget. The Centro Nazionale Ricerche (CNR) [National Research Centre] funding was doubled from 265 million lire to 540 million lire. The CNR invested a significant portion of its new funds in basic nuclear physics research. In July 1951, it founded the Centre of Experimental and Theoretical Nuclear Physics, under the directorship of Gleb Wataghin. Under the aegis of the CNR, the National Institute of Nuclear Physics was founded to coordinate activities at research facilities in Rome, Padua, Turin, and soon afterwards, a new facility in Milan. Though this solution enabled nuclear physicists to emerge from the uncertainties that had beset them since the war, there was no resolution in sight regarding the relationship between basic research into nuclear energy and nuclear applications. CISE's requests for funding went empty-handed; the issue of relations between nuclear research and defence was not even broached. The scientific community decided to make one final political push and approach the Minister of Public Works, Pietro Campilli. Amaldi acted as go-between, after contacts were initiated by Francesco Giordani, who was Chairman of the CNR Chemicals Committee, and a man well-schooled in how the world of state-run industry worked, having been Chairman of the main public industrial holding the institute for industrial reconstruction [Istituto ricostruzione industriale] (IRI) from 1936 to 1943 and Chairman of the CNR from 1940 to 1943. Immediately after the war, he represented Italy in the upper echelons of the World Bank in Washington; he was also a friend of Bank of Italy governor Donato Menichella, who himself had previously worked as Director-General of IRI. Campilli had been busy working on energy issues. A few months earlier, he had fostered the birth of Finelettrica, an IRI financial holding company for all state investments in the electricity industry. Amaldi, Giordani and Campilli came up with the strategy of establishing a National Committee for Nuclear Research by Prime Minister's Decree, which would be funded by IRI and the Ministry of Industry, and access resources from the Coal Committee. This approach would have avoided the necessity of going through Parliament, and therefore running the risk of further interference. Campilli's involvement proved to be crucial to establishing a national centre for nuclear research. This formal move was soon followed by tangible action. The Ministry of Industry granted 100 million lire in funding to CISE through the CNR, which was enough to balance the budget. Moreover, Colonnetti told the CISE's Board of Directors that the State budget for 1952-1953 would contain 1 billion lire in support of basic and applied nuclear research.

Colonnetti, however, was less than happy that the CNR's role had been downgraded, not to mention the fact that physicists and industrialists were, in Giordani's view, to have a new go-between. Colonnetti succeeded in getting the new Committee to report not to the Ministry of Industry, as Giordani and Campilli had been hoping, but to the CNR, which pledged to help with funding by offering 250 million lire for the National Institute of Nuclear Physics. The time was ripe for the foundation of the first nucleus of State intervention in the nuclear energy, as a particular branch of CNR structure.

De Gasperi signed the decree that established the *Comitato nazionale di ricerche sull'energia nucleare* (CNRN) [Nuclear Researches National Committee] on 26 June 1952. The Nuclear Committee was chaired by Giordani, who was assisted by deputy chairman Modesto Panetti, an engineer at the Turin Polytechnic and a Christian Democrat Senator. The Committee included physicists of the calibre of Amaldi, Bruno Ferretti and Enrico Medi; high-profile industrialists such as Vittorio De Biasi and Finelettrica deputy chairman Arnaldo Maria Angelini; senior civil servant Aldo Silvestri Amari (director general of the Ministry of Industry); and a geologist who had specialized in uranium research in Italy, Felice Ippolito. Following established practice at that time, as the youngest and least academically-experienced member of the committee, Ippolito was appointed Committee secretary. The official CNRN founding ceremony took place at the Ministry of Industry on 23 July 1952.

3.3. Event 2

The roots of first "nuclear scandal" in the world

The Italian "nuclearists" got a primary connection with the American nuclear complex, while the CNRN took the initiative from the private sector of CISE. Italian participated in the EURATOM with the research centre of Ispra, as well in the international nuclear organisation of IAEA. Among the protagonists of Italian nuclear adventure arose the role of Felice Ippolito, who represented for the public opinion the magnificent nuclear development. In these years, the nationalisation of electric power changed the political landscape, and Ippolito was still a protagonist of this process. When he was put on trial and eventually jailed, was put on trial also the Italian nuclear program. It was the first time the public opinion seen a negative image of nuclearists. The scientists defended Ippolito, while the liberalism oriented policy makers and managers were against him.

At a CNRN meeting on 9 March 1955, Giordani suggested sending a technical mission to the US "to establish contacts with the US Atomic Commission, with a view to entering into a partnership agreement, in the spirit of President Eisenhower's December 1953 statement on atomic collaboration for peaceful purposes".

In the meetings of 17 February and 12 July 1956, the CNRN resolved to commission CISE to look into the construction of a research reactor which would be purchased from the United States. They chose the reactor type (a CP-5, like the one at the Argonne nuclear labs), and contracts were approved between the CNRN and CISE to install and run this reactor, along with a contract with American Car & Foundry to provide it. CISE was also issued with directives for acquiring the chosen site, near Ispra. The Committee then resolved to appoint a Commission to look into finding locations for nuclear plants. Sitting on the Commission were CISE members, CISE itself, the CNRN, the *Ente nazionale idrocarburi* (ENI) [National hydrocarbons authority], which had recently set up AGIP Nucleare to build a power station, and the *Società elettronucleare italiana* (SELNI) [Italian electronuclear company], a company established by Edison to build their planned nuclear power station.

At the end of the 12 July 1956 session, Giordani announced that he would be stepping down as the CNRN Chairman. Notwithstanding his (in truth barely credible) stated health reasons, Giordani's resignation was prompted by the Committee's parlous financial condition. His resignation focused public attention and the political milieu on the future of nuclear power in Italy, which was already in the public eye in the wake of the Geneva conference. Giordani evidently wanted to force the government to make a decision and bring to an end a climate of uncertainty that had been lasting for the past year or so. His move spelled an end to political in-fighting between supporters of a stronger CNRN, and those who wanted the organization to be cut down to size.

At the end of its 12 July 1956 meeting, the National Committee for Nuclear Research (CNRN) accepted a proposal put forward by Ministry of Industry representative Aldo Silvestri Amari in which he nominated "Secretary General Professor Felice Ippolito to undertake day-to-day administration and ensure the fulfilment of the resolutions taken thus far, and to maintain all necessary relations with government departments, most specifically the Ministry of Industry and Trade, with regard to the applications programmes currently underway." On 20 July, Italian Prime Minister Antonio Segni received Amaldi, Angelini, Ferretti and Ippolito.

The CNRN was officially renewed in a decree issued by the Prime Minister on 24 August 1956. The decree contained a number of regulatory changes with respect to its 1952 predecessor. The new chairman was Basilio Focaccia, a Full Professor of Electrical Engineering at the University of Rome, who was also a Christian Democrat senator and a former government undersecretary at the Merchant Navy and Industry – indeed, most emphatically a political figure. The new decree led to the CNRN taking on a great many new members of staff. Up until the summer of 1956, the entire staff consisted of secretariat employees seconded from the CNR. By December 1956, the committee had gained its first "Temporary General Services Administration". In July 1957, the committee's organization was subdivided into Services (later designated as Divisions), plus an Accounts Office, all of which reported to the Secretary General. The Committee's growth was undertaken through a series of restructuring plans. Four such sweeping plans were put into effect (at a rate of one year!). Ippolito was man behind all of this.

Though in theory it should have drawn staff on secondment from the Ministry of Industry, with the blessing of the Ministry and the CNR (now chaired by Giordani), the Committee proceeded to hire its own staff. This rapid growth led to a radical de facto change in the organization's administrative standing.

The new CNRN met for the first time under Focaccia's chairmanship on 23 and 24 October 1956. In the agenda for the meeting we fund the building of a Centre and a reactor in Ispra, Lombardy. The new CNRN began operations at a time when the international expectation was that civil nuclear applications were about to undergo rapid and imminent growth.

The decision to build a nuclear research centre for the research reactor was taken in late summer 1955. Once the site was chosen, the Committee provided funds for its purchase through an ad hoc company (Immobiliare Ispra), whose managing director was CISE director Federico Nordio. Several CNRN members sat on the company's Board of Directors. It was necessary to set up a company under private law to acquire the land because the CNRN did not enjoy legal status. CISE was put in charge of constructing the facility buildings, as well as designing and building the reactor commissioned from American Car & Foundry.

The CNRN sent a group of its own technicians to join CISE technicians who were already in the US, led by Salvetti. In early 1957, following a number of disagreements between the technicians and Nordio, the CNRN took an increasingly prominent role in the construction of the Ispra facility. Tensions flared once more between the CNRN and CISE, until the CNRN reached a decision to go it alone and build the facility itself. Relations were cut off between the two organizations in September 1957.

Once more, the Committee found itself having to tackle operational problems arising from its lack of legal status. Once more, these problems were resolved by drawing on the Committee's funds to set up a joint stock company, *Nucleare italiana* (NUCLIT), which took on a large number of the staff formerly employed by CISE need to build the Centre. Deprived of some of its technicians and of its main activity, CISE had to recast its programme of activities. In early 1958, Gino Bozza was drafted in to replace Giuseppe Bolla at the head of the organization. The CNRN had finally taken a dominant position in Italy's civil nuclear industry.

At the end of 1957, the CNRN's study commissions submitted a series of reports on the results of their labours. These reports were combined to form a "white paper", which then served as a five-year plan for nuclear research in Italy. The CNRN's core activity, however, was applied research: above all, building the necessary infrastructure. To achieve this, throughout the 1950s the organization's main priority was to set up the Nuclear Research Centre at Ispra. However, almost immediately after it was completed in 1959, it was transferred to Euratom to serve as one of the common research facilities defined in that organization's founding agreements. By 1958, though, work had commenced on building another nuclear research centre near Rome: the future Casaccia Centre. This facility became the focal point for a whole series of activities in chemistry, electronics and radio-biology, alongside several basic research programmes. A great many activities and many employees were transferred from the Ispra Centre after its transfer to EURATOM.

Since its foundation, the CNRN's stated objectives included drafting industry-wide legislation for the nuclear sector to regulate the complex and delicate technical aspects of the industry, and at the same time transform the Committee into a nuclear body comparable to those that existed in other industrialized nations, especially as regards its legal status and access to its own budget. However, converting these provisions into law met with widespread opposition owing to tensions triggered by the on-going debate on nationalization of the Italian electricity industry. One of the Committee's priority objectives was to obtain reliable funding within a more modern legislative framework. By this time, the Committee had become a major research body with industry-leading technical and scientific expertise that administered significant amounts of money and employed around 1,700 people.

The eventual autonomy of Italian nuclear agency and its crisis

In the end, the idea of founding an organization for nuclear research was taken off the table during the drafting of general nuclear industry legislation, which made its way through Parliament and in August 1960 led to establishment of the *Comitato nazionale per l'eneregia nucleare* (CNEN) [National Committee for Nuclear Energy]. Among other things, the emergence of the CNEN made it possible to resolve the anomalies that had been created by setting up Immobiliare Ispra and the NUCLIT; these companies transferred their assets to the new organization and were wound up. The CNEN was chaired by the Minister of Industry, and run by an Executive Committee; Felice Ippolito was confirmed as Secretary General. The transitional law that led to the establishment of the CNEN was not, as we noted above, the much-needed overarching law on the nuclear industry; this did not find its way onto the statute books until after the electricity industry was nationalized and *Ente Nazionale Energia Elettrica* (ENEL) [National Electric Power Authority] was founded.

A new political era dawned in Italy at the start of the 60s. One new development was an agreement in late 1962 to nationalize the country's electricity industry. Immediately after this decision was taken, the foundation of ENEL triggered what came to be known as the "Ippolito affair".

On 10 August 1963, under Prime Minister Giovanni Leone's so-called "summer holiday" government, the Social Democratic party's press agency published a note written by party leader Giuseppe Saragat, in which the politician defended ENEL's top management from "controversial leaks" published in "L'Espresso" magazine on 4 August, which, he claimed, "doubtlessly were released by one of the directors at ENEL on the first report by General Manager, Professor Angelini". After praising the electricity company's directors (General Manager Arnaldo M. Angelini and Chairman Vito Di Cagno, who had formerly been Chairman of SME) for their work over the previous months, Saragat went on to violently and "inexplicably" criticize the top brass at CNEN (the second adjective is taken from the 12 August issue of "Avanti!", the official organ of the Italian Socialist Party, the PSI). After dwelling on "purely technical issues with which" – once again, this comes from "Avanti!" – "he has never been overly familiar," Saragat criticized "this obsession with atomic energy" and concluded that: "When it comes to the projects we keep hearing about, the plans to throw yet more hundreds of billions of lire out of the window to build new nuclear-fuelled power stations, you may rest assured that we will be keeping a very close eye on things to prevent more of this absurd waste of public money."

Between 10 and 17 August, the leader of the PSDI issued no fewer than five notes about the CNEN, in which he savaged both the organization and its Secretary General, Ippolito, expressing his concern that Ippolito, who also sat on the ENEL Board, wanted to impose the same style of management on the new electricity company as he had on the nuclear organization. Those in the know could hardly help notice that Ippolito was Saragat's true target from the very first of his notes, what with his allusions to attacks by an ENEL board member (it could only have been Ippolito), and his defence of Di Cagno and, most notably, Angelini, who had been at loggerheads with Ippolito since 1959. Saragat's final note ended with an out-and-out threat: "It is unthinkable that the CNEN could be awarded the 15 billion lire it is seeking for its second five-year plan before fully clarifying the situation."

Though not normally the kind of story one might expect to be uppermost in the public's thoughts, this story received prominent coverage on 11 August in the Italian business confederation's newspaper "24 Ore" and in the main national newspaper "Corriere della Sera", forcing proponents of the CNEN and Ippolito to make their own statements the following day in leftist newspapers ("Unità", "Avanti!" and "Voce Repubblicana"). On 13 August, the only daily in Italy which reported the spat without taking sides was the "Popolo", the official organ of the Christian Democrat party (DC).

Saragat's notes set off a violent battle in the newspapers and in the political realm, which rapidly turned into a press witch hunt against Ippolito and the CNEN. On 18 August, Social Democrat Luigi Preti launched another attack on Ippolito, questioning whether he should continue in his post as Secretary General of CNEN and ENEL director. On 20 August, in an interview with journalist Piero Ottone, Saragat explained that his criticism of the nuclear organization was not some silly-season prank, it was a clash between two competing approaches on the centre-left in Italy: between people who, like himself, wanted to tackle real problems, and people who were far more interested in "building power bases from which to take control over all of Italian life." On 22 August, the Christian Democrat weekly "Vita" dedicated its cover to Saragat's criticisms, and re exhumed an attack on Ippolito from that June by Bruno Ferretti, a member of the CNEN Executive

Committee. On 24 August, Italian Prime Minister Leone met with the Minister of Industry (who, by law, was chairman of the CNEN) Giuseppe Togni, to look into the matter. On 29 August, "Vita" offered prominent coverage of new leaks about the "nuclear dossier before Leone," including, according to the weekly, the results of an investigation into the CNEN carried out by a group of Christian Democrat Senators led by Giovanni Spagnolli that July; Saragat's notes, CNEN's future programme for which it was seeking financing through Parliament; a note from the Public Accounts Office on the incompatibility of Ippolito's post at the CNEN and his post at ENEL; and insinuations that not everything was above board in relations between the organization and a company to which the Ippolito family was allegedly connected. This last allegation was the one that caused Ippolito's defenders to stop and reassess their position. Indeed, many of them began to distance themselves from him, and drew a line between activities undertaken by the nuclear organization, and Ippolito's alleged personal responsibilities. On 31 August, however, Togni suspended him as secretary general and appointed a ministerial commission of inquiry. On 6 September, the Rome Attorney General asked to be kept informed of legally-relevant developments concerning Ippolito, who had been named in the introduction to the decree of suspension published in the "Official Gazette", and whose name had been mentioned in the papers. On 13 September, Ippolito voluntarily went to see the attorney general, who took his deposition over the following four days. On 17 September, the ENEL Board of Directors submitted the issue of ineligibility to the electricity organization's supervisory authority, which on 14 October removed Ippolito from his post. Meanwhile, the issue reached Parliament in the form of questions and answers, including a proposal to launch a parliamentary inquiry, which was never properly considered. In the space of just a few weeks, Ippolito went from being a major power broker in Italy to a man in disgrace, savaged by everybody and anybody who thought that they had something to gain from his vulnerable position.

With Ippolito gone from the CNEN and ENEL, it seemed that the men who supported the charges – Saragat and the former electricity company executives – had achieved their goal. The former electricity managers did not hide the fact that they had funded the press campaign against the now former Secretary General of the CNEN to make sure that he was not part of the industry's new structure. On 3 March 1964, after a number of months of investigation, Ippolito was arrested, and soon afterwards committed for trial. At the trial itself, he public prosecutor so explicitly harassed and intimidated the witnesses who testified in favour of Ippolito that he was roundly criticized in the foreign press, and in some quarters of the Italian press too. At the end of the trial, which was followed very closely by the press, Ippolito was sentenced to 11 years in jail. Left-leaning newspapers came out in favour of Ippolito, while right-leaning newspapers were against him. Politically non-aligned newspapers remained more or less neutral after initially taking sides; the same was true of the Christian Democrat party's official organ. All newspapers disapproved of the severity of the sentence, with the "Corriere della Sera" leading the way. Subsequently, the Court of Appeal drastically downgraded the charges against Ippolito and found him guilty merely of much more minor irregularities. When Ippolito was freed from prison in 1968, he may have lost a position of great power, but he had neither changed his character nor his ideas. He continued to fight to defend the heritage of everything he had done, and he continued to support nuclear development. Among other things, he put a great deal of effort into disseminating scientific culture – a cultural and political battle that saw him taking on the role of editor- in-chief of the monthly magazine "Le Scienze", the Italian version of "Scientific American", which he founded and produced himself.

3.4. Event 3

The nationalisation of electric power intertwined the nuclear debate

The nationalisation of electric power marked the crucial years for the Italian nuclear programs. The power reactors went in exercise, while a program of expansion of nuclear power plant was in discussion in ENEL. But in these years, Italian nuclearists experienced the first limits of nuclear power growth. The costs of the safeguards system, the unwillingness of oil companies toward an alternative power production, as well as the technological limits of some types of reactors were global dynamics, which affected the Italian nuclear development more than other countries. The institutional weakness of nuclear authority, followed the Ippolito trial, let the nuclear power more and more on the corner side, although the Italian reactors proved a quite good performance.

The start of construction work on three nuclear power stations in Italy was favourably received in the media and by public opinion, but as the whole issue was so tightly bound up with the overriding issue of electricity policy, disagreements were never far away. Criticisms were levelled at the size of the investment needed to build the power stations, the higher costs of nuclear-generated electricity, the location of publicly-owned power stations (both of which were in southern Italy, and too close together at that), the lack of appropriate regulations and monitoring of the electro-nuclear industry (this criticism was raised by those who were in favour of nationalizing the Edison power station), and the lack of overall coordination of the various initiatives. In truth, none of these criticisms was wholly groundless. However, in all cases, those targeted by these criticisms offered staunch (if not always convincing) defences.

In 1958, when Amintore Fanfani opened the third legislature with a speech on the government's plans that reinvigorated the political debate on nationalization, the talk was of setting up a sole National Energy Body (Ente Nazionale per l'Energia, or ENE) by extending ENI's sphere of competence. This approach, which Mattei had been espousing since 1956, was probably the underlying reason for the foundation of Agip Nucleare and the SIMEA, which were established as a means of getting one foot into the electricity industry via the nuclear industry. The original plan was quickly shot down not just by the private electricity enterprises and the so-called "economic right", but because of staunch opposition from IRI, whose Finelettrica company, helmed by Angelini, already had control over a significant portion of the Italian electricity industry. IRI was willing to form a joint venture with the oil company, but it was not prepared to be supplanted by it. Mattei's death in 1962 removed one of the most vociferous participants from the final phase of the nationalization debate. The two methods of nationalizing the industry on the table at that time consisted of either "IRIfying" the electricity companies through a Finelettrica acquisition of majority equity interests in the private companies, or by setting up a State-run electricity organization which would expropriate the private companies and compensate their owners (through so-called "electricity compensation" payments).

Each of these approaches had a different set of potential repercussions on Italy's future economic power structure. The first hypothesis, championed by Christian Democrat economist Pasquale Saraceno, a leading expert on the problems of southern Italy and a leading proponent of state-run industry in the post-war years, had the advantages of lower cost, of respecting minority shareholders' rights, and of leveraging the sound economic and managerial performance of IRI, which it had demonstrated through its STET subsidiary's public takeover of Italy's telephone industry. The second hypothesis was more favourably received by the major private enterprise groups – and not just the electricity companies – because the compensatory payments would generate new economic resources and open up new scope for private enterprise – many private concerns at that time in Italy felt targeted and suffocated by State-run ventures. This second alternative was supported by a convergence of interests ranging from the “economic right” to left wing parties worried about a further increase in the powerbase of IRI, which was firmly within the orbit of the Christian Democrat party.

In the end, the second hypothesis won the day. Nationalization was undertaken by founding ENEL, which was subsequently saddled with making the electricity compensation payments, a more costly solution that had a strong impact on the new organization’s access to funds and its industrial strategies. From a technical point of view, Finelettrica took control over ENEL, and Finelettrica’s Chairman, Angelini, for many years served as the state electricity organization’s General Manager, before becoming its Chairman. This team, supplemented by leading engineers drawn the private companies, was responsible for two of ENEL’s greatest achievements: unifying Italy’s electricity system and completing the National Grid.

The nuclear question, however, remained unresolved. Nationalization was the only move that could get a law on the peaceful use of nuclear energy through Parliament (Law number 1860, December 1962), after various bills had languished in Parliament over the course of two legislatures. The new law clarified the CNEN’s role and duties about industry issues ranging from applied and basic research (the latter of which was mainly carried out by the INFN) to facility inspections. Together, the two laws (on nationalization and the regulation of peaceful nuclear use) clarified the main aspects of the relationship between the nuclear body and the electricity organization with regard to the development of nuclear energy. Alongside its duty to promote, direct and fund applied research into reactors and all activities associated with the development of this new source of energy, the CNEN was also responsible for monitoring plant security, assessing plant design, and ruling on plant locations. CNEN’s Security and Protection Management Office (Direzione Sicurezza e Protezione, or the DISP) consequently took on a particularly important role, before the CNEN was ultimately supplanted by today’s National Agency for Environmental Protection. ENEL was put in charge of developing nuclear power within the framework of the national electricity system. This responsibility entailed decision-making on power station construction, entering into agreements with contractors and fuel suppliers, and managing operations. In addition to drawing on in-house resources, ENEL had access to proprietary industrial research facilities, including the CISE, which the electricity organization had taken over as part of the nationalization process.

The real issue in the nuclear debate, both before and after nationalization, was whether or not nuclear energy could be competitive over the medium term, and what kind of role it would play in catering to the country's energy needs. Part of the controversy surrounding Ippolito in the summer of 1963 revolved around this very issue. At the start of the 60s, nobody had any realistic idea of what the cost of nuclear power might be, though this situation was destined to change. In the meantime, private enterprise (and Vittorio De Biasi, CISE's first chairman) claimed that though it was necessary to engage in industrial scale experimental nuclear generation of electricity, it was not economically feasible to take on the enormous financial commitments required to build new plants. Ippolito, on the contrary, believed that a large-scale and long-term nuclear commitment (which, in Italy, seemed to only be within the scope of the public sector) would have ended up making nuclear energy cheaper than traditional thermoelectric energy, which is why he thought it was wrong to proceed so cautiously. This was yet another reason why Ippolito's removal was a negative signal for those who hoped that nuclear energy would undergo rapid development in Italy. The Ippolito issue was considered by many to be emblematic of a crisis that swept through state institutions as a whole, and had extremely serious repercussions right across Italian scientific research. However, the most direct repercussions of the whole business were, not surprisingly, on energy policy. Nationalization of the electricity industry and the CNEN's plans created a climate of expectation amongst industry professionals, who believed that civil nuclear use would develop quickly and broadly across the country. Though they often took opposing views on economic strategies and institutional roles, the electricity industry and the nuclear organization represented two sides of the same coin. Both sides, as became evident in later years when the CNEN was directed by Salvetti and ENEL run by Angelini, backed one another up. The negative repercussions of the weakened CNEN that emerged from the "Ippolito case" were only partially offset by Angelini's ENEL. The electricity organization was itself hamstrung by financial difficulties that were exacerbated by the economic crisis that struck in the 70s. As a result of this, development of Italy's nuclear industry suffered a marked slowdown just at the time that other European countries were boosting their output of nuclear-generated electricity and using this fuel source to cater – finally – to a significant proportion of their energy demand.

The nationalisation of nuclear complex

Once work had been completed and the plants were up and running, all of the power stations that had been ordered prior to nationalization were handed over to ENEL. The necessary decrees were published in October 1963 (Latina), December 1964 (Garigliano), and January 1965 (Trino). Actual transfer to ENEL, however, required another year, and took place in December 1964 for Latina, and January and February 1966 respectively for Garigliano and Trino. All together, the capacity of these three power stations exceeded 600 MW; in 1965 they generated a total of 3.5 billion kWh, corresponding to 4.2% of all electricity generated in Italy that year. In September 1964, when the new Geneva Conference opened its doors, Italy sat down at the table as the world's number three electronuclear power generator, after the US and UK.

It is worth noting that Italy's three power stations were built within a reasonable length of time (around five years), kept to schedule, and came in on budget – three things that were never achieved again.

The "commercial phase" of nuclear power station construction officially began after phase three of the PRDP came to an end in 1963, when contractors (first General Electric, then Westinghouse) began to sell "turnkey" nuclear power stations at a fixed price. This was the point at which ENEL became a nuclear player. Despite the fact that it could leverage the experience acquired with the "first generation" plants, it had to move in a structurally different nuclear market, and face a whole new set of social and political challenges. The many obstacles that the Trino power station had had to overcome in many ways anticipated the difficulties – not all of which were either technical or inevitable – which would beset Italy's future nuclear development.

Between 1963 and 1965, the approach to nuclear power in Italy was somewhat schizophrenic, what with the start-up of the country's first reactors, their transfer to ENEL, and the CNEN's responsibility for supervision, requests, and authorization for operation. During this same period, Ippolito was being defenestrated and sent for trial, and the CNEN's responsibilities were being curtailed by a technical committee led by Mario Silvestri, resulting in the closure of a number of programmes that Silvestri had opposed in previous years.

Things improved from hereon in, with a "white paper" on nuclear power issued by Minister of Industry Giuseppe Medici, and Carlo Salvetti's appointment as Deputy Chairman at CNEN. Meanwhile, Angelini and his staff were getting to grips with organizing ENEL's central and geographical structure, and merging together legacy assets from the former Finelettrica companies and the former private electricity generating firms. The new organization had a number of pressing issues to deal with, most notably unification, standardization, and completion of the national grid. On the nuclear power front, ENEL had taken on not just the power stations but highly-trained, specialist human resources who were more than capable of running what was already in operation.

As far as industrial development was concerned, major advances were underway in the US. Technological progress and a significant boost to the power output of individual nuclear units, without a major increase in the (still large) capital requirements, promised economies of scale that were especially impressive for water reactors, and marked an important step towards economic competitiveness. Moreover, now that US companies were offering nuclear reactors at much lower prices, there was an increasing belief that the product was now mature, and the market improved its outlook on the new technology. Last but not least, the boom in orders for electricity power stations in the US following the 1966 New York blackout led, the following year, to thirty nuclear power stations being commissioned. Lombardi noted that these events "had a widespread echo on the situation in Italy, where strong growth in energy consumption had made the nation increasingly dependent on oil imports. Electricity consumption was also affected, as hydroelectric power was no longer sufficient to cover demand." In 1966, Salvetti and Angelini independently and on multiple occasions announced that a major nuclear power station building programme was on the cards.

By the end of the 60s, it was clear that loading the organization with responsibility for paying electricity compensation fees, failure to provide it with an endowment fund, and failure to embark upon an overhaul of pricing – all of which were political decisions, and had nothing to do with the desires of ENEL or CNEN management – entailed the cost of failure to develop what, in all industrialized nations, was considered the energy source of the future.

For the record, ENEL admirably acquitted all of its statutory duties. Indeed, it was precisely for this reason that after placing an order for the fourth power station, the organization could do little more than lobby the political authorities. At every opportunity, ENEL championed a nuclear programme as the only feasible solution to the country's energy and electricity demand issues. For as long as he was at the helm of ENEL, and indeed beyond that, Angelini fought his corner hard. Commentators of the day and a number of historians opposed the idea of reprising the nuclear programme, which, though justified in terms of demand, became unfeasible. However, in all likelihood the jury will remain out on this topic for quite some time.

In the spring of 1973, one decade after nationalization, Angelini took over from Di Cagno as ENEL chairman.

3.5. Event 4

The impact of oil crisis on the Italian electric nuclear sector

In Italy, the 1973 oil crisis is often remembered for the drastic measures that were introduced that autumn and in the winter of 1974 to cap oil consumption. That year, a confluence of negative events took place: for the first time since the war, the inflation rate hit double figures (12%); the discount rate rose to 6.5%, and the advance rate peaked at 9%; in addition, a ceiling was imposed on bank lending to limit business access to credit. All this took place after a year (1972) in which all Western economies except Italy experienced economic recovery. For ENEL, 1973 was the year that Law no. 253 guaranteed the organization a 250 billion lire five-year endowment fund (corresponding to just 50 billion lire per year); a price review was undertaken "to enable the organization to conduct long-term energy industry development, particularly in the nuclear sector" (article 6), and the Italian State stepped in to guarantee bonds that the organization had issued. These measures – the endowment fund in particular – were too little, too late, certainly in terms of the size of investment required for the nuclear programme, not to mention the then rate of inflation and higher borrowing costs. An in-house ENEL document from March 1974 noted: "In 1973, ENEL was granted a 50 billion lire annual endowment fund for five years, corresponding to a total of 250 billion lire. This overall figure, considering how much more a pair of 1 million kW nuclear power stations costs than two traditional power stations generating the same amount of power, is insufficient even to cover the difference of 300 billion lire. The entire endowment fund is insufficient even to cover the larger investments required every year to build the new nuclear power stations. Not only do past difficulties remain, they continue to worsen as time goes on." The oil crisis persuaded the government to relaunch the nuclear programme, and to empower ENEL to order new power stations. The national body in charge for the steering of Italian economy was the Comitato interministeriale per la programmazione economica CIPE [Committee of economic program]. The same document added: "Drawing on loans accessible following recent CIPE decisions, ENEL is taking steps to order the two 1 million kW power stations decided upon in 1973, and hopes to move forward at a rate of two power stations per year until 1976."

At the beginning of 1974, ENEL had three nuclear power stations in operation and a fourth under construction, which had been ordered in 1970 (though the decision to build it had been taken back in 1967). In 1968, the organization decided to build a fifth power station, before the financial problems described above put the nuclear programme on hold. In December 1971, ENEL resolved to initiate procedures prior to ordering a fifth power station. A call for tenders commenced in December 1972, along the lines of the Caorso power station procedure. Specifications were published that same month. Technical bids were received by ENEL in June 1973. After assessing the bids and seeking several changes, bidders were requested to submit their prices by November. The power station for which they were bidding was to have a power capacity of between 800 and 1,000 MW; the company reserved the right to order a second power station of the same specification within one year of choosing the winning bid. Clearly, this condition was intended to accelerate the tender process and reduce delays in ordering reactors.

When it came to drafting the tender specifications, ENEL ruled out gas technology, following a rethink in the British nuclear programme, and France's decision to replace gas-cooled reactors with Canadian-style heavy water and natural uranium reactors. ENEL called for tenders from *Elettronucleare Italiana* (a Westinghouse licensee) for a pressurized water reactor, AMN (a General Electric licensee) for a boiling water reactor, and Canadian company AECL (affiliated with *Italimpianti*). ENEL had already completed an initial survey of potential sites for future power stations, which were listed in a confidential memo dated February 1973. It was from this list that potential sites for the newly ordered power stations would be chosen.

In December 1973, after receiving assurances from the Italian government and the adoption of new legislation, ENEL decided to order not just a fifth but also a sixth nuclear power station. The organization was following – to the letter – Angelini's April 1972 proposal to order two power stations in 1973 and a further two in 1974. The ENEL Board of Directors commissioned Italy's fifth and sixth nuclear power stations from Elettronucleare and AMN. Though the AECL bid was not taken up, a deal was subsequently struck with the company for a smaller and different commission under the auspices of the CIRENE project. ENEL reserved the right to exercise an option by the summer of 1974 to double the order from both winning bidders. In the summer of 1974, orders were placed for Italy's seventh and eighth nuclear power stations, which were twins of the fifth and sixth power stations. In effect, the seventh and eighth power stations were new reactors that would be located on the same sites as their twin, in effect doubling the capacity of power stations number five and six. Plans for the fifth and sixth reactors at one point called for certain parts of the power stations and plant to be shared. The new power stations were due to be located in the Molise region (the fifth and seventh units) and in Upper Lazio (the sixth and eight units). In his 1974 report, the managing director warned: "The most pressing issue is to obtain site access as rapidly as possible. Throughout the year, with great endeavour we have been working on obtaining the necessary authorizations to begin construction, especially the building permits." Having at long last put its financial problems behind it, ENEL now had to tackle the issue of finding new locations. It should be said that this issue also applied to traditional thermoelectric plants, and to electricity power lines, but in the case of nuclear power stations, opposition tended to be particularly strong.

In August 1975, the government passed Law no. 393 to regulate localization procedures. The final paragraph of Article 2 called for robust intervention from central government, but as this portion of the law was never invoked, the measure did not end up making sites available. In 1975, after oil prices suffered a further hike, Minister of Industry Carlo Donat-Cattin drew up the government's National Energy Plan, which was approved by the CIPE on 23 December 1975. Under this plan, the government pledged to start building new 1,000 MW nuclear power stations, drawing on experience that had been acquired and leveraging domestic and international programmes underway at that time. The Plan stated that Italy might have as many as twenty nuclear power stations in operation by 1985.

The government also commissioned a parliamentary enquiry into energy, which was undertaken in Autumn 1976 by the Chamber of Deputies' Industry Committee. The Committee concluded with the unanimous adoption of a document on 28 April 1977, confirming the government's focus on nuclear power stations. The government reiterated its intentions in a resolution approved with cross-party support on 5 October 1977. The third government of Christian democratic Giulio Andreotti (which included the Italian Communist Party in the coalition) subsequently called for an immediate start to work on power stations that had already been approved, and sought immediate preparation of a locations plan. With all of this political backing, in 1977 ENEL sent out calls for submission of technical bids for the provision of a further eight 1,000 MW units. At the end of 1977, in acknowledgement of delays to the scheduled construction of power stations and difficulties in securing the necessary sites, on 23 December 1977 the CIPE adopted a revised Energy Plan which retained the same overall objectives but reduced the target for 1985 to "at least 6,000 MW" of nuclear energy.

Atomic autonomy?

In 1973, a further law (no. 856 of 18 December) authorized ENEL to set up a joint venture with EDF of France and RWE of Germany to build and commercialize FBR.

The CNEN had begun working on fast reactors under its reactor Prova elementi combustibile (PEC) [Fuel Rod Testing programme], the goal of which was not to generate energy but to build a reactor for testing fuel for the first French commercial FBR, so fuel elements with characteristics that differed from thermal reactors. Angelini had personally been a proponent of a European-wide joint venture in this field, bringing together public nuclear organizations and the private nuclear industry. Angelini was backed in these efforts by Salvetti, who had long supported this type of research. A trilateral European venture began to take shape in 1971 to build two fast reactors in France and Germany. ENEL's wishes to reap benefits in terms of electricity generation, industrial experience and orders; the CNEN hoped to be able to complete its PEC programme.

In 1974, ENEL acquired a 33% share in the German ESK company, owner of the SNR-2 power station which was to be built in Germany, and in the French NERSA company, in which EDF had a controlling 51% stake, and which was to oversee construction of the first fast reactor at Creys Malville: this was the future Superphénix reactor. This venture spawned major industrial agreements between NIRA (Nucleare Italiana Reattori Avanzati) and Novatome of France, to supply the nuclear boiler for the power station, and between NIRA and the CEA (the French nuclear organization) to share the expertise developed through the fast reactor system. Further industrial agreements were struck between CEA and AGIP on fuel, and between French and Italian industrial companies regarding the supply of various nuclear block and refrigeration circuit components. The CEA and the CNEN also entered into research and development agreements. Construction work began on Superphénix in late 1976. The power station achieved criticality for the first time in September 1985, and went into commercial service in early 1986. Belgium, Holland and the United Kingdom subsequently signed up to these fast reactor-related agreements.

One of the reasons why ENEL had been so interested in developing fast reactors was because of their potential with regard to *CISE Reattore a Nebbia* (CIRENE) [CISE Mist Reactor] an Italian-designed natural uranium and heavy water reactor which CISE had been working on since 1957, in a project led by Silvestri. CISE had opted for this type of technology because of the particular history and circumstances of Italy's home-grown reactor project, which had begun back in 1946. Though a complex technology, heavy water was scientifically and industrially feasible for Italy; a pilot plant for manufacturing heavy water was one of CISE's early achievements, even before the CNEN had been established. Moreover, being able to fuel the reactor with natural uranium circumvented the political and technical issues associated with importing enriched uranium; manufacturing enriched uranium in Italy would have required technological, industrial and financial abilities that were beyond Italy's reach.

Silvestri and his team undertook a feasibility study for a reactor moderated using heavy water and cooled using natural boiling water. The CIRENE was an original solution that adopted technology under development at that time not only in Italy but in Canada (which went on to sell this type of reactor under the name CANDU), Britain and Japan. Work continued on CIRENE after funding was secured from EURATOM and the CNEN, which had first expressed interest in the reactor when Ippolito was still in charge of the organization. In 1967, through Salvetti the CNEN struck a deal with ENEL to build a 40 MW prototype. In 1972, ENEL commissioned AMN to build a prototype of this technology in Latina, on the same site as the SIMEA gas-cooled power station. This commission was only completed in 1987.

3.6. Event 5

The road to the first referendum on nuclear energy

Criticisms of ENEL during the Seventies basically fell into two categories: on the one hand, the electricity organization was rebuked for an excessively prudent approach to the nuclear programme in the 60s, which led to Italy being worse off than the rest of Europe when the 1973 economic crisis struck and the country did not have sufficient nuclear electricity generating capacity to draw on. On the other hand, the organization was taken to task for development plans that failed to consider the shortcomings of Italy's industrial system, and the country's "backward looking" management practices.

ENEL shrugged off the first category of criticisms by saying that a prudent approach to nuclear programmes in Italy had allowed the country to leverage the experience acquired by others in new reactor technologies. Curiously enough, the company did not defend itself by citing its economic difficulties; something that, in internal documents and the organization's annual report, it made abundantly clear was the main reason why Italy's nuclear programme had fallen behind schedule. Understandably, no mention was made, either, of the blows that the ENEL and CNEN's nuclear operations suffered between 1963 and 1967 owing to a series of events beyond their control, ranging from the Ippolito case to technical and organizational emergencies that ENEL was required to tackle immediately. Within the heated framework of Italy's energy debate, citing these reasons would have sounded like a *j'accuse* against the political authorities, and the electricity organization and its top managers depended precisely upon these political authorities.

This assertion was borne out by the facts. A 1978 Confindustria document confirmed that in 1977 and early 1978, Italian electromechanics companies won more than 40% of all international electricity power station calls for tenders. The market, however, was increasingly shifting towards nuclear power stations, and Italian companies were in danger of losing their position because of insufficient domestic orders. As Ansaldo Chairman Ambrogio Puri pointed out in a letter to Angelini in March 1976, Italian industry could manufacture all of the components of a nuclear power station, and could “actively” manage licenses, but it could not develop specific nuclear power plant systems experience without in-the-field experience. As competitors gained more and more experience on their home turf, Italy was losing its technological competitiveness. After the dust had settled on the clashes that marred the 60s, by the early 70s Italy’s nuclear industry had acquired a lasting configuration in which ENI *Fabbricazioni Nucleari* [Nuclear Fabrications] focused on fuel-related provisioning, and IRI-Finmeccanica (AMN) was responsible for building plants under license from General Electric. Both of the nuclear power stations that had been ordered used American-licensed light water technology; one licence was held by Elettronucleare Italiana, the consortium that had built the Trino power station, before becoming a supplier to ENEL. By the late 70s, IRI’s leadership in the industry was uncontested, and it had proceeded to set up joint ventures with private companies, particularly with Fiat. The real bottleneck in implementation of the nuclear plan regarded siting the power stations, which was not part of ENEL’s responsibilities. The issue was also not “Italy-specific”, as some modern-day commentators would have it. If this had been the case, then it would have been impossible to build any of the three first-generation power stations, or the Caorso plant either. Chroniclers pointed their finger at the paradoxical behaviour of Italy’s political parties. At central government level, ENEL’s nuclear programme had broad cross-party support, but at local level party activists were bitterly opposed to the prospect of a plant being built in their area. Central government never had the appetite to invoke the authoritative procedures enshrined in the 1975 law. Evidently, the issue was not sufficiently important to risk a showdown with local party potentates. It was this issue, and insufficiently strong political backing, that in the second half of the 70s led to ENEL’s nuclear programme finally grinding to a halt. Local opposition was first experienced by Edison when it wanted to locate its Westinghouse power station in the municipality of Moneglia, near Genoa. The problem was quickly resolved when the town of Trino Vercellese offered land to the company, and perhaps, because of this, people undervalued the importance of the issue. Difficulties were also encountered in Caorso, though these ended up being resolved; indeed, here the problems were related more than anything else to an earlier dispute over the nearby Isola

Serafini hydroelectric power station. However, before starting site work, AMN hired a specialist advisor to investigate potential social and local unrest and perceptions of the power station. Far stronger opposition was encountered during the selection of sites in the Molise region for the fifth and seventh units. Here, local government held out for particularly expensive infrastructure commitments in exchange for giving their OK. In the end, the CIPE was advised not to proceed. ENEL was consequently forced to relocate the two units to Lombardy and Piedmont, only for the regional administration in these two areas to wage their own rear-guard defence. The regional government in Lazio, however, offered ENEL a site at Pian dei Gangani, near Montalto di Castro. However, local and regional political backing was insufficient to counter the opposition of local people, who kept up permanent protests which significantly slowed down work on the power station. Safety checks by the DISP did not seem to reassure the locals about the minimal risks they ran; local people did not view the organization as independent.

ENEL countered the problem by running a concerted nuclear information campaign, which reached its peak between 1976 and 1981. However, by the end of the 70s, it had become clear that out of the four power stations ordered under ENEL's nuclear programme, only the Montalto site had any realistic chance of being completed. By the late 70s, the international climate was increasingly unfavourable to Italy's nuclear plans. The events that took place in the 80s are well-documented. In 1981, the government issued a revised National Energy Plan calling for three new 2,000 MW power stations to be built in Piedmont, Lombardy and Puglia. The plan was the first to introduce the "standard plant" concept. Dubbed PUN (Progetto Unificato Nucleare, or Unified Nuclear Project), the plan was based on Westinghouse pressurized water technology, and allocated responsibilities as follows: ENEL was the commissioning party and systems architect; ENEA (founded in 1982, to take over from the CNEN) was the monitoring authority; AGIP Nucleare was the fuel supplier; and Italy's private nuclear companies, through a consortium led by AMN (which was named main contractor), were to supply plant systems and components.

Protests arose, up to the referendum turning point

The public opinion attitude toward nuclear power changed dramatically during the Eighties. If technocrats and other elites drew the consequences of the oil shock looking the promising plutonium economy, the public debate on the limits of the growth argued also the large investments in the nuclear sector. When the nuclear industry experienced the first big nuclear accident in Three Mile Island power plant (see USA Short Country Report), the local communities were the Italian reactors are or would located turned to a growing concernment for the safety of the plants. The turning point was the Euromissiles crisis, when the Communist party, the larger party of Italian left, endorsed the peace movement demands. Because of a certain sharing between peace movement and anti nuclear power one, ecologists and extreme lefts militants shared both protests. They promoted a referendum on the nuclear power, as well as a moratorium on the Euromissiles. When the Communist party shifted toward the anti nuclear power positions, the opponents of nuclear power won the referendum. Whereas the referendum didn't turned off automatically the existing plants but only certain seminal features of the plan of expansion of nuclear power, its effects were magnified by the renunciation of the political parties of any nuclear power present and future. This concluded the Italian nuclear programs, affecting also the research in nuclear sciences.

In the 1976, a study of the environmental impact was presented in respect of the location of the aforementioned nuclear reactor at Montalto di Castro, which would lead to the authorization for its construction in 1979. In 1977, Carlo Donat Cattin, Ministry of Industry in the third Giulio Andreotti government, issued an ultimatum to the Regions in order that they should indicate potential sites for the construction of 20 nuclear plants. So the government gave the word to local public opinion, located close to possible nuclear sites, and this permitted a shifting of attitude in the public opinion as a whole. Indeed the meantime strong protests were growing, from the local populations, committees, environmentalist associations, some minority political forces, and even local administrations. If not the majority of the whole population living near the nuclear sites, but in any case a very visible part of that population took part in big demonstrations at Montalto di Castro, Viadana, Suzzara, San Benedetto Po (in Lombardy, when the location of nuclear plants was proposed there); the associations World Wildlife Fund and "Italia Nostra" also produced documents and organized meetings. The Lombardy Region appointed a Commission of study on nuclear plants, and requested advice from the *Istituto Superiore di Sanità* (ISS) [Public Health High Institute]. A bipartisan front arose, based at the local level of the populations living near some plant sites. However, the majority of the political forces and Unions were strongly in favour of nuclear energy, including the majority of the Communist Party and the left-wing Union CGIL.

In any case, in response to these movements the political debate grew: the Commission of Industry of the Parliament held a fact-finding inquiry, and there was a Parliamentary debate.

However, a second national energetic plan was approved by Committee of economic program CIPE in December 1977, providing for the immediate construction of 12-13 nuclear plants, leaving the remaining 8 to after 1985. In response to this, the popular protests and demonstrations continued to grow. The more so when Romano Prodi, Ministry of Industry in the fourth Andreotti government, on 19 February 1979, authorized the construction of the plant in Montalto di Castro: just before the Three Mile Island accident, on 28th March 1979. During the same days the movie *China Syndrome*, with Jane Fonda, came out. In the meanwhile, in August 1978 the Garigliano plant had been shut down after several accidents.

In the USA, following the Three Mile Island accident, two commissions were appointed (headed respectively by John G. Kemeney, the President of Dartmouth College, and Mitchell Rogovin, of Nuclear regulatory commission), which invited the nuclear utilities to radically change their safety regulations, and proposed to authorize the nuclear plants far distant from residential areas, to provide emergency plans approved by a Federal agency for safety, and to provide for the evacuation of the population in case of accidents to a radius of 30-40 km. Both the reports circulated in Italy, offering the basis for the anti-nuclear ecologist movements.

In Italy, on the institutional side, in June 1979 the results of a fact-finding special ecological commission from the Senate garnered much of favourable opinions, except for the ecological associations WWF and “Italia Nostra”. In December, the new Ministry of Industry, Bisaglia, appointed a Committee on nuclear safety, which approved a document with the relevant opposition, and a minority report, from the three environmentalist representatives, denouncing the deficiency of the Italian safety rules with respect to the international ones. The National energetic plan was successively revised in 1980 and 1981, providing for the construction of nuclear plants of at least 6.000 MW (indicating potential sites in the Regions of Piedmont, Lombardy, Veneto, Tuscany, Campania, Puglia, and Sicily), with a Nuclear Unified Plan (PUN) based on the PWR Westinghouse reactor ostensibly in contradiction with the previous choice of the BWR Caorso plant from General Electric. It is worthy to note in these same years Italy had reduced from 25 to 16,5 % its participation in the Eurodif enrichment plant, and was obliged to undersell a part of the enriched uranium it had already acquired, following a down-sizing of its nuclear project. In the meantime, in 1982 CNEN acquired the new name of *Ente Nazionale per l'Energia Nucleare e le Energie Alternative* (ENEA) [National agency for Nuclear Energy and Renewable Energy], with a few changes, but with a new research section on renewable energies: an alternative choice, since the new 1985 PEN confirmed 12.000 MW of nuclear energy.

In the years 1981-1983 the opposition against nuclear energy grew further, as several municipalities expressed their opposition. A law in 1983 provided for economic incentives to those municipalities which had accepted nuclear and thermoelectric plants on their territory; besides nuclear power, also coal fuelled plants were pushed by the various national energetic plans. ENEA expressed its positive opinion for the suitability of the sites of Viadana and San Benedetto Po, and ENEL begun the geological tests. Anti-nuclear demonstrations, fights with police, and arrests followed. Two municipal popular referendums were held in Viadana (1984) and in San Benedetto Po (1985) in the Mantua neighbours, Lombardy, and opposition to the nuclear plants won out in both cases. In 1985 there was a big demonstration in Rome in which the protest against the deployment of Cruise missiles in Comiso, Sicily, merged with the local delegates protests against the localization of nuclear isles.

Just one month before the Chernobyl accident, the situation changed rapidly. On 20 March 1986 the CIPE approved the 4th PEN, providing only for the construction of the 2.000 MW plant at Montalto di Castro, plus 2.000 MW more at Trino Vercellese, in Piedmont (never begun), and the localization until 1986 of two more 2.000 MW plants each, respectively in Lombardy and Puglia; in addition, as recalled, it provided the acquisition of 400 MW from the 1.2000 MW fast reactor Superphénix under construction in France.

On 9-13 April 1986 in Florence, the Communist party held its XVII congress, in which an anti-nuclear motion was presented and attracted many votes. Two weeks later, on 26 April 1986 the Chernobyl accident happened. It made a deep impression amidst great concerns for the behaviour of the "Chernobyl cloud", and the public debate and polemic was thus revived. Local and national demonstrations (Rome, 10 May) proliferated. In July the gathering of signatures for a national referendum began. In October, after a huge demonstration at Montalto di Castro, the

Bettino Craxi (Italian Socialist Party) cabinet decided to halt the process, and called for a major Conference on Energy, which was held in February 1987, without any significant result.

The execution of the referendum, on 8-9 November 1987, was the prologue to the termination of Italian nuclear power. Promoted by the Radical Party, the referendum abrogated: the prerogative of CIPE to decide on the location of nuclear plants, when the interested municipalities were not able to decide; the compensation available for municipalities which hosted nuclear or coal plants; and the possibility for ENEL to participate in international nuclear programs let say the FBR. The 65% of having right citizens voted in the referendum. The first one stroke the 80,57% of favourable votes; the second one stroke the 79,70% of favourable votes; the third one stroke the 71,90% of favourable votes. It means that most of the electorate wasn't interested in the debate or voted against the abrogation, so to continue the nuclear programs.

4. Facts and figures

The purpose of this section is to give an overview of nuclear power in Italy. This section contains such data as number of reactors, reactors' locations, technical and chronological details of reactors' construction as well as statistics on electricity production, periodization and social connections to nuclear constructions. This data can be used as a supportive material to the following sections of the country report and in order to understand the overall country's situation. Key dates and abbreviations used in this report are presented in the beginning of this section.

4.1. Data summary

- Italy had four reactors in the past but shutdown two reactors after the Chernobyl accident.
- There were plans to build two new reactors but this project was cancelled.
- Italy is the only country in G8 that has no nuclear power plants however Italy imports about 10% of its electricity from nuclear power.
- Italy was active to build and plan new nuclear plants in the past despite antinuclear movements that were widespread in Europe in 1970s.

4.2. Key dates and abbreviations

Key dates:

1952	National Committee for Nuclear Research (CNRN)
1958	Construction of the first nuclear reactor for production of energy
1958	Construction of the second nuclear reactor
1960	CNRN was reorganized to the National Committee for Nuclear Energy (CNEN, now the ENEA)
1961	Construction of the third nuclear reactor
1962	Nationalization of the electricity sector and founding of Enel
1964	Latina NPP was acquired by Enel
1966	Enrico Fermi and Garigliano NPP were acquired by Enel
1966	Enel's plan to have 12,000 MWe of NPP installed by 1980
1967	CNEN and Enel began developing own nuclear heavy water reactor with light water cooling CIRENE (Italian version of Candu reactor)

1969	Enel orders the fourth power plant to Italy from GE/Ansaldo
1970s	Antinuclear movements
1972	Start of building CIRENE reactor at Latina site which later has never been operating neither finished
1974	Partnership with France and Germany to develop FBR type
1981	New energy plan contained three new nuclear power plants with two units each and 1,000 MWe each with technology from Westinghouse
1982	Start of construction of Montalto di Castro NPP with two units but the project was delayed because of local opposition
1986	New energy plan that called for increase of capacity of nuclear power plants, one month before the Chernobyl accident
1987	National Conference on Energy was positive about continuation of nuclear power developments
1987	Referendum in November, after which government decided to cancel nuclear power projects
1987	Latina NPP was closed in December
1990	Decision to shut down Caorso and Enrico Fermi NPPs
1999	Sogin state-owned company was founded in order to decommission nuclear facilities in Italy and allocate the waste
2004	Energy law that allowed importing electricity from foreign nuclear power companies
2007	Public opinion of 800 respondents showed that 83% were against nuclear power in Italy
2008	Plans of government to return to nuclear power and build new NPPs
2008	Public opinion of 800 respondents showed that 54% were in favour of nuclear power in Italy
2009	Official legislation of government to have 25% of Italian electricity generated by own nuclear power by 2030
2010	Legislation and framework to site nuclear power plants with agreement with local governments
2010	Strong local opposition against nuclear power and bids to the Constitutional Court
2010	Eurobarometer survey on nuclear power in Italy showed that 62% of respondents were for decrease of nuclear energy share
2011	Constitutional Court decided to provide a public referendum on nuclear power in Italy that received a strong opposition votes against all proposals by Mr Berlusconi and plan to have 25% of nuclear power share by 2030

2011	Government decided a one year postpone of nuclear power construction after Fukushima accident

Abbreviations:

CNEN	National Committee for Nuclear Energy
CNRN	National Committee for Nuclear Research
ENEA	National Institute for Research and Development of Nuclear and Alternative Energy (Ente Nazionale per la Ricerca e lo Sviluppo dell'Energia Nucleare e delle Energie Alternative)
Enel	National Agency for Electric Energy (Ente Nazionale per l'Energia Elettrica)
FBR	Fast breeder reactor
MWe	Megawatt electrical
NPP	Nuclear power plant
Sogin	Nuclear Plant Management Company (Società Gestione Impianti Nucleari)
WNA	World Nuclear Association

4.3. Map of nuclear power plants

Figure 1 represents a map of nuclear power sites in Italy.

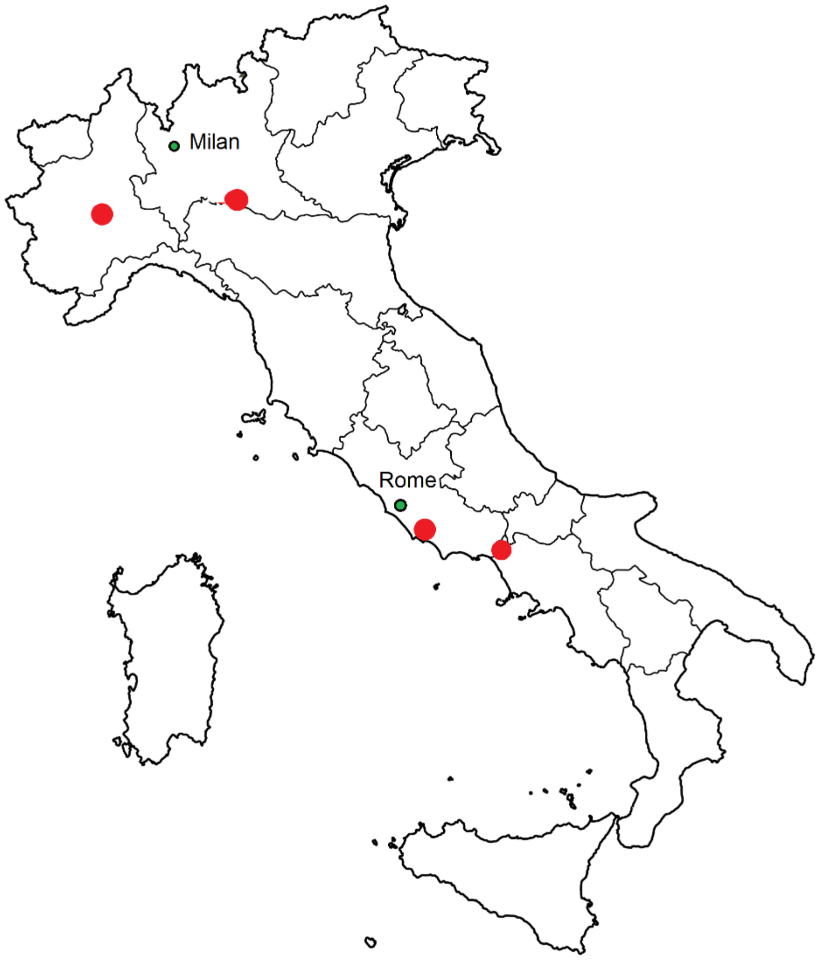

Figure 1 – Nuclear power plants in Italy

4.4. List of reactors and technical, chronological details

Tables below shows the list of reactors, suppliers, operators as well as date details.

Table 1 - Operational and projected commercial nuclear power reactors in Italy. Source: IAEA 2016; WNA 2016.

No.	Name	Operator	Supplier	Type	MWe net	Construction began	Grid date/ power	Shutdown	Status
1	**Caorso**	Sogin	GE/Ansaldo	BWR	860	1970	1978	1990	Permanent shutdown
2	**Enrico Fermi**	Sogin	Westinghouse	PWR	260	1961	1964	1990	Permanent shutdown
3	**Garigliano**	Sogin	General Electric	BWR	150	1959	1964	1982	Permanent shutdown
4	**Latina**	Sogin	Magnox	GCR	153	1958	1963	1987	Permanent shutdown
5	**Montalto di Castro 1&2**	-	-	BWR	982	1982	-	-	cancelled

4.5. Overview of statistics on electricity production

A general overview concerning the data on the energy sector in Italy are available on the OECD website[1]. In the following chart a recap of the main indicators contained in the Energy Statistics of the OECD Countries for the period 2010-2014.

	2010	2011	2012	2013	2014
Primary Energy Supply Total, Toe/1000 US dollars	0,100	0,098	0,097	0,095	0,090
Crude Oil Production Total, Thousand toe	5 079.03	5 282.99	5 395.97	5 500.95	5 762.90
Electricity Generation Total, Gigawatt-hours	290 747	291 441	287 802	278 833	-
Renewable Energy Total, Thousand toe	169 992	166 893	161 311	155 372	146 227
Nuclear Power Plants Total, Number	0	0	0	0	0
Crude Oil Import Prices Total, US dollars/barrel	79,3	110,2	112,2	110,0	99,1

The following data presented in this country report were collected in the first instance by the Italian *Autorità per il sistema elettrico il gas e il sistema idrico* and published in the Annual Report 2016 disclosed for the first time on 21th June 2016 at the Italian Chamber of Deputies in Rome[2]. The Italian Regulatory Authority for Electricity Gas and Water is the independent body which regulates, controls and monitors the electricity and gas markets in Italy. It has been established by the law November 14th 1995, n.481 with the purpose to protect the interests of users and consumers, promote competition and ensure efficient, cost-effective and profitable nationwide services with satisfactory quality levels.

The Authority mission includes defining and maintaining a reliable and transparent tariff system, reconciling the economic goals of operators with general social objectives, and promoting environmental protection and the efficient use of energy. It provides an advisory and reporting

[1] OECD (2016), Primary energy supply (indicator). doi: 10.1787/1b33c15a-en (Accessed on 30 June 2016)
[2] http://www.autorita.energia.it/it/relaz_ann/16/16.htm

service to the government and parliament, and formulates observations and recommendations concerning issues in the regulated sectors of electricity and gas.

Energetic National Balance Sheet 2014-2015 (Mtep)

	Solids	Gas	Oil	Renewables	Electric Energy	Total
2015						
1 Production	0,30	5,55	5,47	31,41	-	**42,72**
2 Import	13,19	50,12	81,28	1,86	11,18	**157,64**
3 Export	0,26	0,18	27,04	0,11	0,98	**28,57**
4 Variation reserves	-0,22	0,19	0,50	0,03	0,00	**0,50**
5 Available for internal consumption (1+2+3-4)	13,46	55,30	59,21	33,13	10,20	**171,29**
6 Consumption losses in energetic sector	-0,11	-1,61	-3,62	-0,01	-41,28	**-46,64**
7 Transformation in Electric Energy	-10,61	-17,11	-2,23	-25,64	55,59	**-**
8 Total final use (5+6+7)	2,73	36,58	53,35	7,48	24,50	**124,65**
- Industry	2,68	11,47	3,95	0,03	9,31	**27,44**
- Transport	-	0,90	36,73	1,15	0,91	**39,69**
- Civil Uses	0,00	23,50	3,01	6,29	13,82	**46,62**
- Agriculture	-	0,14	2,14	0,01	0,47	**2,75**
- Non-energetic Uses	0,06	0,57	4,95	-	-	**5,57**
- Storage	-	-	2,58	-	-	**2,58**
2014						
1 Production	0,35	5,86	5,77	32,61	-	**44,58**

2 Import	13,46	45,67	71,19	2,22	10,28	**142,83**
3 Export	0,24	0,19	20,31	0,14	0,67	**21,55**
4 Variation reserves	-0,12	0,62	-	-0,63	0,02	**-0,11**
5 Available for internal consumption (1+2+3-4)	13,69	50,71	57,27	34,67	9,62	**165,97**
6 Consumption losses in energetic sector	-0,12	-1,68	-3,55	-0,01	-40,84	**-46,20**
7 Transformation in Electric Energy	-10,65	-14,65	-2,34	-27,79	55,43	**-**
8 Total final use (5+6+7)	2,93	34,39	51,38	6,87	24,21	**119,77**
- Industry	2,85	11,87	3,98	0,03	9,20	**27,93**
- Transport	-	0,86	35,33	1,03	0,90	**38,12**
- Civil Uses	0,00	21,02	2,94	5,80	13,65	**43,42**
- Agriculture	-	0,12	2,13	0,01	0,46	**2,71**
- Non-energetic Uses	0,08	0,51	4,71	0,00	-	**5,30**
- Storage	-	-	2,29	-	-	**2,29**

Gross Production per source 2011-2015 GWh

SOURCES	2011	2012	2013	2014	2015[3]
Thermoelectrical Production	**217.674**	**205.075**	**175.897**	**157.439**	**171.108**
Solids	44.726	49.141	45.104	43.455	43.600
Natural Gas	144.539	129.058	109.876	93.637	107.600
Petroleum Products	8.474	7.023	5.418	4.764	4.700
Others	19.935	19.852	16.499	15.583	15.208
Pumped Hydroelectrical	**1.934**	**1.979**	**1.898**	**1.711**	**1.369**
Renewable Energy Sources	**82.962**	**92.222**	**112.008**	**120.679**	**109.561**
Hydroelectrical	45.823	41.875	52.773	58.545	43.894
Aeolian	9.856	13.407	14.897	15.178	14.676
Photovoltaic	10.796	18.862	21.589	22.306	25.206
Geothermic	5.654	5.592	5.650	5.916	6.181
Biomasses	10.832	12.487	17.090	18.732	19.604
TOTAL PRODUCTION	**302.570**	**299.276**	**289.803**	**279.829**	**282.038**

[3] Provisional Data

Production and demand of electric energy in Italy – Historical data 1963-2014 (GWh)

Year	Gross Production						Energy allocation			
	Hydroelectrical	Thermoelectrical	Geothermic	Nuclear	Aeolian & Photovoltaic	Total	Auxiliary Services	Pumping	International Exchange Balance	Energy demand
1963	46.107	22.487	2.427	323		71.344	1.919	517	+1.299	70.207
1964	39.328	32.482	2.527	2.402		76.739	2.407	513	+1.002	74.821
1965	43.008	33.874	2.576	3.510		82.968	2.636	569	+331	80.094
1966	44.321	39.176	2.633	3.863		89.993	3.215	876	+842	86.744
1967	42.949	48.118	2.610	3.152		96.829	3.636	888	+1.910	94.215
1968	43.477	55.264	2.694	2.576		104.011	4.138	1.177	+2.116	100.812
1969	42.001	64.002	2.765	1.679		110.447	4.516	1.205	+2.480	107.206
1970	41.300	70.222	2.725	3.176		117.423	5.005	1.360	+3.965	115.023
1971	40.019	78.812	2.664	3.365		124.860	5.550	1.389	+1.661	119.582
1972	42.715	86.338	2.582	3.626		135.261	6.079	1.984	+200	127.398
1973	39.125	100.771	2.480	3.142		145.518	6.934	2.337	+879	137.126
1974	39.346	103.647	2.502	3.410		148.905	7.168	2.247	+2.293	141.783
1975	42.576	98.474	2.483	3.800		147.333	6.929	2.271	+2.581	140.714
1976	40.943	116.277	2.523	3.807		163.550	7.918	2.583	+1.088	154.137
1977	52.726	107.933	2.501	3.385		166.545	7.553	2.271	+2.777	159.498
1978	47.413	120.706	2.494	4.428		175.041	8.272	2.785	+2.126	166.110
1979	48.212	127.924	2.500	2.628		181.264	8.671	3.265	+5.393	174.721
1980	47.511	133.350	2.672	2.208		185.741	9.037	3.249	+6.083	179.538
1981	45.736	130.549	2.664	2.707		181.656	8.965	3.917	+9.632	178.406
1982	44.080	130.823	2.737	6.804		184.444	9.158	3.736	+7.151	178.701

1983	44.216	130.167	2.714	5.783		182.880	9.083	3.909	+11.082	180.970
1984	45.434	127.508	2.840	6.887		182.669	9.229	4.278	+20.890	190.052
1985	44.595	131.440	2.681	7.024		185.740	9.486	4.950	+23.669	194.973
1986	44.531	136.281	2.760	8.758		192.330	9.724	4.786	+22.114	199.934
1987	42.585	155.627	2.986	174		201.372	10.476	4.216	+23.146	209.826
1988	43.547	156.932	3.082	-		203.561	10.385	3.902	+31.256	220.530
1989	37.484	170.111	3.155	-		210.750	11.046	4.714	+33.729	228.719
1990	35.079	178.590	3.222	-	..	216.891	11.640	4.782	+34.655	235.124
1991	45.606	173.253	3.182	-	..	222.041	11.577	4.577	+35.082	240.969
1992	45.786	176.995	3.459	-	3	226.243	11.810	4.946	+35.300	244.787
1993	44.482	174.634	3.667	-	5	222.788	11.431	4.189	+39.432	246.600
1994	47.731	180.648	3.417	-	8	231.804	11.642	4.150	+37.599	253.611
1995	41.907	196.123	3.436	-	14	241.480	12.272	5.626	+37.427	261.009
1996	47.072	193.551	3.762	-	39	244.424	12.058	6.882	+37.389	262.873
1997	46.552	200.881	3.905	-	124	251.462	12.174	6.728	+38.832	271.392
1998	47.365	207.970	4.214	-	237	259.786	12.843	8.358	+40.732	279.317
1999	51.777	209.068	4.403	-	409	265.657	12.920	8.903	+42.010	285.844
2000	50.900	220.455	4.705	-	569	276.629	13.336	9.129	+44.347	298.510
2001	53.926	219.379	4.507	-	1.183	278.995	13.029	9.511	+48.377	304.832
2002	47.262	231.069	4.662	-	1.408	284.401	13.619	10.654	+50.597	310.726
2003	44.277	242.784	5.340	-	1.463	293.865	13.682	10.492	+50.968	320.658
2004	49.908	246.125	5.437	-	1.851	303.321	13.299	10.300	+45.635	325.357
2005	42.927	253.073	5.324	-	2.347	303.672	13.064	9.319	+49.155	330.443
2006	43.425	262.165	5.527	-	2.973	314.090	12.864	8.752	+44.985	337.459
2007	38.481	265.764	5.569	-	4.073	313.888	12.589	7.654	+46.283	339.928
2008	47.227	261.328	5.520	-	5.054	319.130	12.065	7.618	+40.034	339.481
2009	53.443	226.638	5.342	-	7.219	292.642	11.534	5.798	+44.959	320.268
2010	54.407	231.248	5.376	-	11.032	302.062	11.314	4.454	+44.160	330.455
2011	47.757	228.507	5.654	-	20.652	302.570	11.124	2.539	+45.732	334.640
2012	43.854	217.561	5.592	-	32.269	299.276	11.470	2.689	+43.103	328.220
2013	54.672	192.987	5.659	-	36.486	289.803	10.971	2.495	+42.138	318.475
2014	60.256	176.171	5.916	-	37.485	279.829	10.681	2.329	+43.716	310.535

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WP2

Lithuania

Short Country Report

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HoNESt History of Nuclear Energy and Society

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CONTENTS

Executive Summary

This report belongs to a collection of 20 short country reports on the History of Nuclear Energy and Society (HoNESt, project Ref.662268). The reports tackle the complex sociotechnical system around nuclear energy. Nuclear developments, notably nuclear energy, are closely intertwined with social, economic, environmental, political and cultural spheres. Nuclear energy is also a globalized system involving transnational transfers of knowledge, materials, technologies, people and products including electrical power, medical elements, toxic wastes and other environmental hazards, materials, capacities and knowledge that must be carefully safeguarded. Nuclear energy is a complex social and technological phenomenon that influences societies but is also shaped by societies.

The short country reports are designed to assemble information and research results on the history of the relations between nuclear energy and society in an accessible manner, and to document the findings with references.

The purpose of the country reports is threefold, addressing three different audiences:

1. To provide basic elements of narrative and analysis for further historical research by HoNESt researchers;
2. To provide information, context and background for further analysis for HoNESt's social science researchers;
3. To provide accessible information on nuclear-societal relations in the various countries for the purposes of outreach and communication with stakeholders (civil society, industry, associations, policy makers, journalists).

This report focuses on the history of the relations between nuclear energy and society in Lithuania. From the first years of construction until its full decommissioning in 2009, the Ignalina NPP shaped relations between the population and the authorities, as far as nuclear policy is concerned. The case of the Ignalina NPP demonstrates how different claims were articulated and used by scientists and experts, political actors and grass-roots organizations from the Soviet period to Lithuania's accession to the European Union (EU). It illustrates the interplay of the pro- and anti-nuclear contexts of debates over politics, the environment and citizenship.

1. Historical context (narrative)

1.1. The Ignalina Case: Public Engagement vs. Soviet Nuclear Exceptionalism?

The Ignalina Nuclear Power Plant was built on the territory of the Lithuanian Soviet Socialist Republic between 1975 and 1987. Located in a forest park on the banks of Druksai Lake on the border with the Byelorussian Soviet Socialist Republic the Ignalina NPP is furnished by the two largest RBMK reactors in the world with a generating capacity of 1,500 MWe. The Ignalina NPP is similar to other NPPs with the RMBK type reactor in terms of its design and operational characteristics; as such it constitutes the Soviet technological legacy. Despite being more powerful and being furnished with an Accident Confinement System (ACS), the Ignalina NPP is similar to the Leningrad, Kursk, Chernobyl and Smolensk NPPs. This is because all of them possessed such technical and operational characteristics as “two cooling loops, a direct cycle, fuel clusters [which] are loaded into individual channels rather than a single pressure vessel, the neutron spectrum is thermalized by a massive graphite moderator block” (Almenas, Kaliatka, and Uspuras 1998, 17). Because of its online re-fuelling capability the RMBK reactor technology had never been exported outside the USSR.

The Soviet techno-political system was built as a monumental iconography of the victory of science and technology over the power of nature. Josephson (1996) has noted that Soviet-style technology differed from the European and the US styles in that it seemed to fit the mass production of monumental industrial objects, so-called “gigantomania.” This victorious gigantomania combined with standardization and centralized bureaucracy which created the conditions for “functional designs in which safety and comfort played a secondary role, and environmental issues were rarely raised” (Josephson 1996, 300). Although Soviet engineers considered safety an inherent factor in reactor design, and in the way it was constructed, as Josephson shows, Soviet engineer-physicists “demonstrated their conviction that reactor technology could be made inherently safe. They designed the Chernobyl-type channel graphite (RBMK) reactor with a positive void coefficient … ignoring the chance of ‘highly improbable’ accidents (like the one at Chernobyl that occurred during an ill-advised experiment). The RBMK also was designed to reload fuel without a complete shutdown; there are reinforced concrete plugs on top of the reactor for ease of refuelling that could blow apart during an explosion” (1996, 308).

Before the 1980s nuclear energy, in the context of economic and industrial developments in the USSR, had been challenged by controversial political processes of decentralization and centralization, by multiple technological choices, negotiations and confrontations inside the scientific community and within the Soviet political system, as well as by organizational changes in nuclear governance. This flux remained until it became an undisputed agenda for national energy programs and a part of USSR’s large-scale planning processes.

“By the late 1960s, the change in how proponents justified nuclear energy was complete. The industry’s fundamentally altered institutional status allowed a rhetoric of economic efficiency to dominate arguments over nuclear energy’s role in the country’s development” (Schmid 2015, 39).

The implementation of nuclear technology within national nuclear programs became possible due to the technological choices made in 1970 and mediation of the central political institutions. In the beginning of 1970s the necessity and feasibility of civilian nuclear energy programs appear as controversial within scientific and political contexts. However, in the 1980s, the use of nuclear energy in national energy programs became less contested and the local administrative bodies were involved with different degrees in its implementation. The countrywide nuclear program moved to the forefront of the national energy mix. The civil nuclear became a political agenda; the feasibility of the Soviet nuclear program was no longer questioned.

After Chernobyl, the focus informing the choice between different types of reactors shifted from scientific and technological preoccupations towards safety and future of the RBMK reactors. In other words, safe reactor design became a transnational techno-political concern. This is not without pressure from other countries: for example, international experts and politicians used this lack of safety culture as a reason to stop the export of Soviet reactors into Europe (Wellock 2013).

According to the general Soviet planning in the 1970s, the Ignalina NPP was among the nuclear plants with RMBK reactors to be constructed in the European part of the USSR as an integral part of the Soviet Union’s North-West Unified Power System: in the Northern part - the Leningrad NPP, in the Eastern part - the Smolensk NPP, and in the Southern part - the Chernobyl NPP. Moreover, although the NPP in the neighbouring Byelorussian Soviet Socialist Republic was never constructed, it was designed with another type of reactor. (See Belarus SCR)

Following this plan the first reactor of the Ignalina NPP started operation in 1983, with the actual launch of the reactor in 1982. As Josephson (1996, 2005) noted in his research on Soviet nuclear programs, civil nuclear power was informed by the strong political and ideological commitment to link political and social development with technological and innovative progress: “For citizens, scientists, and officials alike, successes in atomic energy provided undeniable confirmation that at long last society had embarked on the final leg of the long journey to communism.” (1996, 297)

From the first years of construction until its full decommissioning in 2009, the Ignalina NPP shaped relations between the population and the authorities, as regard to nuclear policy. During various transformations, from exiting the USSR to accessioning to the EU, the Ignalina NPP offered public actors different means of claiming practices - expertise, sovereignty, governance and citizenship.

Timeline	Ignalina Nuclear Power Plant (INPP)
1971 – 1988	**The Ignalina NPP as a part of the Soviet nuclear program** The decision about the construction of the Ignalina NPP was made on the 16 September 1971. Following this plan the first reactor of the Ignalina NPP came on line in 1983. Scientific disputes between the Soviet Academy of Sciences and Lithuanian Academy of Sciences were taking place regarding the Ignalina NPP’s site, as well as the 3rd and 4th reactors at the INPP. After the accident at Chernobyl occurred, the political responses and immediate identification of technical errors during the INPP construction works was made.
1988 – 1991	**The Ignalina NPP and anti-nuclear, environmental and nationalist mobilization** This period can be characterised by the following processes: • Development of social and political movements; • Formation of the environmental, political and independence agenda; • Ring of Life around the Ignalina NPP; • Tensions within the central Soviet political and academic institutions.

1991-1994	**The Ignalina NPP and political and energy transitions** The following was taking place: • Reestablishment of political and national independence; • Economic and Energy Crises; • Political and Economic Transformations; • Formation of an independent energy system; • Nuclear and Radiation Safety Advisory Committee (NRSAC) working on safety; the committee upgraded and built a strong regulatory and technical infrastructure of the nuclear facilities.
1994-2004/2008	**The Ignalina NPP as new energy and political agenda** Safety system was improved; the INPP was technically upgraded according to the European standards; The EU and INPP politically negotiated; A National Referendum on the future of the INPP was held.
2008-2014	**The Ignalina NPP and revival of the debates on nuclear energy** During this time a new NPP project, the Visaginas NPP, was being developed. Another National Referendum, this time regarding nuclear program developments, was organised. That resulted in suspension of the political decision on the Visaginas NPP. Political tensions with Belarusian authorities about the construction of the Belarusian NPP became noticeable.

The case of the Ignalina NPP demonstrates how different claims were articulated and used by scientists and experts, political actors and grass-roots organizations from the Soviet period to the moment of Lithuania' accession to the European Union. It illustrates the interplay of the pro- and anti-nuclear narratives of political, environmental and citizenship debates.

The Ignalina NPP is not an ordinary case of nuclear decommissioning, or of the end of "inherently unsafe Soviet technology". This is a case of the establishment of nuclear techno-politics in Lithuania, and of the relationships between political institutions and the public, between ethnic groups and authority, scientists and politicians, as well as between individual and collective actions as they engage with nuclear issues.

If the scientific mobilization of the 1980s was against the construction of a NPP on the territory of Lithuania, then political and nationalist responses at the end of the 1980s were deeply linked to issues of national identity and sovereignty. During the 1990s anti-nuclear claims were framed in terms of energy independence and sufficiency, and then became an issue for EU accession. In the late 2000s, after the second reactor was shut down, anti-nuclear claims reappeared in the context of debates about the revival of a national nuclear program, in line with a broader movement called the "nuclear renaissance". (See Russia SCR)

The capacity of the State to exert sovereignty remains crucial in nuclear techno-politics. The nationalist mobilization in Lithuania at the end of the 1980s was clearly linked to control over the Ignalina NPP as well as over domestic natural resources with claims of independence. Within political declarations and programs the requirement of the withdrawal of Russian's nuclear weapons from Lithuania was also mentioned. Political claims over nuclear energy both concerned military and civilian uses. In the post-Soviet world, nuclear power continues to produce or reproduce the same geopolitical choices: for the Lithuanian government the Ignalina NPP served as an engine for clamouring for its exit from the USSR and later as a condition of its accession to the EU.

The collapse of the USSR fell in the same symbolic frame as the disastrous impacts of the accident at Chernobyl but also marked an important political transformation that allowed the introduction of an independent nuclear regulatory regime in Lithuania. This period concerned not only the transfer of nuclear facilities and infrastructures from Russia to Lithuania, but also the emergence of new political actors, as well as of new public and social engagements in the field of nuclear power. During this stage the INPP has become an object of multiple controversies.

In the 1990s the transformative effects on policy issues played a significant role. The political and economic transitions produced an uncertain effect on the Ignalina case. Rinkevicius (2000) argues that during the 1990s Lithuania faced a "double risk": the transition to a new political and economic model accompanied by social anxiety about old and new institutions. The case of the Ignalina NPP illustrated this interplay of political and environmental risks.

After the 1990s anti-nuclear claims were introduced into new democratic procedures and tools, such as public opinion surveys and referendums. Anti-nuclear activism was replaced by nuclear attitudes. As Hecht notes, the participatory processes and institutions could make nuclear objects visible and actionable (2012, 325). The Ignalina case was an example of how, in a more democratic regime, political lock-in faces new democratic procedures that do not—or perhaps cannot—ensure that a political decision will be revised according to issues of democratic legitimacy. The Lithuanian authorities until now, after the Ignalina NPP shutdown and the negative result in the referendum concerning the construction of a new NPP, are postponing the final decision about a nuclear power program in the country and are not daring to put an end to the nuclear story in Lithuania. The Ignalina NPP does not produce energy any more but still "leaves room for the possibility of recruiting nuclearity for better governance" (Hecht 2012, 338).

Nuclear exceptionalism, as the "difference manifested in political claims, technological systems, cultural forms, institutional infrastructures, and scientific knowledge" (Hecht 2012, 6), concerns the distribution and redistribution of political qualities: how the relationships in nuclear techno-politics are negotiated and rebalanced. The Ignalina case opened nuclear issues for Lithuanian public, authorities, scientists and activists and has translated different meanings of nuclear in various arenas: citizenship, sovereignty and governance, environmental and effective regulation. Anti-nuclear activism is a part of this convergence of the meanings in debates contributing to the importance of nuclear issues; both to its exceptionalism and banality.

1.2. List of events

Event 1: The Start Up of the First Unit of the Ignalina NPP on 31 December 1983

This event illustrates the relationship between the central and local political and scientific bodies in the USSR and outlines the first set of arguments used in opposition to INPP construction and reproduced at the later stages. In addition to taking into the consideration the relationship between Soviet authorities and general public in the field of the civil nuclear development in Lithuania, this event focuses on media coverage of the launch of INPP and illustrates the ideological commitment within Soviet nuclear uses.

Event 2: The Chernobyl Nuclear disaster on 26 April 1986 and its disastrous consequences

The accident at the Chernobyl NPP in Soviet Ukraine had an impact on civilian nuclear power use and development as well as on social attitudes to nuclear power. This is a key event for analysis of the Soviet and Post-Soviet nuclear programs, including in the Lithuanian case. It illustrates firstly increasing uncertainties amongst the nuclear personnel, operators and engineers of the INPP, local political actors and of course amongst the public. The post-Chernobyl shifts in nuclear discourses in Lithuanian case concerned mostly the safety of RMBK reactors and established a framework for debates on nuclear decommissioning

Event 3: The Rally “The Ring of Life” (16-18 September 1988)

This rally took place on the site of INPP on 16-18 September 1988 and was organized by the Lithuanian Movement for Reforms, Sąjūdis. It was the first national anti-nuclear protest under Soviet rule in Lithuania and became possible due to the relaxation of restrictions on political mobilization due to Gorbachev’s policy of perestroika. This event had pronounced political and symbolic significance. It aimed not only at the mothballing of construction of the 3rd unit of the NPP and the temporary closing of units 1 and 2, but also the transfer of control over INPP from Moscow to Lithuanian authorities.

Event 4: The Decommissioning of the First Nuclear Unit of the Ignalina NPP on 31 December 2004

This event demonstrates all the difficulties, debates and contradictions within the processes of admitting Lithuania to the EU and the decommissioning of INPP. The decision about decommissioning has appeared as an irrevocable and inevitable decision without taking into account all the national arguments about energy independence, the costs of altering and upgrading technology. In this case nuclear techno-politics clearly linked Soviet nuclear technology and culture with the political issues concerned with EU admission as well as the incompatibility of democratic modes of governance with an outmoded technology created under totalitarian rule.

Event 5: The National Referendum about new NPP construction in 2012

A second referendum about nuclear power in Lithuania in 2012 concerned whether to build new NPPs, the first one held in 2008 (with insufficient turnout) concerned decommissioning INPP. The two events are linked by the changing public attitudes towards nuclear power and illustrate the linkages and fluctuations between political strategies and public opinion. This event considers public opinion discourse in Lithuania about the content and measurement of nuclear attitudes as a form of civic engagement and participation.

1.3. Presentation of main actors

Name/Title	Institutional/Formal/Informal Role	Actor Category Promoter/Receptor/ Regulator
Žukauskas, Algirdas	Chairman of the nuclear energy commission of the Lithuanian Academy of Sciences, Vice-President 1966-1992	Receptor
Styra, Boleslovas	Institute of Physics, Director of the sector of radioactivity of atmosphere (1967-1993), A.M. of Lithuania Academy of Sciences	Receptor
Vilemas, Yurgis	Institute of the Energetics, Lithuanian Academy of Sciences,1966-1986.	Receptor
Brasauskas, Algidras	Secretary of the Central Committee of the Communist Party of Lithuania, 1977-1987	Receptor
Semionov, Nikolaj	Vice Minister of SredMash, 1971	Regulator, promoter
Burnazian, Avetik	Vice Minister of Health, State Sanitary Doctor of the USSR, 1956-1981	Promoter
Griškevičius, Petras	Secretary of the Central Committee of the Communist Party of Lithuania, 1974-1987	Receptor
Sakalauskas, Vytautas	Chairman of the Council of Ministers of LSSR,1985-1990	Receptor
Maniušis, Juozas	Chairman of the Council of Ministers of LSSR, 1967-1981	Receptor
Brezhnev, Leonid	Secretary of the Central Committee of the Communist Party, 1964-1982	Promoter
Kosygin, Alexei	Chairman of Council of Ministers of USSR, 1964-1980	Promoter
Tikhonov, Nikolai	Chairman of Council of Ministers of USSR, 1980-1985	Promoter
Slavskii, Efim	The Ministry of Medium Machine-Building Industry of the USSR, 1957-1986	Regulator, promoter
Sniečkus, Antanas	Secretary of the Central Committee of the	Receptor

	Communist Party of Lithuania, 1940-1974	
Neporojnij, Piotr	Minister of Energy of the USSR, 1962-1985	Promoter
Mikalauskas, Vladas	Chairman of the Direction of Geology (Council of Ministers of LSSR), 1986-1978	Receptor
Grigelis, Algimantas	Director of the Lithuanian Research Institute of Geology, 1963-1977	Receptor
Gorbachev, Michail	Secretary of the Central Committee of the Communist Party, 1985-1991	Promoter
Ryzhkov, Nikolai	Chairman of Council of Ministers, 1985-1991	Promoter
Solomentsev, Mikhail	Chairman of the Communist Party Control Committee, 1983-1988	Regulator
Vaišvila, Zigmas	Lithuanian Academy of Sciences, Institute of Physics, environmental group, Žemyna, Movement for Reforms, Sąjūdis (1981-1991)	Receptor
Shevaldin, Viktor	General Director of the INPP, 1991- 2010	Regulator
Demčenko, Michail	Engineer, Senior and First Category Engineer in Ignalina NPP's Nuclear Safety Division (1983–1991), Nuclear Safety Expert, Head of Safety Assessment Division, Deputy and Acting Head of VATESI (1991-2012). Head of VATESI.	Regulator
Juozaitis, Rymantas	Chairman of the Board "LEO" (2008-2009)	Promoter

2. Showcase: Political and Energy Transitions

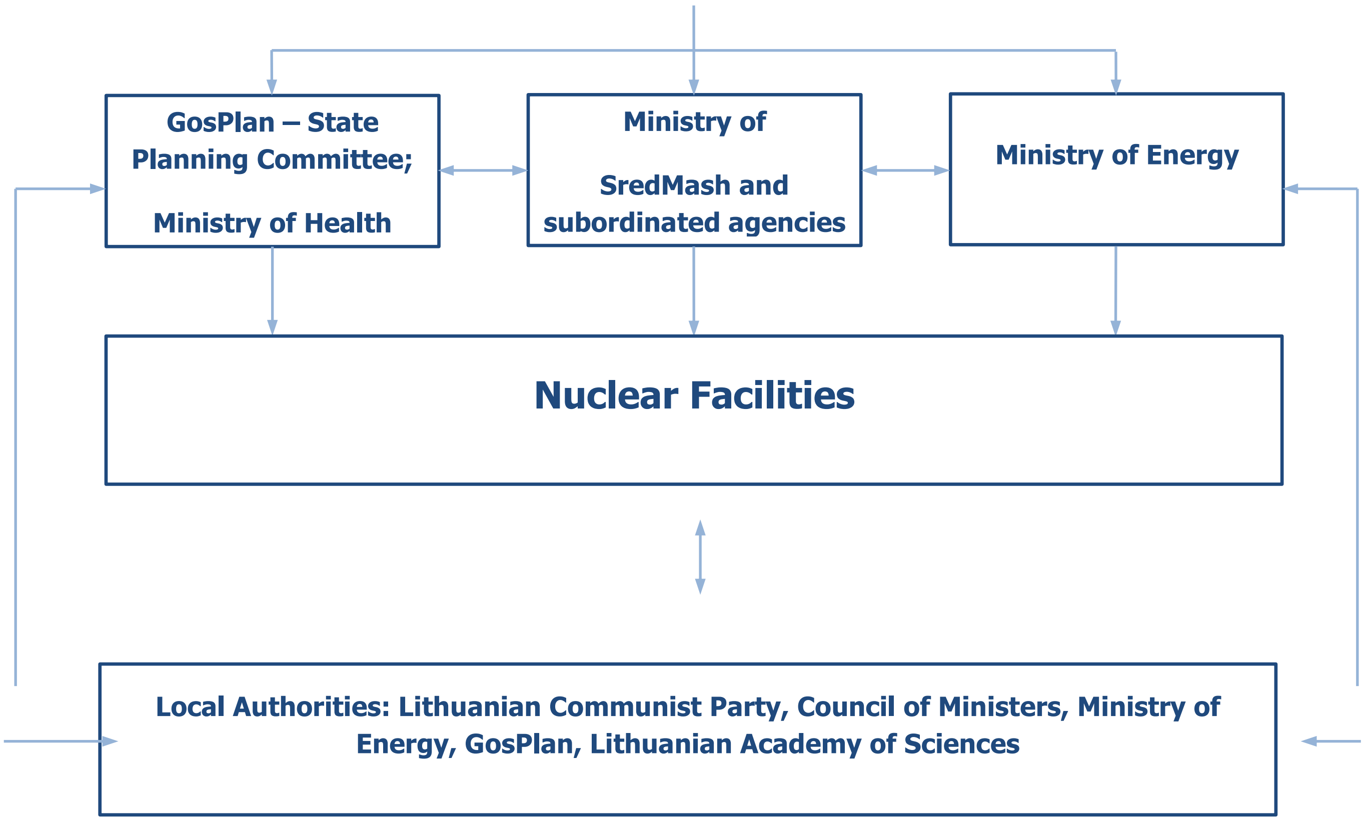
How to (re)establish the legitimacy of civil nuclear power in a country undergoing economic, political and energy transitions? How to make the Ignalina NPP both necessary and feasible for the national economy, energy system, social and natural environment? These are questions faced by Lithuanian authorities after the collapse of the USSR. The Lithuanian authorities exert sovereignty in nuclear industry and have diversified the uses of nuclear energy: for economic rationale (in a scarce energy system with increasing industrial demands), for political commitment (to obtain admission to the EU, and to break from dependence on the Russian energy system), for scientific reputation and for new nuclear governance and bureaucracies.

Following the post-soviet context of transition the case of the INPP appears as a showcase of the breaks within the Soviet nuclear decision-making and large scale industrial and energy systems. Firstly, it concerns the *institutional transition*, the relationships between Soviet central institutions and Lithuanian governmental bodies. Secondly, this period illustrates various *nuclear attitudes* in decision-making and in public opinion. And thirdly, this showcase is about how during the 1990s the civil nuclear program in Lithuania was affected not only by Chernobyl but also by the *geopolitical qualities* of post-Soviet economic and political relations.

Institutional Transitions. Soviet nuclear policy was implemented through a vertical and centralized system of decision-making and implementation. The central state body responsible for nuclear innovation, investigation, construction and control, was the Ministry of Medium Machine Building (Sredmash). The Ministry of Energy was responsible only for serial production of reactors, i.e. after Sredmash had launched the first version of a new reactor. There was an intense rivalry between these two bodies over the nuclear production and post-production: “The division of responsibilities, however, implied a hierarchy of expertise in which the Sredmash leadership considered Minenergo’s nuclear capabilities inferior to their own. This attitude, in turn, deepened existing rivalries and blurred responsibilities. More fundamentally, it led to asymmetries in the degree of agency, level of experience, and access to and distribution of knowledge” (Schmidt 2015, 61-62)

Usually the local level of government, i.e. of the Soviet Socialist Republics, never participated directly in nuclear decision-making; local voices were seldom taken into account under Soviet rule:

"[the] Soviet Lithuanian Republic did not participate at the political level in the nuclear decision-making. The Lithuanian scientists were involved in the process of the investigation of the possible locations of the INPP but have never participated in the selection processes. The decision about the choice of the nuclear site was taken directly by central institutions".[1] This kind of exclusion created tension between local authorities and the central one.

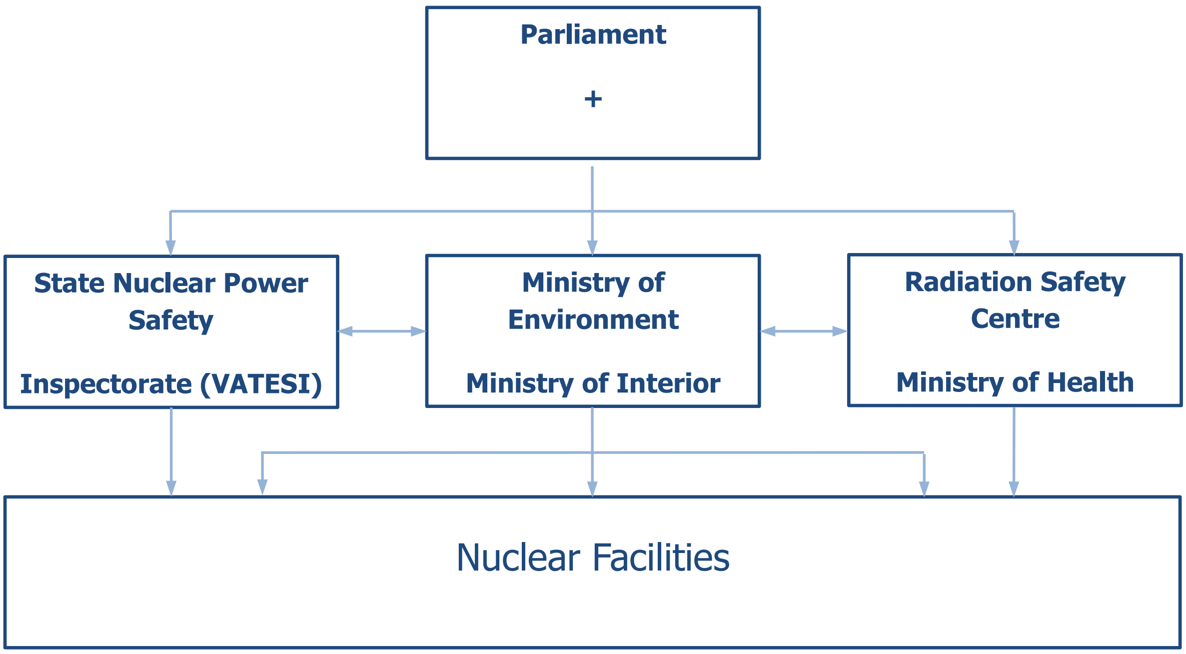


The competing relations between nuclear bureaucracies, Minenergo and Sredmash, had created a volatile environment for the implementation of national nuclear programs in the Soviet Socialist

[1] Jurgis Vilemas, professor, expert interview, Kaunas, 1.07.16

Republics. In the 1980s these relations were diluted by the tensions between governmental bodies in the Soviet Socialist Republics and central institutions. These organizational and institutional shifts shaped the trajectories of governments' manoeuvres in Soviet Socialist Republics and resulted in the eventual collapse of the Soviet institutions during *perestroika*.

In the 1990s the new model of regulatory regime was established as a result of the transfer of the nuclear facilities to the control of Lithuanian authorities after the dissolution of the USSR: "In this transition period it was highly important to organize two processes: the transition of nuclear governance functions from Central Soviet bodies to the Lithuanian authorities and the creation of the new independent State supervision institution over the safe uses of the nuclear energy. In creation of this new regulatory regime the lessons from the Chernobyl disaster were taken into account" [2]. VATESI was a newly created state body responsible for regulation and supervision of nuclear power safety. The INPP was subordinated in 1990's to the Ministry of Economy and then to the Ministry of Energy. The State Enterprise Radioactive Waste Management Agency (RATA) was established in 1999 by the Lithuanian government following the implementation of the Law on Radioactive Waste Management.



[2] Demčenko Michail, Head of VATESI, an expert interview, Vilnius, 20.09.2016

Nevertheless the process of transferring the INPP's nuclear facilities to Lithuanian control was not an ordinary case. In October 1991, the representatives of the Ministry of Atomic Energy, the owner of INPP, came to Lithuania and signed the act transferring INPP to Lithuanian control. According to this Act, signed by the Minister of Energy, the Lithuanian government became the owner of INPP and its facilities, including the city of Visaginas, its surrounding territories and infrastructures[3]. Before 1991 INPP's administration governed all these facilities which had never been under the authority of the Soviet Lithuanian government[4]. The exceptional nuclear status of the area during Russian Soviet rule created a special self-governance regime within the Ignalina NPP site where the NPP Director was the principal agent. After the transfer in 1991 a new regime was established: the NPP administration vested a separate status on Visaginas with its entire infrastructure, thus an independent local government system had been implemented. A split between the INPP and non-nuclear facilities took place. This was an important symbolic break from the exceptional status of the nuclear sites in the Soviet system.

Moreover, nuclear governance processes raised the question of citizenship for the personnel, mostly a Russian-speaking community. During the rise of nationalist movements certain tensions occurred around Visaginas as a Russian speaking town but the situation never escalated into ethnic conflicts.

The beginning of the nationalist mobilization in 1988 created conditions for citizenship claims to be brought up. In the case of INPP this concerned ethnic relationships at the nuclear site: in 1989 the Visaginas (Sniečkus)[5] population consisted of Russians (64.2%), Belarusians (11.0%), Lithuanians (7.7%), Poles (6.4%), and other ethnicities (10.7%) (Kavaliauskas 1999, 41). On the wave of nationalist mobilization, individual and collective self-identification claims emerged. Letters from Visaginas inhabitants were published in the *Atgiminas* newspaper (16.12.88; 27.01.89); these letters touched upon such issues as domination of the Russian language in the media and schools, equal relationships between the Russian and Lithuanian speaking communities (150 signatures). The Russian-speaking workers at the Ignalina NPP, identifying themselves as Russians and living in

3 Viktor Shevaldin, former INPP Director, interview, 04.05.16, Visaginas.

4 Jurgis Vilemas, professor, expert interview, Kaunas, 1.07.16

5 Sniečkus the name of the city for the Ignalina NPP personnel, renamed in Visaginas in 1992.

Visaginas, also articulated citizenship claims. In "Dobriy den" (№4: 13-19.04.1990) an official letter to the Mikhail Gorbachev from the Ignalina workers was published. The core of this appeal was the status of the Ignalina NPP after *Sąjūdis* came into power. They asked Gorbachev "to find a solution to withdraw the Ignalina NPP and Sniečkus from Lithuanian SSR authority without reference to a decision about the future of Lithuania itself" (№4. 13-19.04.1990, 4). The INPP case exceeds nuclear and antinuclear limits, it creates forms of political claims it shakes concepts of Soviet nuclear exceptionalism and opens space for struggles over nuclear governance as well as the political opportunity to introduce the nuclear issues to the national political agenda.

Compared with the situation of ethnic Russians in Latvia and Estonia the Lithuanian authorities preferred a softer version of citizenship policy after the collapse of the USSR: two years residence without break on the Lithuanian territory before 1991 was an imperative condition for obtaining Lithuanian citizenship; linguistic, ethnic and cultural conditions were not primary for this transition period. In addition, the use of the Russian language was authorized for nuclear personnel at INPP to facilitate professional communication at the site: neither technical documentation nor special terms existed in the Lithuanian language during this period. This situation was regulated by local legislation. The Law about the National Language adopted by the Lithuanian Parliament on the 1st February 1995 had established Lithuanian as national language. The Lithuanian National Language Law Implementation Act signed on 7th February 1995 allowed the personnel of INPP to use one of the languages of the IAEA, Russian included, for their communication[6]. This political manoeuvre avoided not only social tensions within the Russian speaking community at the INPP site but also difficulties in a possible emergency situation at INPP where a shift to the Lithuanian language in reporting documents could lead to technical errors. This is not only a question of language; this is the question of technology itself. For this particular location the nuclear technology, from basic

6 DĖL LIETUVOS RESPUBLIKOS VALSTYBINĖS KALBOS ĮSTATYMO ĮGYVENDINIMO, Lithuanian National Language Law Implementation Act Nr.I-789 art.3, 7 February 1995. Amended on 1 October 2011: « The use of the official languages of the International Atomic Energy Agency (IAEA) is authorized for the activities in the field of nuclear energy and other activities related to the nuclear and/or to the nuclear fuel cycle, for the use of documents, with the exception for the public administrative decisions. When such documents are submitted to the State regulation and supervision bodies the correspondence must be in the official language - Lithuanian language, and attached documents may be submitted in one of the official languages of the IAEA. State regulation and the supervisor's request must contain the attached document translation into the state language - Lithuanian language.»

documentation to the safety standards and emergency prescriptions, was written, described, invented and implemented in the Russian language. Russian was a part of the nuclear technology then and still remains significant for the whole technological culture behind its uses.

Nevertheless this quite favourable situation for transition did not stop an outflow of qualified personnel from the INPP site. According to rough estimations more than 100 high-qualified personnel left INPP and found a job at a NPP in Russia[7]. This structural change created additional obstacles for transition since Lithuania lacked the necessary facilities for training nuclear personnel, especially for highly-qualified positions.

Nuclear Attitudes. The Ignalina NPP was a part of the national political agenda during the transformation period which was marked by a pro-nuclear turn in public opinion and political attitudes. Public opinion surveys regarding nuclear issues were commenced in the Ignalina NPP region in 1989 to investigate the impact of Chernobyl on public opinion and problems of integration of the Russian-speaking community. Nevertheless the central question in surveys was about the status of the Ignalina NPP: “Should the Ignalina NPP pass under the national control what will be its future?” Only 28% of respondents wished the station to close down and 63 % called for safety upgrades and continued operation (Gaidys and Rinkevičius 2008).

During the period from 1993 to 1997 surveys of experts and of the local population were conducted within the state program “Nuclear energy and environment”. The surveys showed that 77% of the experts had pro-nuclear attitudes: “The RMBK reactors could be used further”. Survey of residents revealed worries and uncertainties about the influence that Ignalina NPP produces on the health and environment among 80% of respondents (Baubinas R.,1998).

Public opinion polls conducted in 1998 during the EU admission negotiations by the Sociological Centre “Vilmorus” showed that the absolute majority of the respondents (80%) were against closure. The surveys after EU admission showed the same trend: the absolute majority of the respondents (94%) among 62% possible participants would vote for the extension of Ignalina NPP if

7 Viktor Shevaldin, former INPP Director, interview, 04.05.16, Visaginas

a referendum was to be held (Gaidys and Rinkevičius 2008). This trend persisted with a survey about plans for a modern reactor to be constructed (Rinova, 2007-2009)[8].

Nevertheless the new political institutions and procedures marked an important shift in the Ignalina case: becoming a part of the political agenda the nuclear issues raised public awareness. With the new democratic procedures the Ignalina case has been transformed into a public opinion case. With the political transition public opinion became an important part of the democratic political process. Public opinion polls as well as referenda emerged as newly accepted procedures by society and political institutions.

Geopolitics of Energy Transitions. After the collapse of the USSR the Lithuanian government faced the problem of sustainable energy supply of to consumers, including industry and households. From the Soviet period Lithuania was a part of the Soviet economy and energy systems with large energy consumption; it also exported energy to its neighbours, especially to the Byelorussian Soviet Socialist Republic. The Lithuanian energy system consisted of two large energy units constructed for both national needs and for the needs of other Soviet Socialist Republics; they are the Lithuanian Thermal Power Plant (with capacity of 1,800 MW) consuming natural gas and heavy fuel oil and the Ignalina Nuclear Power Plant (3,000 MWe). Within the large scale industrial and energy systems of the Soviet Union these energy installations never created problems of distribution and redistribution of energy. Starting from the period of Independence the national economy and energy systems faced the problem of managing the oversupply of energy in the context of the decreasing energy demand, economic crises, and changing economic and political relations in the post-Soviet region.

> Thus, the primary energy consumption of Lithuania, which in 1991 amounted to 17.5 million toe [Tons of Oil Equivalent], has decreased to 8 million toe, i.e., more than twice. Electricity consumption and district heat supply decreased at about the same

[8] "Risk perceptions, public communication and innovative governance in knowledge society" (RINOVA) (2007-2009). "Public Perceptions of Nuclear Power in Lithuania: Symbolic Meanings, Public Participation and a Quest for Democracy" Aistė Balžekienė, Leonardas Rinkevičius, 1st ISA Forum of Sociology, Barcelona, 8 September 2008.
www.riskanduncertainty.net/TG04/Barselona_balzekiene_rinkevicius.ppt

> degree. Major energy installations in Lithuania encompass a few large thermal plants, a nuclear power plant, and a refinery designed not only for the needs of Lithuania, but to supply a significant proportion of its production to Lithuania's nearest neighbours, which after 1991 were in the same economic decline. (Gaigalis, Skema. 2014:720)

From the 1990s the Lithuanian government started the elaboration and implementation of a national energy strategy in the way suggested by the EU accession procedures and taking into account the necessity of reforming the energy sectors using data of the Lithuanian energy system's outputs before and after the decommission of the INPP. The first document elaborated in collaboration with western experts appeared only in 1994 and was meant to demonstrate willingness to reform the energy sector and to outline the techno-political controversy about the upgrade of INPP.

Energy Strategy	Inputs	Outputs
1994	Decreasing energy consumption and excess of energy production; Economic crises and transformation of the political relationships in the region; De-monopolization of the energy sector; Diversification of energy supply.	Transfer of management to the municipalities; Total energy consumption in decline; Implementation of the legal framework: Law on Energy (1995), Law on Nuclear Energy (1996), Nuclear Activity Licensing Requirements (1998) Creation of VATESI (1996).
1999	Nuclear safety (continuation and full implementation of Safety improvement Programs); Improvement of energy efficiency; Implementation of the principles of the market economy in the power sector; Environment protection; Regional co-operation; Preparation of Lithuania's energy sector for the integration into the EU; Improvement of energy sector management and regulation.	Restructuring and privatization of the electricity and gas supply sectors; Separation between production, transmission and distribution by creating independent companies; Continuation of the large scale reforms; The electricity transmission sector and nuclear power plant remain the state's property; The deadline for decommissioning of Ignalina NPP Unit 1 set as December, 31 2004; Strategy did not provide a decommissioning date for INPP Unit II.
2002	The available energy potential is not used to the full; Dependence on a single supplier of natural gas; The use of energy is still inefficient in many areas of the	Secure energy supply at minimal cost and with minimum environmental pollution; Enhancing the operational efficiency of the energy sector; Liberalization and privatization of the energy sector;

	national economy; Old housing energy infrastructure needs modernization and requires considerable investments; A large amount of radioactive waste and spent nuclear fuel accumulated; the funds necessary for its safe disposal have not been obtained; Reserves of petroleum products conforming to the European Union requirements have not been built up and natural gas storage facilities have not been set up.	Implementation of the European Union environmental directives in the energy sector; Compliance with the nuclear safety requirements; Preparation for the decommissioning of the reactors of the Ignalina NPP, the disposal of radioactive waste and the long-term storage of the spent nuclear fuel; Integration into the energy systems of the European Union within the next 10 years; Improvement of the energy sector management.
2007	Energy security issues; Efficient use of energy; Introduction of competitive principles in the energy sector; Gradual integration into the energy systems of the European Union; Diversification of primary energy sources and ways of their import; The increase of renewable and local energy resources and reducing the share of natural gas in the energy mix.	The liberalization of electricity and natural gas markets according to the EU directives; Creation of a Baltic common electricity market and its integration with the EU markets; The continuity in the use of nuclear energy by building a new nuclear power plant for all three Baltic States; Connection to the networks of the Nordic countries and Poland; Compliance with the EU directives related to the accumulation of reserves of oil and natural gas; Increasing the share of renewables in the primary energy balance up to 20%; Improvement of the consumption efficiency of all types of energy.
2012	Energy independence: domestic energy demands covered by local and diversified sources; Competitiveness; Integration to the European energy markets; Reforms of energy monopolies; Guarantee for energy prices and for sufficient investments into the energy; Sustainability and principles of sustainable development; Nuclear energy and promotion of renewable energy sources will ensure sustainable energy production.	Start-up of the Lithuanian–Polish power link LitPol Link 1 in 2015 and extension of the link in 2020; also the completion of the extra Lithuania-Poland cross-border power connection (LitPol Link); Completion of the Lithuanian–Swedish power link NordBalt in 2015; Development of the Regional Baltic States' electricity market and integration into the Nordic and European Electricity Markets; Synchronous interconnection of the Lithuanian, Latvian and Estonian electricity Transmission systems with the European Continental Network of ENTSO-E; Construction of a new regional nuclear power plant in Visaginas;

Sources: Gaigalis, Skema. 2014; Vilemas 1995,2010; Valentukevicius 1998;

The analysis of the successive energy strategies allows us to outline two major periods within the energy transitions in Lithuania: before and after the decommissioning of INPP. The first period covers the political transformation period until the 1999 Strategy introducing the timeframe for decommissioning unit 1 of INPP. This period emphasises serious debate about the possibility of updating INPP and about its safe functioning. The debate covers the following: implementation of the regulatory regime with the creation of the VATESI; establishing the Nuclear and Radiation Safety Advisory Committee (NRSAC) and the Ignalina Safety Analysis Group (ISAG). The implementation of the safety improvement program (SIP) began with the signature of the first grant agreement between the Lithuanian government, the Ignalina NPP and the European Bank for Development and Reconstruction on 10 February 1994. During this period the use of nuclear energy was considered as necessary for the economic and social developments of the country; political personnel, nuclear engineers and Lithuanian citizens embraced the energy produced by the INPP as a national resource.

Nevertheless the preospect of accession into the EU turned the use of nuclear energy into a political debate and have determined its new framework within clearly articulated geopolitical qualities. After the 2002 Strategy was prepared and adopted on the eve of Lithuania's admission to the EU, and then within the 2007 Strategy, the liberalization and the privatization of the energy sector and market are accelerated. A common Baltic energy market was created and launched and the integration of Lithuania into the European energy network is enlarged. The use of the nuclear energy did not disappear form the political agenda after the INPP began to be decommissioned. It reappeared within the new NPP project – Visaginas NPP, included in the 2012 National Energy Independence Strategy. This project has ended the history of implementation of Soviet nuclear technology on Lithuanian territory; it also has framed not only a technological but also a geopolitical choice.

3. Events

3.1. Event 1: The Start Up of the First Unit of the Ignalina NPP on 31 December 1983

Institutional Actors: *Central Committee (CC) of the Communist Party of the USSR (CPSU), Council of Ministers of the USSR, Central Committee of the Lithuanian Communist Party (LCP), Council of Ministers of the Lithuanian Soviet Socialist Republic (LSSR), "Sovetskaya Litva" (central media), Ministry of the Medium-Machine Building (Sredmash), Lithuanian Academy of Sciences, USSR Academy of Sciences.*

The decision about the construction of INPP was taken by Central Committee of the CPSU and Council of Ministers of the USSR on 16 September 1971 (№ 684-200)[9]: The Ministry of the Medium-Machine Building (Sredmash) was named responsible for technical assistance in the project and for its construction with the introduction of the first unit at 1,000 MW in 1979; a special commission to study the region of Ignalina and Lake Druksai was established[10].

On 26 July 1980 the CC of the CPSU and Council of Ministers of the USSR adopted a secret decree about nuclear power in the USSR [11] with reference to the Brezhnev speech about the further development of nuclear power at the plenary session of the CC of the CPSU in November 1979. In this Decree are clearly marked the mission and goals of the Soviet Nuclear Program for the period from 1981 to 1985 and until 1990: to introduce NPPs with total capacity of 66.9 million kWt and increase to 100 million kWt before 1993.

According to this decision the Ignalina Nuclear Power Plants (INPP) was among the nuclear plants with RMBK reactors to be constructed in the European part of the USSR as an integral part of the

9 The first archive indications about nuclear history of Lithuania in Gryva L. (1996) The construction of the Ignalina Power Plant and its Operation 1971-1988 (MA Thesis, Vilnius University); Čėsna, B. Davulienė, L. Aliulis K. (2004) Lithuania's Nuclear Past: A Historical Survey. Lithuanian Energy Institute. Some documents for this report were found due to these contributions.

10 Lithuanian Special Archive (LYA), f. 1771 a. 247 b.147 p.3

11 Lithuanian Special Archive (LYA), f. 1771 a. 257 b. 192 p. 29-34

Soviet Union's North-West Unified Power System: in the Northern part - the Leningrad NPP, in the Eastern part - the Smolensk NPP, and in the Southern part - the Chernobyl NPP.

Following the plan the first reactor of Ignalina NPP came on line in 1983. In the local media the start-up of Ignalina NPP was presented as part of the Soviet energy program to develop the energy capacities in the LSSR. During the year before the official launching the Soviet media covered this event as an iconographic development for the Soviet nuclear industry: "The reactor of the Ignalina NPP – a huge but extremely subtle construction. The Herculean heart of the Ignalina NPP has no equal on the Earth. Mankind has not yet created such a powerful nuclear reactor" (Sovetskaya Litva, 21/10/83:1). Even if in Lithuania as well as anywhere in the Soviet Union there were neither debates about nuclear safety nor the necessity of the civil nuclear developments; the increasing number of pro-nuclear articles could indicate public concern (Idzelis 1983).

Several articles published in 1983 illustrated how the multinational working class and enterprises from various parts of the USSR contributed to the construction. The official start-up of the first reactor on 31 December 1984 was followed by an article "*Born due to the Friendship*" in the "Sovetskaya Litva" newspaper. It described the NPP construction as orchestrated from Moscow with Russian specialists from other NPP constructions – Obninsk, Chernobyl, and Kursk – to illustrate the Ignalina NPP as a part of the common Soviet nuclear network without any national character.

But in reality the INPP was designed and engineered by central political and economic institutions of the secret Sredmash that involved in greater degree Russian specialists from Moscow and Leningrad: the Research and Development Institute for Energy Technology (Leningrad), Kurchatov Atomic Energy Institute (Moscow), and Research and Development Institute of Power Engineering (Moscow). The local inhabitants were engaged in unskilled labour. From this point of view the Ignalina nuclear project represented an attempt to centralize the Baltic republic by connecting it fully to the Soviet electricity grid, Soviet nuclear technology and a Russian-speaking working class. In addition the management of the Ignalina NPP was completely under Moscow's control. Even after the Declaration of the Independence in March 1990 the Ignalina NPP remained under Soviet jurisdiction until August 1991 and was guarded by Soviet army troops and KGB operatives.

The lack of the influence of the Lithuanian authorities on civilian nuclear decision-making was partly compensated by scientific opposition to the Ignalina project during the 1970s and 1980s among Lithuanian specialists. From the very beginning a number of scientists from the Lithuanian Academy of Sciences were opposed to the project because of the very small amount of preliminary geological and environmental research. During the procedure of the selection of the site Russian scientific authorities limited the role of Lithuanian scientists.

In correspondence with Sredmash the first Secretary of the Lithuanian CP, Sniečkus, formulated the question about the safety of the NPP planned in Lithuania. The Planning Committee responded with a report by Sredmash and the Ministry of Energy of 14 July 1972[12]: the choice in favour of the Lake Druksai was reached for economic, geological and infrastructural (closer to the Leningrad NPP construction site) reasons. Even if the Lithuanian government accepted this report, Sniečkus sent Gosplan, the State Planning Committee, remarks of the Geological Direction of the Council of Ministers of the LSSR and Lithuanian Geology Institute[13] about the choice of the NPP site and necessity of additional geological study. Finally the decision about the INPP site, Lake Druksai, was adopted by the Council of Ministers of the USSR on 30 November 1972 (№2542-pc).

The dispute between Lithuanian scientists and their counterparts in Moscow remained almost invisible at the political level of communication until two commissions were established. In 1976 the first commission of the Lithuanian Academy of Sciences revised Moscow's ambitious plan to build a number of RBBK reactors in the European part of the USSR and concluded that this type of reactors was too dangerous to be constructed in densely populated areas (Dawson 1996, 36). These conclusions did not impact the on-going decision-making process.

The second commission, a Commission of Atomic Energy attached to the presidium of the Academy of Sciences of the Lithuanian SSR headed by Algidras Zukauskas, dealt with the number of reactors to be constructed and environmental issues. Based on the opinion of Lithuanian scholars, this commission argued that cooling capacity of the Lake Druksai could sustain only 2,500-3,000 MW (maximum of 2 reactors) of power in production and not 6,000 MW (4 reactors) as

12 Lithuanian Special Archive (LYA), f. 1771 a. 247 b.147 p.5-9

13 Lithuanian Special Archive (LYA), f. 1771 a. 247 b.147 p.11-12

suggested by Moscow in 1982. The debates between the Lithuanian commission and the Russian Academy of Science in 1982-1983 ended with the decision to limit the Ignalina NPP's installed capacity to three reactors (total of 4,500 MW) only in 1987.

Lithuanian scientists questioned not only environmental issues, like the cooling capacity of Lake Druksai and the geological structure of the INPP site, but also Moscow's decision itself to build the RMBK type reactors at Ignalina region (Dawson 1996:36). This duality of claims in the late 1970s concealed political reactions: the Lithuanian Academy of Science opposed nuclear power not only because of environmental issues but techno-political ones. Lithuanian scientists contested not only the siting of the NPP, and its layout but the necessity and safety of the nuclear technologies. This dispute also concerned a proposed method for underground storage of liquid radioactive waste. Lithuanian scientists opposed this method at INPP. In correspondence in 1978 between Sredmash and the Lithuanian Academy of Sciences via local Party institutions[14] the Lithuanian scientists used a range of technical and social arguments to oppose it. A joint Commission established in 1977 finally decided to abandon underground liquid waste storage.[15]

Waste Disposal Dispute	Lithuanian Academy of Sciences	SredMash
Lack of scientific evidence	Very limited examples of the use of this method for nuclear waste (except in Dimitrovgrad).	This method was in use in the USSR from 1968 in different domains and would contribute to international experience.
	Contradictory scientific discussions during national conference in 1977 and lack of evident scientific conclusions.	Only scientific opinions were taken into account for decision-making; there was no place for non-professional conclusions.
Uncertainty/Risk	High probability of groundwater pollution at the INPP nuclear site. Differences/variations in geological structure not taken into account. No NPP in the world ever used this method for liquid radioactive waste	Additional geological study and investigation at the INPP site with Lithuanian specialists.

14 Lithuanian Special Archive (LYA), f. 1771 a. 255 b.236 p.2-12

15 Expert interview with professor Jurgis Vilemas, 1st July 2016, Kaunas

	disposal.	
Irreversibility	Once stored underground disposal liquid radioactive waste will be impossible to remove in case of accidents or seismic and other sub-surface geological activities.	
Rationale	Only the method of *bituminization of waste* was possible for use at INPP.	The underground method could be more rational for usage with the adequate evaluation, calculation and control.
	The local population would oppose the underground method.	It is necessary to inform the public with scientific data.

Between the late 1970s and the end of the year 1980 the Ignalina NPP has emerged as a key aspect in relations between Lithuanian scientists and the Soviet Academy of Sciences in Moscow in the context of the weakness and powerlessness of Lithuanian political authorities. In this context the Ignalina NPP was presented as an environmental and technological controversy within the Soviet nuclear Program. This kind of institutional (but fragmented) mobilization became a platform for further anti-nuclear, environmental and nationalist discourses by the end of the 1980s.

Event 1	**The Start Up of the First Unit of the Ignalina NPP**
Who was involved?	Soviet Media, general public, central and local political and scientific institutions
When and where did it take place?	Ignalina NPP, Lithuanian SSR, 31 December 1983
What type of process was it (communication, consultation or participation)? How did this change over time?	Communication to the general public. Claims of the Lithuanian Scientists in 1970s and 1980s about INNP siting, technology, and waste.
What rationale was given by the party that implemented the engagement?	Environmental, geological and techno-political arguments against the NPP construction

3.2. Event 2: The Chernobyl Nuclear Disaster on 26 April 1986 and its disastrous consequences

Institutional Actors: *Central Committee of the Communist Party of the USSR (CPSU), Council of Minister of the USSR, Central Committee of the Lithuanian Communist Party (LCP), Council of Minister of the Lithuanian Soviet Socialist Republic (LSSR), Ministry of the Medium-Machine Building (Sredmash), Committee of Party Control.*

When the Chernobyl accident occurred, the Soviet nuclear network—comprised of industry, military, science, workers and the broader population—immediately faced the threat of a new, uncertain future of Chernobyl-type reactors that challenged the position of the Soviet leadership (see Ukraine SCR).

Only in 1983, after a set of nuclear incidents and hazards of different degrees, did the government establish a government body to regulate nuclear safety the State Committee for Supervision of Safety in the Nuclear Power Industry[16]. The initial imbalance between reactor design and safety control in the Soviet nuclear industry is explained by the rapid growth of the civil nuclear power industry, the implementation of multiple technical, organizational, and administrative structures to ensure its operation and development, and by the lack of an adequate "safety culture."

The Chernobyl disaster in 1986 made this imbalance visible. Some scholars explain the lack of safe design as stemming from underdevelopment of Soviet concepts of design uncertainty and risk, accompanied by a strong commitment to technical and authoritative opinions: "Before Chernobyl, Soviet notions of nuclear risk had been technical, involving numbers and probabilities, while uncertainty was equated with incompetence or lack of experience" (Schmid 2004, 354).

Potter (1990), in his report about Chernobyl's impact on Soviet decision-making, emphasizes that Soviet responses to Chernobyl involved technical and political changes. The technical responses to nuclear safety included a set of engineering solutions aiming to make existing Soviet type reactors safer. In turn, the political responses saw organizational changes: the creation of the Soviet Ministry

16 From 1964-1979 several incidents occurred at the Beloyarsk NPP; from 1974-1975 at the Leningrad NPP; and in 1982, a generator explosion occurred at the Armenian NPP.

of Atomic Energy, which affected the future of existing Soviet type's reactors. On 1st July 1987, the Soviet Council of Ministers and Central Committee of the CPSU had already decided to mothball the construction of planned Chernobyl type reactors[17]. Nevertheless, Soviet nuclear physicists and engineers continued to pressure for "inherently safe reactors" as advocates of the RBMK concept [Chernobyl type] continued to argue for its retention (Potter 1990, 78). Inherently safe reactor design became a sort of transnational techno-political concern, with much pressure from other countries also ensuing. International experts and politicians referred to this lack of safety culture as a condition to stop the export of Soviet designed reactors into Europe (Wellock 2013).

In fact, Chernobyl disaster not only led to questions about the safety of Soviet nuclear technologies, but also created the condition for political claims in civil nuclear industry. The political authorities in Soviet Socialist Republics began to reconsider the techno-political aspects of the nuclear safety and the necessity of the national program to engage local expert opinions. In an appeal to the Soviet government "On the question of the Ignalina NPP" [18] the Central Committee of the Lithuanian CP and the Council of Ministers of the LSSR addressed major doubts and uncertainties about INPP. Reacting to this situation the Committee of Party Control on 20 April 1987 passed a resolution about serious violations on the side of Sredmash and the Ministry of Energy during the launch of the INPP and recognized serious flaws and errors in the planning and construction of Unit 1 at the INPP[19]. Finally, on 1 July 1987 Gorbachev, first Secretary of the Central Party Committee, and Ryzhkov, the chair of the Council of Ministers, acted to limit and correct some aspects of the Soviet nuclear program[20]. This reflected a level of the uncertainty among political leaders about the security and quality of the Soviet nuclear reactors after Chernobyl.

17 Lithuanian Special Archive (LYA), f. 1771 a. 270 b. 175 pp.17-28

18 Lithuanian Special Archive (LYA), f. 1771 a. 269 b. 263 pp.16-19

19 Lithuanian Special Archive (LYA), f. 1771 a. 270 b.177 pp.136

20 Lithuanian Special Archive (LYA), f. 1771 a. 270 b. 175 pp.17-28

Central Committee of the Lithuanian CP / Council of Ministers of Lithuanian SSR	Committee of Party Control	CPSU Central Committee/ USSR Council of Ministers
- To give more control on a republican level over the INPP and fewer functions to the central regulatory body (Sredmash); - To limit the INPP capacities to 4.5 million Kwt for ecological, sanitary and health reasons; to reject economic justifications, as well; - To recognize several violations during the construction works on the part of Sredmash, a potentially high risk situation; - Recognition that the system of accident containment has a number of flaws and the first experiments has shown its insecurity; - Lack of exact information about levels of radioactive emissions into the atmosphere; - To organize a system of automatic control of the radioactive situation on the NPP site and its zone, independent from the Sredmash, coordinated by Lithuanian Academy of Sciences.	-Errors in design; -Unjustified reduction in start-up complex; - A large number of defects; - Poor training of operating personnel on the first power unit; - Over three years 115 emergency stops and forced unloading of the reactor, 12 fires and elevated emissions of radioactive materials into the atmosphere.	- Finalize in 1987-1988 projects of power units with VVER-1000 reactors, providing additional technical security improvement measures; - Authorize Sredmash and the Ministry of Atomic Energy to pursue the construction and preliminary work on the 11 NPP with VVER reactors; - Elaborate criteria for the choice of the NPP siting; - Mothball NPPs near Minsk and Odessa, abandon the construction of NPPs in Azerbaijan, Georgia, Moldova and the second Chernobyl NPP, the 4th reactor at Ignalina NPP and 5th reactor at Beloyarsk NPP. - Complete the construction of the third stage on the Kursk NPP (5 ,6 Units), Smolensk NPP (3,4 Units) and Ignalina NNP (3 Unit) with RMBK reactors.

These decisions on the highest Party level illustrate the importance of taking into account local uncertainties articulated by the Lithuanian Academy of Sciences and moderated by the Lithuanian

Communist Party. In addition this kind of reaction can be considered as the *Chernobyl effect* on nuclear decision-making where the promoters of nuclear energy intend to keep the Soviet nuclear program moving while local receptors on the republic level are trying to influence this decision making and to limit nuclear power. This is more or less a common trend in centre-periphery relations in the civil nuclear industry during this period, namely with the Byelorussian SSR, Ukrainian SSR and Armenian SSR (see Belarus and Ukraine Short Country Reports).

Event 2	The Chernobyl Nuclear disaster on 26 April 1986
Who was involved?	Central and local political institutions
When and where did it take place?	Ukraine, 26 of April 1986
What type of process was it (communication, consultation or participation)? How did this change over time?	Contestation. Attempts of Participation. The Chernobyl Nuclear disaster opened a window of political opportunity for Soviet Socialist Republics, the possibility to contest and to question certain central governmental decisions given the high degree of uncertainty about the future of the Soviet nuclear energy program. In the Lithuanian case the engagement took form of the participation, not public during this time period, but with clear arguments against the central decision-making and with certain impact on it.
What rationale was given by the party that implemented the engagement?	After the Chernobyl nuclear disaster the safety of the Soviet reactors must be reconsidered and regulatory regime transferred to local control. Shift from environmental and technological argumentation of the 1970s –1980s to the political claims.

3.3. Event 3: “The Ring of Life”, 16-18 September 1988

Institutional Actors: *environmental group, Žemyna, movement for Reforms, Sajūdis, Academy of Science, Visaginas population, media - Tiesa, Komjaunimo tiesa, Atgiminas.*

After the pressure of the Lithuanian scientists, anti-nuclear claims continued to obtain new forms, actors and institutions during the period of the perestroika. The Ignalina NPP became the national issue deployed by environmental groups such as *Žemyna*, and by the movement for Reforms, *Sajūdis*. The Ignalina issue was nationalized; control of INPP remained central to discussions of environment and independence.

During perestroika, environmental issues served as the basis for the development of informal or amateur organizations orchestrated by the new politics of glasnost. In the LSSR these organizations emerged focusing on issues of national language and culture, historical heritage protection as well as on the environment and ecology. Named as Goddess of the Earth, the club *Žemyna* was among them. It was one of the first associations to appear in Lithuania in 1987 and originated from the networking of intellectuals concerned by environmental issues. For a long time supported and sheltered by the Academy of Science and officially registered in December 1987 under the auspices of the Lithuanian Komsomol (Communist Youth League), this group questioned the safety and environmental impact of the Ignalina NPP functioning as priority for collective action such as public media campaigns and public forums. During 1988 *Žemyna* organized a powerful media campaign with the publications of the physicist of the Academy of Science, Zigmas Vaišvila, in the local press - *Komjaunimo tiesa* - and the independent press – *Atgiminas*. This media campaign in the conditions of Soviet censorship covered environmental and safety issues of the INPP after Chernobyl and the possible consequences of the construction of thethird reactor; and was followed by public forums – open meetings and round tables on Ignalina issues – organized in March and April 1988.

The Lithuanian government replied by organizing a round table at Ignalina in March 1988 to focus on the safety issue of the RBMK reactors after the Chernobyl disaster. Namely during this meeting the decision to cancel the fourth reactor at Ignalina was announced (Tiesa, 24.03.88). On 5-12 April 1988, *Žemyna* organized a meeting at the Lithuanian Academy of Sciences entitled "What we know about Ignalina NPP?" with the participation of government representatives. As a result a collective letter with 5,000 signatures about the 3rd reactor at Ignalina NPP was sent to the Council of Ministers of the USSR.

Due to the *Žemyna* information campaign, the Ignalina issue became a national political concern. The leaders of the Lithuania CP uttered anti-Ignalina discourse and during the XIXth Communist Party Conference in Moscow announced this concern as a reason to suspend the construction of the 3rd reactor until the project was officially approved by the Lithuanian government. During the official meetings of the Lithuanian delegates with the masses on 8 July 1988, in the Opera Theatre and on 9 July in Vingis Park the official position of the Lithuanian CP was declared along with other questions about national language and sovereignty (Sovetskaya Litva, 9.07; 12.07.1988). This significant change in the official rhetoric reveals not only the change in the political agenda but also the transformation of the environmental and anti-nuclear issue into political and nationalist ones. INPP was associated now with the claim for the independence of Lithuania: “The dictatorship of the central government body continues, we must increase the independence of the republic” (Ozolas, Sovetskaya Litva, 12.07.1988, 3).

The shift from environmental to political arguments would not have been possible without national mobilization under the auspices of *Sąjūdis* – the Movement for Perestroika or Lithuanian Reform Movement. Organized in 1988 *Sąjūdis* followed the trajectory from a local initiative in favour of perestroika to the National Front and elections to the Supreme Council of the Lithuanian SSR in 1990. During the summer of 1988 starting from organizational meetings in Vilnius on 3 June and in Kaunas on 10 July and finishing with 100,000 participants a meeting in Vilnius, *Sąjūdis* had definitely framed national political agenda: national language and symbols, historical heritage, environmental issues of the Ignalina NPP and elections to the Supreme Council.

On September 16 and 18 *Sąjūdis* organized a “Ring of Life” rally around the Ignalina demanding an end to the construction of unit 3, to temporarily close down units 1 and 2, and to organize an international commission about the safety of INPP. It was one of the turning events in the anti-nuclear campaign of the *Sąjūdis* and mobilized thousands of people (between 20,000 and 100,000 participants according to different estimates) without any local administrative support. On the contrary the Lithuanian authorities aimed to avoid the rally: Sakalauskas, the Chairman of the Council of Ministers of the LSSR, invited the organizers of the rally to a meeting where he suggested cancelling the event (Ашмантас 1996, 22). Nevertheless on 8 September 1988 the appeal was distributed in the local press and continued to link the anti-nuclear rhetoric of the scientific community with nationalist political claims of independence.

“Ring of Life”, *Sąjūdis rhetoric*

- invite an international commission of experts to test the reliability of INPP
- the alarming situation at INPP and around it. The first two RBMK reactors are technologically obsolete, power plant personnel are not able to ensure the stable and secure operation of INPP. Since 1987, 32 unplanned stops occurred and 3 fires in the last 2 months.
- the INPP is located in a geologically unsafe and under-investigated area. Despite public

protests, and the government of Lithuania requirements to mothball the 3rd Unit, the central authorities continue the construction.

- demand to stop the construction of the 3rd Unit and temporarily halt the 1st and 2nd units until they have been approved by international examination.
- 287,000 Lithuanian citizens signed an appeal to Mikhail Gorbachev, as well as to the UN General Secretary and the President of the International Atomic Energy Agency.

After the Ring of Life Meeting on 22 October 1988, *Sąjūdis* has adopted its main documents, political program, statute and resolutions. Zigmas Vaišvila, member of *Sąjūdis,* discussed the Ignalina issue among a number of major environmental issues linked to industry and introduced the rhetoric of Lithuania as a *nuclear-free territory* which was a major part of the *Sąjūdis* political program (Atgiminas 4.11.1988). A *nuclear-free territory* was a strong political claim common to other Soviet Socialist Republics, their nationalist claims, and demands to withdraw nuclear weapons from their territory. *Sąjūdis* demanded that INPP must be transferred to the control of Lithuanian authorities because it represented a threat to the political future of Lithuania as an independent republic.

INPP was also the focus of green rhetoric in the first environmental local initiatives and groups at the end of the 1980s. On 1st May 1989 the First Congress of the Lithuanian Greens took place, and on June 15 the General Assembly of the Green Party of Lithuania published the slogan: “independent, ecologically pure and healthy, demilitarized and neutral Lithuania”. On 26 November 1989 the Green Party of Lithuania organized a rally called “Chernobyl is our pain and the last warning” where the anti-nuclear discourse concerned environmental issues of INPP. By the beginning of the 1990 INPP had been dissolved into general environmental issues.

The experience of the Lithuanian environmental groups and movements shows how the environmental claims of the perestroika period were translated into (post)colonial and political claims by the end of the 1980s that Russian rulers in Moscow were systematically destroying their economies, cultures, and natural resources. During the Conference on Security and Cooperation in Europe (CSCE) in 1989 the Lithuanian Greens distributed a document with the clear political message against Moscow’s control over industrial and natural resources that had turned the republic into “a colonial industrial dump site producing goods and services far beyond the needs of its own inhabitants” (Peterson 1993, 215).

After the cancellation of the 3rd and 4th reactors and the separation between political and environmental issues, the importance to this discourse of the INPP decreased. *Sąjūdis* won elections in 1990, the new political period started with the re-establishment of the independence of Lithuania on 11 March and control over the Ignalina NPP was transferred to Lithuania in August 1991.

Event 3	Rally “The Ring of Life”
Who was involved?	New environmental groups, political movements, population.
When and where did it take place?	Ignalina Nuclear Power Plant 16-18 September 1988
What type of process was it (communication, consultation or participation)? How did this change over time?	Participatory form of engagement. Became possible due to *perestroika*, *glasnost,* and the emergence of new social organizations. Started by a post-Chernobyl political appeal to the central government, the social mobilization before, during and after the Ring of Life emphasizes the social attitudes to the INPP as a part of the Soviet nuclear program and links the INPP with the political and nationalist claims.
What rationale was given by the party that implemented the engagement?	Under Soviet rule the INPP was not properly constructed nor managed in an appropriate safety regime and must been transferred from central control of Sredmash under Lithuanian control.

3.4. Event 4: The Decommission of the First Nuclear Unit of the Ignalina NPP on 31 December 2004

Institutional Actors: *Atomic Regulatory Agency VATESI, European Union authorities, Lithuanian Government, Lithuanian Parliament, Committee on Security of the Ignalina nuclear power plant.*

Moscow naturally reacted to Lithuanian independence with anger followed by a fuel blockade. In addition, it ordered one reactor of the INPP shutdown for technical reasons to increase energy pressure. The Lithuanian authorities discovered their vulnerability in political independence from

Moscow was energy dependence on Moscow. The Ignalina NPP from this moment became part of the new Lithuanian political strategy: a project of expanding the capacity of INPP was discussed with the support of anti-nuclear activists. Dawson (1996) points out that some nuclear activists had not only forgotten about their anti-Ignalina claim after elections but had spoken out about the expansion. From 1990 to 1993 a special parliamentary commission discussed this question. Under pressure from Scandinavian countries and with the grant of the European Bank for Reconstruction and Development (EBRD) the Ignalina NPP was technically upgraded several times on the condition that the reactors' lifetimes could not be extended (Almenas, Kaliatka and Uspuras 1998).

From 1997 the Lithuanian government started negotiations for EU admission. The Ignalina case here emerged as an energy and political issue. The Ignalina nuclear power plant generated from 76% to 86% of Lithuania's electricity production, but Lithuania had an obligation to the EU to close this nuclear power plant by 2009. This admission condition transformed Lithuanian energy policy from its reorientation on supply dependency to proactive domestic and external diversification[21].

Balmaceda (2014) analyses the post-Soviet transformation of the Lithuanian energy policy in the context of the asymmetrical interdependence from Russian energy supplies and outlines four transformation periods: from independence to 1996; from 1996 to 2004; from 2004 to 2006; from 2006 to the present. INPP was crucial in this transformation. During the first decade of independence the nationalized nuclear energy sector was a reliable source of energy during unstable political relations with the Kremlin. In the period from 1997 to 2004 the nuclear energy issue was framed as a non-negotiable condition for EU accession and decommissioning became part of the National Energy Strategy in 2002.

[21] «Nuclear power and fossil fuels dominate the Lithuanian energy mix. The share of natural gas in the national balance of primary energy resources constituted 28.4% in 2005, while the share of petroleum products constituted 30.8% in 2005. The Ignalina nuclear power plant generated from 76% to 86% of the total electricity production in the past, but Lithuania has an obligation to the EU to close this nuclear power plant by 2009. Currently, renewable energy sources generate little energy in Lithuania. In 2005 8.7%, of energy was generated by renewable energy sources, and this number is expected to reach 12% by 2010". (Watch №4, EU 25/27, 139)

In the beginning of the 1990s anti-nuclear claims were removed from public debates and "nuclear power changed from being seen as a personification of Soviet imperial control over Lithuania, to being seen as a guarantee of the country's independence" (Balmaceda 2014, 218). In the later stages, after EU admission, the Lithuanian government tried revoke the decision to close the second Ignalina reactor arguing that its closure would increase dependency on Russian gas supplies and damage the economy – an "impossible burden for consumers and the country's economy" (Balmaceda 2014, 244).

The shutdown of Ignalina NPP in Lithuania was an inevitable and irrevocable decision: neither technology nor political arguments held force against shutdown, and the possibility of updating the station was rejected on economic and scientific grounds. Shevaldin, Director of the INPP during the period of negotiations about INPP decommission, indicated that after several upgrading technical projects the INPP became an object of political bargaining: "when negotiations on Lithuania's accession to the EU began western politicians have established strict conditions - early closure of the first and second Units: until 2005 to close the first Unit, by 2010 - the second. That's all that Lithuania was able to bargain in exchange for EU memberships. If you do not accept, then you do not participate in further negotiations"[22].

In 1992 the Committee on Security of the Ignalina nuclear power plant, which included Lithuanian specialists and foreign experts, officially convened. One of the Committee members said: "We declared that after the introduction of additional safety systems of the second reactor, the station corresponds to the safety requirements. But everyone already knows, especially all the foreign members, they had some instructions that a political decision has been taken and the technical issue here is not a point. Nobody asked us – 'you are the experts, what do you think, should we, politicians, change everything' - this kind of question was not formulated"[23].

Nevertheless, Lithuania managed to get some concessions for this political inevitability by keeping the station open as long as possible. First of all, according to project documentation Ignalina NPP the reactor fuel channels were to be replaced every 15 years, with the first replacement in 1998. But

22 The interview with Viktor Shevaldin, former INPP Director, 04.05.16, Visaginas.

23 The interview with Yurgis Vilemas, 08.07.13, Kaunas.

Lithuanian authorities managed to push the shutdown schedule of the Ignalina nuclear power plant to 2004 and 2009, respectively. Among the countries mentioned in the EU Nuclear Decommission Assistance Program Lithuania was the last one to close its NPP.

Event 4	The Decommission of the First Nuclear Unit of the Ignalina NPP
Who was involved?	Political Institutions in Lithuania and EU, Atomic Regulatory Agencies, experts and political leaders
When and where did it take place?	*Ignalina Nuclear Power Plant, 31 December 2004*
What type of process was it (communication, consultation or participation)? How did this change over time?	Participation. The requirement that INPP be closed to secure EU admission permitted a form of engagement where the local experts were involved in the processes of evaluation and decision-making. Nevertheless, a political choice was valued over any technical one, for example, an upgrade of the RMBK reactors.
What rationale was given by the party that implemented the engagement?	Existing Soviet reactors could not be technically upgraded to the necessary safety level, nor was it economically feasible.

3.5. Event 5: The National Referendum about new NPP construction in 2012

Actors: *Sociological Centre "Vilmorus", Lithuanian Government, Lithuanian Parliament, Lithuanian Green Movement, population, Lithuanian Electricity Organization" (LEO LT)*

Before decommissioning of the second unit, on 12 October 2008, a referendum on its closure was held in Lithuania, where 88.7% were against the shutdown. However, the referendum had no legal ramifications because of insufficient voter turnout (47.6%). But its political meaning was unclear. Beginning with the collection of signatures for referendum in February 2008 this initiative was replaced by a consultative referendum i.e. its results were non-binding (Mažylis, Jurgelionytė 2012). Why did the Lithuanian authorities take such a step in the context of irreversibility of the political decision to close the Ignalina NPP? The reasons and explanations may be found within the internal political games between contesting political forces, the conservatives and social democrats, or in the area of democratic practices and procedures, where the Lithuanian authorities wanted either to demonstrate the vitality of democratic decision-making or to show the EU the value of the people's choice. Therefore, holding this referendum posed as an attempt to turn back the process of political irreversibility by utilising democratic procedures. Such a strategic game in the context of technology and democracy could be a winning one in 2008 except for the insufficient turnout, and may have been successful in moderating the accession deal with the EU.

Political conditions changed by 2012 when another referendum was held on the construction of a proposed station. According to the National Energy Strategy accepted in 2007, the construction of the new NPP jointly with Latvia and Poland was among the energy priorities on the way to the energy independence. The *Law on the Nuclear Power Plant* passed through the Parliament in 2007 provided the creation of the energy holding company “Lithuanian Electricity Organization” (LEO LT) comprising regional energy distributors and companies. This holding company supported by the acting Lithuanian government, was responsible for the implementation of energy projects, including the new NPP construction. After the elections in 2009 the new parliament dissolved the company – after conviction of its Directors in the Constitutional Court of attempts to acquire a monopoly on the energy market.

A few months after the Fukushima accident, in July 2011, the Lithuanian government announced that Hitachi GE Nuclear Energy would be the strategic partner and investor of a new Visaginas NPP that would use the infrastructure of the Ignalina NPP as its foundation. While this decision marked less continuity with Western technologies (of Europe and the US), it also marked a rupture with Russian technologies previously central to Lithuanian development since the 1950s, (not only in the nuclear power industry). Nevertheless this announcement came in the active period of post-Fukushima debates, with intense social mobilization and sharply divided public opinions pressuring the Lithuanian government to hold the referendum.

In October 2012 referendum, the Lithuanian people rejected the planned construction of a nuclear power plant at Visaginas. The referendum occurred in conjunction with legislative elections; the results marked a change of political attitudes from conservative to social-democratic orientations, and also indicated the impact of the nuclear issue on the political process.

Campaign/Surveys	Pro-nuclear Attitudes	Anti-nuclear Attitudes
Public opinion surveys, Ignalina NPP region, 1989 *"If we suppose that the INPP pass over to Lithuanian control. What would be its future?"*	63%	28%
"Vilmorus", 1998 *"What is your opinion about the future of the INPP?"*	80%	9%
"Vilmorus", 1999 *"Do you agree or disagree with the proposal of the international authorities to close the Ignalina nuclear power plant earlier than has been foreseen?"*	65%	13%
"Vilmorus", 2002 *Do you agree or disagree that Lithuania should retain a nuclear energy use for maintaining the State?*	62%	18%
"Vilmorus", 2008 *Will you participate in the referendum on the Ignalina nuclear power plant extension?* *If you participate in the referendum what will be your choice?*	62% 94%	15% 3%
"Rinova", 2007-2009 *Is a referendum necessary for considering new nuclear power plants in Lithuania?* *Attitudes towards the construction of a new modern reactor, %*	48.2% Totally in favour 29.8% Fairly in favour 19.4%	30.1% Totally opposed 12.2 Fairly opposed 8.7
Referendum 2008, turnout 44,8% *"I approve the extension of operation of the Ignalina Nuclear Power Plant for a technically safe period, but not longer than completion of the construction of a new nuclear power plant."*	88.7%	8.3%
Referendum 2012, turnout 52,6% *Do you agree with the new nuclear power plant in the Republic of Lithuania?*	35,2%	64,7%

After the shutdown of Ignalina NPP, anti-nuclear activism declined, but after Fukushima it renewed and developed new forms with a transnational character. For example anti-nuclear protests in Vilnius on 26 April 2011 by the Lithuanian Green Movement framed new techno-political claims that the nuclear safety issue reflected not a national NPP project but a regional one, specifically to the Baltic NPP in the nearby Russian Kaliningrad region and the Ostrovets NPP in Belarus. The anti-nuclear claims are in the same row with the contentious narrative of the Lithuanian Green Party, Russian Ecodefense and Belarusian Ecohome, which organized a set of common protest actions. This transnational form of protest has been effective and made the referendum possible.

Event 5	**The National Referendum about new NPP construction**
Who was involved?	Population, political leaders, social movements
When and where did it take place?	14 October 2012
What type of process was it (communication, consultation or participation)? How did this change over time?	Participation. This is the second attempt to conduct a referendum about civilian nuclear power in Lithuania. The first one in 2008 failed to be binding because of insufficient turnout. The second in 2012 showed that anti-nuclear forces had the upper hand. Nevertheless to understand properly the social nuclear attitudes these results must be seen within the context of public opinion surveys. The future of the new NPP project remains unclear.
What rationale was given by the party that implemented the engagement?	The impact of the decision-making and new democratic institutions on the public attitudes to the nuclear power.

4. Facts & Figures

The purpose of this section is to give an overview of nuclear power in Lithuania. This section contains such data as number of reactors, reactors' locations, technical and chronological details of reactors' construction as well as statistics on electricity production, periodization and social connections to nuclear constructions. This data can be used as a supportive material to the following sections of the country report and in order to understand the overall country's situation. Key dates and abbreviations used in this report are presented in the beginning of this section.

4.1. Data summary

- Lithuania had one nuclear power plant, Ignalina NPP, with two operating reactors of RBMK type – similar to reactors at the Chernobyl NPP in Ukraine.
- By joining the EU, Lithuania had to close its two reactors in 2004 and 2009 respectively.
- The last reactor Ignalina 2 produced 70% of country's electricity.
- Lithuania was exporting its electricity before the shutdown of the NPP and after the shutdown it became highly energy-dependent on Russia.
- There were large political and social uncertainties about the INPP shutdown.
- A new nuclear plant is planned with cooperation between Baltic States.

4.2. Key dates and abbreviations

Key dates:

1970's	Soviet plans to construct NPPs with RMBK reactors in European USSR in order to integrate European part to the Soviet North-West unified power system
1975 -1987	Building of the Ignalina NPP
1980's	Scientific protests against Ignalina NPP
1983	After several serious accidents the State Committee for Supervision of Safety in Nuclear Power Industry was finally founded in the USSR
1983	Ignalina 1 was launched
1985	Start of construction of the third nuclear reactor at Ignalina NPP
1986	The Chernobyl nuclear disaster occurs on 26 April
1986	Following the Chernobyl accident the project of the third nuclear reactor was

	cancelled and later the plant was demolished
1989	The Soviet Council of Ministers gives decision to stop construction of four planned RBMK reactors
1991	Lithuania got ownership of Ignalina NPP
1994	Nuclear Safety Account (under EBRD) gives grant of $36.8 million to Lithuania for Ignalina NPP's safety improvement program
2001	The Ministry of Economy founds The Radioactive Waste Management Agency (RATA)
2004	The first unit of Ignalina NPP was shut down by EU requirements
2004	Lithuania joins EU
2006	EU's Eurobarometer survey conducted that 69% of responded residents were sure that it was possible to operate NPP safely
2007	Lithuania, Latvia, Estonia and Poland agreed upon building a new NPP at Ignalina NPP site named Visaginas NPP
2008	Visaginas Nuclear Energy (VAE) was established to operate the new NPP
2009	Full decommissioning of Ignalina NPP, the second unit was shut down
2009	Survey by VATESI of 1,000 residents showed that 73% were sure that it was possible to operates NPP safely
2010	Russia starts to build Baltic NPP in Kaliningrad with two VVER-1200 units
2012	Public referendum on new nuclear capacity - 63% voted against
2012	Nuclear fuel from unit 2 of Ignalina NPP was unloaded
2013	Belarus started to build a VVER-1200 nuclear plant in Ostrovets district near the border with Lithuania

Abbreviations:

EBRD	European Bank for Reconstruction and Development
IAE	Plant operator and supplier of energy to national company Lietuvos Energija (Ignalinos Atominé Elektriné)
IAEA	International Atomic Energy Agency
MWe	Megawatt electrical
NPP	Nuclear power plant
RATA	Radioactive Waste Management Agency

RBMK High-power channel reactor - Chernobyl type (*reaktor bolshoy moshchnosty kanalny)*

VAE Visaginas Nuclear Energy (*Visagino Atominė Elektrinė*)

VATESI Lithuania's State Nuclear Power Safety Inspectorate

WNA World Nuclear Association

4.3. Map of nuclear power plants

Figure 1 presents the map of nuclear reactors in Lithuania.

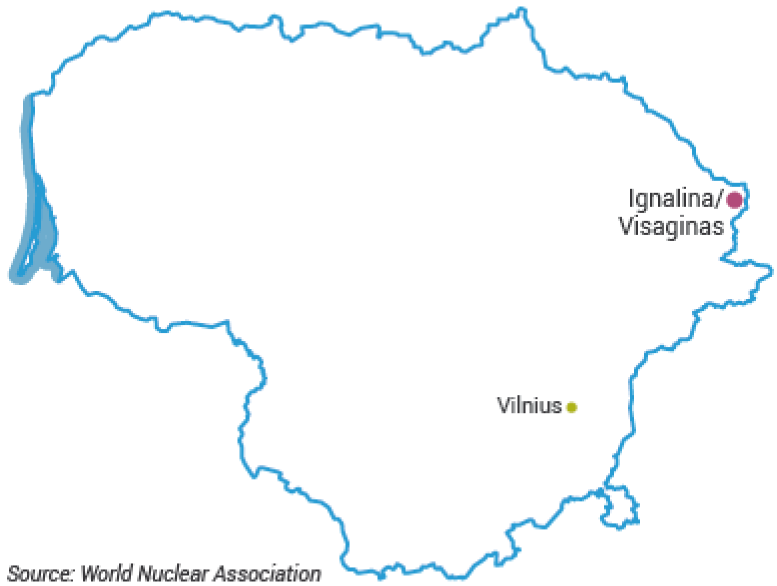


Figure 1 – Nuclear power plants in Lithuania

The Ignalina NPP (INPP) is located in the north-eastern part of Lithuania, bordering with Belarus and Latvia. INPP consists of two RBMK rectors that came on line in December 1983 and August 1987. The Soviet-designed RBMK-1500 reactors at INPP differ from the RBMK-1000 reactors launched in Russia and Ukraine under Soviet rule by nominal power capacity and by an improved safety system, an Accident Localization System (ALS). In 1993, INPP provided 88.1% of Lithuania's electricity, in 1996 and 1997 - 85.8% and 81.3% respectively.

The plant is situated on the southern shore of Lake Druksiai, almost 40 km from the town of Ignalina, initially the nearest village before Visaginas was constructed. Visaginas (Sniečkus was the town's first name) is a closed city (*atomgrad*), the home of INPP personnel, and is 6 km from the plant with the population of about 32,438 people. Vilnius, Lithuanian capital, is about 130 km away with a population of 545,000 people. Daugavpils is the nearest Latvian town, 30 km away, with a population of about 125,000 people.

The density of the population in 2001 before the decommissioning of the first reactor within the 15 km was 14.4 persons/m2 excluding Visaginas and 63.1 people/km2 including Visaginas. INPP uses Lake Druksiai as a natural reservoir for cooling water. The INPP was originally planned and constructed not only for the needs of the Lithuanian Soviet Socialist Republic, but also to meet the needs of the Baltic region and Soviet Belarus. Initially 4 unites were planned at INPP. The construction of the third unit had reached 50% completion in 1989, but was cancelled under the pressure of the scientific community and public. After the collapse of the USSR, the Independent Republic of Lithuania took over responsibility for control, operating and regulating the world's largest RBMK. INPP had a key role in the vitality of the economic, industrial and energy systems of Lithuania during the Soviet period and the post-Soviet period of independence.

During Lithuanian negotiations with EU authorities in October 1999, the Seimas or Lithuanian Parliament decided to decommission Unit 1 of INPP in 2004 (before 2005). The Lithuanian government in February 2001 approved a Program for Decommissioning Unit 1. Unit 2 was closed in 2009 within the National Energy Strategy that had been approved in October 2002. At present, the INPP is undergoing decommissioning according to the Final Decommissioning Plan with last amendments in 2014. According to the FDP the end stage of the decommissioning will be by 2038 with a so-called brown field "to arrange power plant's environment in a proper way so that it would be possible to rehabilitate its territory and develop economic activity preserving buildings and infrastructure that can be used" (FDP).

4.4. List of reactors and technical, chronological details

The tables below show a summary of the list of reactors, suppliers, operators as well as date details.

Table 1 - List of reactors in Lithuania

No.	Name	Operator	Supplier	Type	MWe gross	MWe net after Chernobyl	Construction began	Connected to the Grid	Shut -down	Status
1	**Ignalina-1**	IAE	USSR	RBMK	1380	1185	1978	1983	2004	closed
2	**Ignalina-2**	IAE	USSR	RBMK	1380	1185	-	1987	2009	closed
3	**Ignalina-3**	-	USSR	-	-	-	1985	-	1986	demolished
4	**Visaginas-1**	VAE	Hitachi	ABWR	1350	-	?	?	-	planned
5	**Visaginas-2**	VAE	-	-	1350	-	-	-	-	planned

Sources:IAEA. "Lithuania". 2016. https://www.iaea.org/PRIS/CountryStatistics/CountryDetails.aspx?current=LT
WNA. "Nuclear power in Lithuania." 2016. http://www.world-nuclear.org/information-library/country-profiles/countries-g-n/lithuania.aspx

Data on electricity production

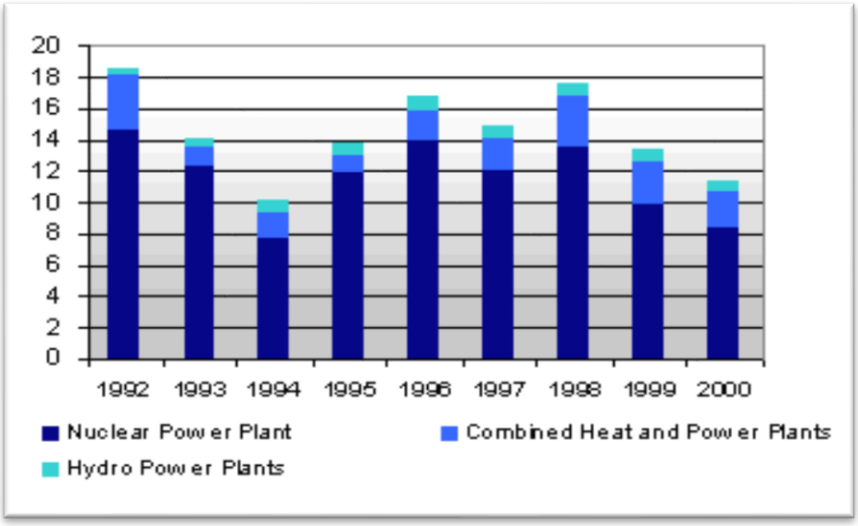


Figure 2 – Electricity production in Lithuania in 1992-2000, TWh (Zakaria 2001)

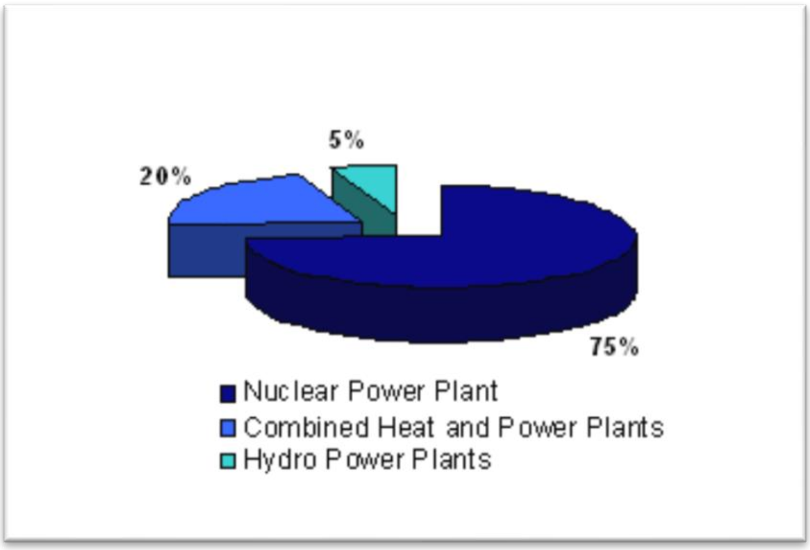


Figure 3 – Structure of electricity generation during year 2000 (Zakaria 2001)

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WP2

The Netherlands

Short Country Report

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HoNESt History of Nuclear Energy and Society

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Deutsches Museum

DIALOGIK

EHU Europos humanitarinis universitetas

TU/e Technische Universiteit Eindhoven University of Technology

Friedrich-Schiller-Universität Jena

Swedish Defence University

GRE

KTH

LUT Lappeenranta University of Technology

upna Universidad Pública de Navarra Nafarroako Unibertsitate Publikoa

UPMC Sorbonne Universités

The University Of Sheffield.

Science Museum

spi Sociedade Portuguesa de Inovação

CONTENTS

Executive summary

This report belongs to a collection of 20 short country reports on the History of Nuclear Energy and Society (HoNESt, project Ref.662268). The reports tackle the complex sociotechnical system around nuclear energy. Nuclear developments, notably nuclear energy, are closely intertwined with social, economic, environmental, political and cultural spheres. Nuclear energy is also a globalized system involving transnational transfers of knowledge, materials, technologies, people and products including electrical power, medical elements, toxic wastes and other environmental hazards, materials, capacities and knowledge that must be carefully safeguarded. Nuclear energy is a complex social and technological phenomenon that influences societies but is also shaped by societies.

The short country reports are designed to assemble information and research results on the history of the relations between nuclear energy and society about all the different country cases in an accessible manner, and to document the findings with references.

The purpose of the country reports is threefold, addressing three different audiences:

1. to provide basic elements of narrative and analysis for further historical research by HoNESt researchers;
2. to provide information, context and background for further analysis for HoNESt's social science researchers;
3. to provide accessible information on nuclear-societal relations in the various countries for the purposes of outreach and communication with stakeholders (civil society, industry, associations, policy makers, journalists).

This report focuses on the history of the relations between nuclear energy and society in The Netherlands after World War 2. This history can be summarized as follows:

After 1945 The Netherlands wanted to recapture its strong pre-war position in science as well as to modernize the country in several domains. Investing in nuclear technology was part of both. From 1950 to 1955 Dutch and Norwegian scientists together builtthe Joint Establishment Experimental Pile (JEEP) in the Norwegian Kjeller. Meanwhile the electricity producing sector and Dutch industries also got attracted to the opportunities of the technology in the early 1950s. Especially after Eisenhower's "Atoms for Peace" speech the government was determined to let parties work on nuclear energy for The Netherlands. A reactor research centre was established in 1955. Furthermore, it felt important to ripen the minds of the general public for nuclear energy. An exhibition at Schiphol airport in 1957 was a significant outcome of this aim. Both efforts proved to be successful. Albeit later than expected, the first Dutch nuclear reactor (Dodewaard) was built in the 1960s without meaningful societal questioning let alone opposition.

However, Dutch nuclear ambitions went further. Unlike Dodewaard, the main projects that were underway by that time met severe social criticism and opposition. Especially the "Kalkar-levy" in 1973 on electricity bills to finance a fast breeder reactor, gave an important impulse to the anti-nuclear movement that had already been emerging for a couple of years. Those anti-nuclear sentiments were further fed through incidents and reports of unsafe situations and problems with waste in Dodewaard and Borssele, and issues relating to the proliferation of nuclear knowledge to dubious regimes and uncertainty about the origins of Urenco's uranium.

In the late 1970s the government responded to the broad societal resistance against nuclear energy and the deadlock this created for policy-makers by organizing a Broad Societal Discussion on energy policy. The anti-movement was most satisfied with the final outcomes. They felt also the most betrayed by the BMD as the (right-wing) government ignored its conclusions and decided to build at least two more nuclear reactors in the Netherlands. However, the incident at Chernobyl in April 1986 put a spanner in these intentions and put nuclear power on hold for about a period of 15 years.

This situation changed as global warming reached the political agenda in the late 1990s. To meet the Kyoto demands and in the meantime assure the supply of energy, nuclear re-entered the societal and political debate in The Netherlands. The discussions since then lack the fierce polarization of the 1970s and 80s. While the government expressed its support for nuclear initiatives of the electricity sector, the financial-economic crisis hampered their intentions. The nuclear accident in Fukushima in March 2011 played its role too but polls are inconclusive about the lasting and determinative effects on public opinion about nuclear energy.

1. Historical context (narrative)

1.1 Introduction to the historical context: Nuclear energy and society in the Netherlands, 1945-present

The years 1969-1973 are a turning point in the history of nuclear energy and society in the Netherlands: In these years the country became a 'nuclear energy nation'. The first two nuclear power reactors went critical (Dodewaard and Borssele) and – by joining an international consortium – a uranium enrichment plant was built (URENCO Netherlands) (see event 2). Furthermore, in these years, the Netherlands began to participate in a fast breeder reactor project just across the border in Kalkar, West-Germany. But as these technological events proved the Dutch nuclear ambitions - and legislation and regulations institutionalized these – nuclear technology became publicly contested. Within a couple of years a mix of related technological, institutional and discursive factors and events transformed the public perception of 'nuclear' to an embattled reality.

In this section a narrative of Dutch nuclear history and society since 1945 is presented, with a short prologue going back to 1932. It is an overview providing the context for the showcase (section 2) and the events (section 3), in which the relation between society and nuclear is analysed on a deeper level. The post-WW2 period up to the "turning point years" 1969-1973 is divided in two sub-periods. 1945 to 1955 shows the establishment of a nuclear energy research infrastructure. In 1946 the Foundation for Fundamental Research on Matter (FOM) and the *Instituut voor Kernfysisch Onderzoek* (IKO) were established. The joint electricity production sector started its own research program on nuclear energy at its research centre KEMA in Arnhem from 1948 onward. To gain knowledge and experience Dutch scientists and researchers worked with Norwegians on an experimental nuclear pile located in Norway. In these same post-war years nuclear energy was framed in terms of scientific and technological progress. Strong associations were made with publicly favourable desired processes of industrialization, modernization and economic growth (Verhees 2012, 92-98) (see event 1).

A new period started in 1955. That year the Dutch Reactor Centre (RCN) was established in Petten as a collaboration between the Dutch government, the electricity sector and industrial companies. Next to building a research reactor (at RCN) and doing research on promising technologies such as suspension technology (at KEMA) and ultracentrifuge (at FOM/RCN), researchers, policy makers, industry and the electricity sector were preparing for establishing the first nuclear energy reactor in the Netherlands. This was realized in 1969 without societal turmoil. As mentioned above, in a couple of years the general public's attitude towards nuclear energy would change dramatically.

While some new ambitious nuclear projects came in a crucial phase, the anti-nuclear movement grew and nuclear energy became part of a societal debate. In the late 1970s the government tried to institutionalize this debate by organizing the so called Broad Societal Discussion [in Dutch: BMD]. The outcomes of the BMD were presented in 1984 and showed a majority of the population did not favour more nuclear facilities. This however did not hinder the government's new plans for nuclear energy. What a public participation process in the Netherlands could not realize, a nuclear incident in the USSR could. The Dutch nuclear plans were frozen, marking a new period in Dutch nuclear history and society. This lasted until 1999 as nuclear energy returned as a green alternative in the Dutch energy-discussion.

1.2 Contextual narrative[1]

Prologue: Exploring Nuclear Physics (1932 – 1945)

Key data for this period

1932	Philips starts nuclear research at its Physics Laboratory (NatLab)
January 1937	Symposium organized by the Dutch Royal Institute of Engineers about the construction of the atomic nucleus.
Summer 1939	The Netherlands buy c. 10 tons of Uranium-oxide from *Union Minière* from the Shinkolobwe-mine in the Belgian Congo.

The outcomes of international fundamental scientific research on atom-fission in the early 1930s, for example at the Cavendish Laboratory at the University of Cambridge, reached Dutch physicians as well as a broader Dutch public. Newspapers and popular journals published about

[1] See section 5 about general remarks on used sources.

it in terms of an exciting exploration into the hidden secrets of matter and universe.[2] Some items mentioned possible future applications of atom fission, especially in the medical and energy domains: '[Scientists are] thinking of the inexhaustible amount of energy captured in the atom,' a provincial newspaper stated early in 1932.[3] Although opportunities dominated the news, the dark side of the release of energy by atom fission was sometimes also mentioned: 'It would be possible that an input of a certain amount of energy produces a thousand times as much energy […] The economic and industrial revolution that this will bring about cannot be described. The question remains however, whether human kind will be happier, if the whole earth can be blown up by a hectolitre of water.'[4]

At the same time the public was informed about the stunning developments in (international) atomic science, more and more Dutch scientists were attracted to this field of research. For example the physics laboratories of Philips (NatLab) and the *Vrije Universiteit* (VU) in Amsterdam started research on nuclear physics in the early 1930s. As a technical company Philips was interested because of the technological opportunities for the artificial production of radioactive matter, including for biomedical applications (De Groot 1937, 102).

In the 1930's discussions about nuclear science and its applications took place within the scientific community. Early in 1937 for example the Royal Institute of Engineers organized a symposium on nuclear research. Amongst the speakers were Prof. Schizoo of the VU and F.A. Heijn of Philips's NatLab. In these years the general public was not involved in debates on nuclear topics, or, as Verhees concludes: '*Before and during WWII, there was no coherent 'nuclear discourse' in The Netherlands.* [] *This would all change with the atomic bombardment of Hiroshima and Nagasaki in 1945.*' (Verhees 2012, 93).

[2] Some examples of Dutch newspaper articles and popular publications about atomic research in the early 1930s: 'Wat is een Neutroon', in: *De Tijd*, 22-03-1932, 3; 'Triomf der wetenschap', in: *Het Vaderland*, 02-05-1932, 2; 'Splitsing van atomen', in: *Algemeen Handelsblad*, 05-05-1932, 9; A. Troller, 'De Nieuwe transmutaties', in: *Wetenschappelijke bladen* (1933) no. 2, 39-50 (Based on an article in the French journal *La Nature* no. 2882).

[3] *Limburger Koerier*, 07-01-1932, 6; See for an example of applications at the medical domain: A. Pirchan, 'De genezende werking der radioactiviteit', in: *De Zuid-Willemsvaart*, 13-02-1932, 3e blad, 1.

[4] 'De ontleding van het atoom gelukt', in: *Het Vaderland*, 19-05-1932', 2.

Nuclear from military to civil technology (1945 – 1955)

Key data for this period

November 1945	First meeting of the Dutch Committee for Nuclear Physics
April 1946	Establishing Foundation for Fundamental Research on Matter (FOM).
1948	NV KEMA in Arnhem starts research on nuclear physics
November 1951	Start bilateral collaboration between the Netherlands and Norway in the JEEP-project
October 1952	FOM and KEMA sign a cooperation agreement on nuclear research.
January 1954	Proposal of the FOM board to build a 10 MW nuclear reactor in the Netherlands.
About 1955	Educational slide shows 'Men and Atom' and 'Benefits of the Atom', presented by the US Information Service.

There is some discussion amongst historians about the degree of public concern about the atomic bomb in the Netherlands in the post-war years. For here it is relevant to conclude that the public perception of nuclear technology, whether strong or weak and discussed or not, got a strong military connotation after Hiroshima and Nagasaki. This connotation hampered the broader visions and plans scientists and policymakers had with the technology in (re)building and modernizing the Netherlands after WW2.

Nuclear energy had to be framed in terms of scientific and technological progress (again) and strong associations had to be made with publicly favourable desired processes of industrialization, modernization and economic growth. Scientists saw a prominent role for themselves in this (Verhees 2012, 96). While an (unofficial) campaign started to inform civil society about civil applications of atomic power and to pull the technology away from its military connotations, the Netherlands began to build a nuclear research infrastructure. Scientists, backed-up by decision makers, felt that the Netherlands had to catch-up with nuclear science, to re-establish its international position in physics it had in the early 20th century. In 1946 the Foundation for Fundamental Research on Matter (FOM) was founded. Nuclear physics became an important field of research for FOM. Together with the Municipality of Amsterdam and Philips, FOM participated in the Institute for Nuclear Physics Research (IKO) that was set up soon after in Amsterdam. The joint electricity production sector started its own research program on nuclear energy at its research centre KEMA in Arnhem in 1948 (Van Splunter 1993, 109-122 and 144-147).

FOM and KEMA separately did feasibility studies about building a nuclear reactor in the Netherlands. FOM concluded that it was too costly for a small country like the Netherlands and that co-operation with a foreign partner was necessary. Early in 1950 this resulted in a bilateral collaboration between the Netherlands and Norway, more precisely in the building of a nuclear research-reactor in Kjeller in Norway, called the Joint Establishment Experimental Pile (JEEP) and a Joint Establishment for Nuclear Energy Research (JENER). The Netherlands put scientists and their amount of uranium-oxide - which had been purchased just before the war broke out - at the disposal of JEEP. KEMA was not happy with this because it wanted to build a Dutch nuclear reactor together with FOM and Dutch industry. Partly as a reaction to KEMA's criticism, FOM presented plans for building two nuclear power plants in the Netherlands as a follow-up to JEEP. In the fall of 1952, a year after the opening of JEEP, FOM and KEMA signed a cooperation agreement (Van Splunter 1993, 123-143).

In the meantime the strategy to 'uncouple' nuclear power from military applications continued. The Netherlands, as other West-European countries, were assisted in this goal by US propaganda material, such as educational slide-shows. The attempts were successful. In the 1950s '*the association between atomic energy and the atomic bomb [gradually] decreased in the public mind.*' (Verhees 2012, 100).

Preparing for the Nuclear Age (1955-1973)

Key data for this period

July 1955	Establishment of the Foundation Dutch Reactor Centre (RCN) in Petten.
November 1956	The Commission-Roodenburg is established to examine a possible nuclear reactor for the Netherlands.
March 1957	The Netherlands sign the Euratom-agreement.
June 1957	Opening of the exhibition 'The Atom' at Schiphol.
July 1957	Publication of 'Nota inzake de Kernenergie' [Memorandum on Nuclear Energy] by the Minister of Economic Affairs.

Spring 1959	Establishment of the industrial 'nuclear' consortium Neratoom.
March 1960	A delegation of the joint Dutch electricity producers (SEP) visits the US.
May 1961	Contract between SEP and General Electric (GE) for the pre-design of a BWR-type pile of 50 MW capacity.
February 1963	Law on Nuclear Energy.
January 1965	Establishment of the NV *Gemeenschappelijke Kernenergiecentrale Nederland* (GKN) [Joint Nuclear Energy Reactor, Netherlands].
March 1969	Opening of the first nuclear power plant in the Netherlands in Dodewaard.
March 1969	The electricity producer PZEM orders a 450 MW nuclear power plant (PWR) with the German Kraftwerk Union
November 1969	Establishment of Ultra-Centrifuge Nederland NV (UCN) in Almelo
March 1970	Signing of the Treaty of Almelo between the Netherlands, the UK and West-Germany leading to Urenco
1971	Founding of the anti-nuclear grassroots Werkgroep Atoom
January 1972	License asked for the fast breeder reactor at Kalkar
March 1972	Launch of the Kernenergienota [Memorandum on nuclear power policy]
September 1972	Establishment of the 'Anti-Kalkar Committee'.
September 1972	Launch of the Anti-Kernenergienota [Memorandum against nuclear power policy] by the Working group (Nuclear) Energy.
June 1973	License for the nuclear reactor in Borssele is provided
July 1973	The Kalkar-levy on the electricity bill is introduced

By the end of the 1950s nuclear power had gained '*the cultural legitimacy*' that was needed for the successful realization of nuclear energy facilities. As a consequence the public attention to nuclear power which reached a peak in the years 1955-1957, rapidly decreased in the late 1950s and early 1960s, and more slowly in the last part of that decade. The construction of an institutional framework for nuclear facilities as well as the building of the research and commercial plants itself was accompanied by relatively little media attention. The press that showed interest was predominantly positive (Verhees 2012, 111-112).

While in the mid-1950s research - for example on ultracentrifuge technology and suspension-reactor technology - was on going in the Netherlands, plans were shaped for the actual building of reactors. In May 1957 the first working nuclear reactor appeared on Dutch soil. It was designed by the American Machine and Foundry Company and under their supervision built by the Dutch companies Comprimo and Philips. The small open-ended 'swimming pool-type reactor' was part of an exhibition called Het Atoom (The Atom) that can be seen as an event within the above mentioned 'uncoupling from military'- campaign and linked nuclear power to modernity. People were invited to visit the exhibition with the reactor in a hangar at Schiphol airport.[5] That summer, more than 700,000 people experienced the temporary exposition and took a look at a nuclear reactor. In the next six years four nuclear reactors for research and education opened in the Netherlands. Two of them appeared at the site of the Dutch Reactor Centre (RCN) in a small coastal place called Petten.

RCN was established in 1955. In this nuclear research centre the government, some large industrial and shipping companies and the electricity sector participated. Its founding had strong implications for nuclear research and development in the Netherlands. FOM, the key-player until then, lost its position in nuclear research. Also TNO, the traditional applied-research partner to Dutch industry was surpassed as it came to nuclear. Industry dealt directly with RCN on this matter. The shipping companies for example were interested because of the possibilities nuclear had as a propulsive force for ships. Also the electricity producers were a partner at the start. Soon however they decided to focus on their own project. KEMA was working on suspension reactor technology. In June 1953 it had requested a patent on this technology. When it proved that suspension technology was not a priority for RCN, the sector decided to work on the development of its own suspension-reactor at the KEMA-site in Arnheim (Lagaaij and Verbong 1998, 33-34).

RCN focused on building a high flux reactor (HFR). This American (Oak-Ridge) type research-reactor was visited by Dutch scientists on a US-tour in the spring of 1955. It was found most suitable for RCN's planned future research. A contract was signed with US-government, necessary for obtaining enriched uranium. American firms were invited to make offers for the

[5] A movie about the opening of the exhibition at: https://www.youtube.com/watch?v=TEE-97sGNM4.

building of an HFR. Finally in November 1961 the HFR in Petten went critical. Because the realization took longer than expected, RCN had decided in 1959 to build a Low Flux Reactor (LFR) as well. This small British Argonaut-type reactor was in use a year before the HFR.

Within four years two other research-institutes in the Netherlands got a nuclear reactor. In 1963 both the Delft University of Technology got a reactor for research and educational applications as the *Instituut voor de Toepassing van Atoomenergie* in de Landbouw (ITAL) [Foundation for Nuclear Applications in Agriculture] in Wageningen. The latter was established in 1957. In spring 1961 it had signed a 20-year contract with Euratom, making ITAL a European research institute.

As elsewhere in the Western world the Suez-crisis of 1956 boosted nuclear power as a possibility for the production of electricity. In the Netherlands the expectation that atomic energy would become the main source of electricity in the coming decades was widespread among policy makers and politicians. This view was also expressed in the first memorandum about nuclear energy of the Minister of Economic Affairs (EA) in the summer of 1957. The Netherlands had to add ‘nuclear’ to its energy production range as soon as possible (Lagaaij and Verbong 1999, 40). Furthermore, because the production of nuclear energy was seen as an important economic sector in the future, EA wanted Dutch industrial companies to get involved in nuclear activities quickly. This however instigated conflicts of interest with the electricity sector (cooperating in KEMA, the VDEN and SEP),[6] which wanted a free hand in the selection of partners and contractors. The reactor at Calder Hall (UK) had caught the sector’s attention as suitable for the Netherlands, though some modifications were needed.

The discovery of new gas and oil fields by the end of the 1950s –in the northern part of the Netherlands - lowered the prices of fossil fuels on the world market and the sense of urgency for nuclear energy in the Netherlands. Cheaper fossil fuels changed cost-benefit discussions in the energy domain, lowering the need for swift (and costly) actions building large nuclear reactors for electricity supply. Electricity produced by means of nuclear fission with the technology of that time, would cost 1 to 2 cents more per kWh than produced by coal-fired stations, the electricity

[6] VDEN was the association of directors of electricity companies in the Netherlands. The Sep was established in 1949 as a co-operating of the 10 largest electricity producing companies.

companies calculated (Lagaaij and Verbong 1998, 38 and 40-43; Lagaaij and Verbong 1999, 42).

The changing economic context for energy did not push nuclear energy off the policy agenda entirely. The connotation of modernity associated with it, the notion that the Netherlands could not afford to lag behind with this new technology, and the efforts that were set-up to convince society of the possibilities of 'the atom', did not allow so. The electricity producers continued making up their minds about reactor-type, size *et cetera;* they visited the US Atomic Energy Commission and talked to American counterparts. Dutch industrial companies also continued preparing for the atomic age. In spring 1959 they formed the Neratoom-consortium (Lagaaij and Verbong 1999, 43-46).

In May 1961 the co-operating electricity producers (SEP) signed a contract with General Electric for a Boiling Water Reactor (BWR)-pre-design. A year later it proved that this BWR was only feasible with financial support from the Dutch government and from Euratom. Both agreed to subsidize – 10 million and 18 million guilders respectively – and by January 1965 the Joint Dutch Nuclear Power Station Inc. (GKN) was established. It planned its first Dutch nuclear energy reactor at Dodewaard near the river Waal. The eleven provincial Dutch electricity companies were all shareholders in GKN (see section 2).

In March 1969 Dodewaard started producing electricity,[7] without much media-attention as we saw above. Dutch industry was for a large part (about 70%) involved in the building process. Philips provided the fission-elements, the *Rotterdamse Droogdok Maatschappij* (RDM) the reactor vessel, Stork the turbine installation and *Hollandse Signaal* the stainless steel control rods, to name some important contributors (Lagaaij and Verbong 1999, 53).

While building the reactor at Dodewaard, the electricity companies decided in 1966 to order a second, much larger nuclear reactor. The Sloe-area in the province of Zeeland was put forward as a suitable location. A nuclear reactor became part of the negotiations between the province and the French aluminium manufacturer Pechiney that had plans to open a plant there. This customer could guarantee an almost total utilization of the reactor's capacity, which made it

[7] Actually the nuclear reactor already went critical in the summer of 1968.

economically feasible. In the spring of 1969 the electricity company of Zeeland (PZEM, that was part of GKN) signed a contract with the Kraftwerk Union, in which Siemens and AEG cooperated, to supply a 450 MW Pressurized Water Reactor (PWR). Dutch industry and the Ministry of Economic Affairs were not supportive of PZEM's choice of the German consortium. They were stunned by the autonomous decision-making process, in which they found Dutch industrial interests ignored (Lagaaij and Verbong 1999, 57-58). For Philips, this came just before they had been denied the contract for the replacement of the fission-elements for Dodewaard, and PZEM's decision was the straw that broke the camel's back. Philips withdrew from nuclear activities, with the exception of its participation in Ultra-Centrifuge Nederland NV (UCN), an experimental nuclear-enrichment factory that was being built in Almelo (see event 2).

Later than planned – mainly because of some leakage-problems at Dodewaard that delayed the licensing process – the second Dutch nuclear energy reactor at Borssele went critical in the summer of 1973. Compared to the opening of the first in Dodewaard a few years before, the social climate had changed fundamentally. Discussions in the 1960s were about technological choices, about the trajectories of a nuclear energy society, including the roles of different actors involved, about cost-benefit questions, et cetera. These techno-economic issues were debated by nuclear scientists, the energy producers, Dutch construction and electro-technical industry, and economic policy makers. In spite of some harsh clashes and disturbed relationships within this scientific-professional community, these discussions led to a noiseless Dutch entrance into the atomic age. At the end of the decade there was only some local opposition against nuclear power. By 1973 however, '*through various channels, the American concerns about nuclear power* [that started in the late 1950s] *had found their way to The Netherlands*' (Verhees 2012, 57-58).

Societal concerns evoked some protests against the establishment of the Borssele-reactor. Also the safety of the Dodewaard-reactor became part of a discussion outside the arena of experts. Parliamentarians questioned the safety-measures at the pile and the safety of transporting nuclear material in general. The heaviest protests however focused on three other projects that were important in preparing for the Dutch nuclear age: the above mentioned Ultra-Centrifuge Netherlands (UCN) in Almelo, the building of an experimental suspension-reactor at KEMA in

Arnhem, and the planned fast- breeder reactor in Kalkar, Germany near the Dutch border (see event 3).

Nuclear power as a contested technology (1973 – 1986)

Key data for this period

1974	Establishment of the anti-nuclear 'Stroomgroep Dodewaard'
January 1974	A petition was offered to parliament (3686 signatures) against a second pile in Borssele
September 1974	Eerste Energienota [First Memorandum on Energy]. A counter-memorandum was published by the Bezinningsgroep Energiebeleid.
September 1974	The first large-scale anti-nuclear power protest (10,000 participants) by mostly Dutch people at the Kalkar site
October 1974	Petition to Parliament calling for the end of the Kalkar project signed by 155,000 people.
March 1978	Large protest march in Almelo because of the expansion plans of Urenco's uranium-enrichment facility. About 50,000 attended.
April 1979	Anti-nuclear energy protests in Borssele as a reaction to the Three Mile Island accident.
1980-1984	Brede Maatschappelijke Discussie (BMD) [Broad Societal Discussion] on energy policy.
May 1980	Establishment of the Dodewaard Gaat Dicht! [Dodewaard Close Down!] movement
October 1980	Blockades of the Dodewaard reactor by activists.
1982	Establishment Centrale Organisatie voor Radioactief Afval (COVRA) [Central Organisation for Radioactive Waste]
Early 1985	In a letter to parliament the right wing government officially rejects the BMD-conclusions.

The efforts ripening society to accept nuclear power by freeing it from its warfare connotations had resulted in a 15-year period of realizing a number of nuclear facilities, including two nuclear power plants. In the early 1970s plans to expand this nuclear infrastructure were still dominant amongst (nuclear) scientists, the electricity sector and the political majority. A second nuclear reactor at Borssele was considered and in 1971 the Netherlands had signed a contract with West-Germany and the UK to participate in a uranium enrichment plant (Treaty of Almelo) leading to the establishment of Urenco. With Belgium and West-Germany plans to build a fast-breeder reactor at Kalkar were concretized. Furthermore, the electricity sector wanted to expand its suspension-technology research (KSTR), to name some of the most important and far advanced intentions. The Dutch government expressed their plans of a moderate expansion of nuclear energy in a Memorandum on Energy in September 1974: by 1985 three new reactors of 1000 MW each, should be realized.

Opposition against nuclear technology grew as well. The anti-movement broadened and went far beyond groups of worried locals. Environmental groups, critical scientists and left-wing political parties joined the concerned citizens and formed a front to the pro-nuclear lobby. Petitions were handed in, demonstrations organized and an anti-memorandum as a reaction to the government's memorandum of September 1974 was written. The pro-nuclear movement could no longer legitimate its plans with reassuring information brochures, by associating nuclear technologies with modernity and progress, and/or by presenting favourable data and statistics. Progress itself was questioned as was the scientific and political establishment and the data they provided as arguments for their cause were mistrusted. The anti-movement got better informed. Firstly by critical scientists who joined their side and wrote well-argued memoranda and brochures, secondly because it started to build its own information- and propaganda network of which the Amsterdam based World Information Service on Energy (WISE), established in 1978, and the national Documentation- and Research Centre on Nuclear Energy - Laka (1988), were outcomes (Verbong 2000, 257-262).

The accident at the Three Mile Island Nuclear Reactor in Harrisburg in 1979 caused new demonstrations. According to Turkenburg the amount of people that were negative about nuclear energy had grown to over 80% after the Harriburg-incident. This was a growth of 30% in three years' time (Turkenburg 2003, 47). From 1980 onward the Office on Nuclear Physics starts publishing an annual overview of malfunctions in Dutch nuclear facilities. The government responded to the broad societal resistance against nuclear energy and the polarized positions of both fronts by organizing a Broad Societal Discussion (Brede Maatschappelijke Discussie or BMD) on energy policy (see event 4). Hundreds of discussion-meetings were held. But, as Verhees concludes, in the end '*the BMD fell short of its goal of an exchange of ideas. It functioned more as performance stage than as debating forum*.' (Verhees 2012, 132).

The results of the BMD were published in the final report of the Steering Group Societal Discussion Energy Policy in 1984. It proved that a majority of the participants did not want new nuclear reactors. The opinions about closing down the existing reactors by the government were split in the middle. The anti-movement was most satisfied with the outcomes. However, they felt also the most betrayed by the BMD as the (Christian Democratic/ Liberal) government ignored the outcomes and decided to build at least two more nuclear reactors in the Netherlands. However, the nuclear incident at Chernobyl in April 1986 put a spanner in these intentions and put the plans on hold. It lasted until the mid-1990s though, until the government decided to abandon the idea of new nuclear power stations (Verbong 2000, 262).

Out of the large nuclear initiatives of the early 1970s, only the Urenco enrichment plant in Almelo got realized. The fast-breeder plant in Kalkar was built indeed and ready for production by 1986, but never went critical. In 1991 the project was definitively stopped. Four years later the buildings were sold and turned into an amusement park. Already by the end of the 1970s KEMA had ended its research on suspension-technology (Lagaaij and Verbong 1999, 57-59).

Nuclear power of the agenda (1986 – 1999)

Key data for this period

September 1987	The Dutch State, Ultra-Centrifuge Netherlands (UCN) and Urenco are summoned by the UN for importing Uranium from Namibia.
1990	Programma Instandhouding Nucleaire Competenties (PINC) [Program for the Preservation of Nuclear Competences] is launched.
1991	The Kalkar fast-breeder project is stopped.
November 1994	Dutch parliament wants the Borssele reactor closed down by 2004.
April 1996	ECN and Mallinckrodt start the commercial production of Molybdeen (medical isotope) in Petten.
March 1997	The Dodewaard nuclear energy reactor is closed down

The Netherlands experienced relatively little consequences of Chernobyl. The plans however to build two new nuclear reactors in the short term as part of a transition towards more nuclear within the total electricity supply – despite the outcomes of the BMD – were hampered. Directly after Chernobyl the decision making process about the location for the two reactors was stopped. First, the government wanted a thorough analysis of the accident, leading to an evaluation - called rethinking or 'herbezinning' - about the future of nuclear energy in the Netherlands. Early in 1988 this 'herbezinning' was finished and several expert-organs and stakeholders were asked for comments and advice.[8] It took some time to collect. Furthermore, the government decided that additional studies about the safety of (commercial) reactor types were needed. For that reason the Minister of Economic Affairs decided in 1989 to postpone decisions about new nuclear reactors and the replacement of the two in operation.

In the same document that the Minister announced this postponement, he also emphasized that it was of the utmost importance to preserve the Dutch nuclear knowledge and infrastructure. For this reason he launched a four year Program for the Preservation of Nuclear Competences [Programma Instandhouding Nucleaire Competenties (PINC)]. The participants in the program were ECN, KEMA, The Reactor Institute (IRI) of Delft University, GKN, and Stork NUCON BV, a nuclear consulting and executive company.

In 1995 the government – a coalition of socialists, liberal-democrats and liberals – published the Third Memorandum on Energy [Derde Energienota]. It focussed on liberalizing the Dutch energy market as well a stimulating more sustainable energy in society. No decision was made about building new nuclear reactors. Yet, the minister acknowledged a lack of social support for nuclear energy in the Netherlands at the time, because of, as he called it, '(perceptions of) risk, radioactive waste, the problem of proliferation and a moderate competitiveness.'[9] Opposed to this he noticed advantages of nuclear energy that could tip the balance in favour of it in near future. He pointed at the relatively large amounts of uranium and a zero CO_2 emission of nuclear energy. Also social perception on the matter could change. Because of the fluidity of these and other factors and arguments it would not be wise to take any definitive steps about the subject, he concluded (Ministerie van Economische Zaken 1996; Van Kasteren 2011, 382).[10]

The Dodewaard nuclear reactor was closed-down in March 1997. Already in 1994 Dutch parliament had decided that the Borssele reactor had to be closed by 2004, three years earlier

[8] Amongst them were the Commission Reactor Safety [Commissie Reactor Veiligheid (CRV)], the General Energy Council [Algemene Energieraad (AER)], the Central Council for Environmental Hygiene [Centrale Raad voor Milieuhygiëne], the Fire-brigade Council [Brandweerraad], the Health Council [Gezondheidsraad], the Coordinating Police Council [Het Coördinerend Politieberaad] and the Council for Watermanagement [Raad voor de Waterstaat]; see: *Proceedings of the Dutch Parliament*, 1988-1989, no. 21061.

[9] In Dutch: "Kernenergie heeft dan momenteel een aantal nadelen: een beperkt maatschappelijk draagvlak wegens de (perceptie van) risico's, radioactief afval, het vraagstuk van de proliferatie en een matige concurrentiepositie."

[10] See also: *Proceedings of the Dutch Parliament* 1995-1996, no. 24525.

than initially planned. However, next to the definite stop of the Kalkar fast-breeder project (1991), the close- down of Dodewaard (1997), the accelerated close-down plans of Borssele (decided in 1994), and the postponement in decision making, there were new initiatives in favour of nuclear technology during this decade. In 1992 ECN in Petten and the US-company Mallinckrodt signed a long-term agreement for the production of Molybdeen-99 (Mo-99) for medical purposes. In spring 1996 the production started. Furthermore, the uranium-enrichment company URENCO in Almelo was licensed to expand twice. In 1992 to 1300 tons and in 1993 to 2500 tons.

Nuclear power and the greening of energy discussion (1999 – 2016)

Key data for this period

October 2001	Negative reports about bad conduct of business and violations of safety regulations at the HFR in Petten.
February 2002	Temporary close down of the HFR in Petten (restart in March 2002 after examination by the IAEA)
February 2003	Advice to build a new nuclear reactor in Petten to replace the HFR
September 2003	Police raid at the ECN-site in Petten, because violations of safety and environmental laws and regulations with ECN, NRG, Mallinckrodt and GCO (the subsidiary of the European Commission).
September 2003	Opening HABOG at the Covra-site for storage of highly radioactive material.
August 2008	Temporary close down of the HFR in Petten (restart in February 2009)
2012	The national government and the province of North-Holland decide to subsidise a new reactor at ECN in Petten
March 2013	The government decides to keep the Borssele reactor open until 2033

The signing (1997) and ratifying (2002) of the Kyoto protocol by The Netherlands implied far-reaching measures to reduce greenhouse gas-emissions. The country still relied heavily on natural gas, oil and coal for its energy consumption (see facts and figures). As EPZ, the electricity company that owns the Borssele nuclear reactor, challenged the parliamentary decision of 1994 to close the reactor as early as 2004, the nuclear power discussion revived in the Netherlands. In 2000 the Raad van State, the highest judicial court in the Netherlands, rejected the decision and allowed the electricity company EPZ to keep the pile open after 2003.

An emergency law that was prepared to force EPZ to close-down Borssele before 2003 was withdrawn in June 2002 by the Socialist Minister who was under resignation. His argument was ‘a changed political climate’. A couple of weeks earlier the popular right-wing politician Pim Fortuyn was murdered by a radical animal activist. The murder shocked the country and the general elections that went on two weeks after the murder resulted in a huge win of Fortuyn’s right-wing party. In 2006 the centre-right wing government decided that Borssele can stay open until 2033.

The decision to keep Borssele open was in line with an opinion poll in 2005. A two-thirds majority of the participants then was in favour of extending the lifetime of Borssele. Furthermore, 47% was in favour of building new nuclear reactors, 43% voted against (Van Kasteren 2001, 382). Nevertheless the four successive coalition governments under Christian-Democrat J.P. Balkenende (2002-2010) did not take any initiatives to plan new nuclear reactors. The electricity sector however did. In 2006, Delta, one of the two shareholders in EPZ, openly speculated about plans for building a second nuclear reactor that could become critical in 2016.[11] In 2009 it started the license-procedure for a second 2500MW nuclear power plant situated in Borssele. Delta expected the reactor to become critical in 2018. The new right-wing administration that came to government in 2010 expressed its support for new nuclear reactors, because they would contribute to reach the Kyoto goals and because they would make the country less dependent of foreign energy suppliers. ‘Permit applications for new nuclear reactors that meet the norms, will be consented,’ the coalition agreement stated.[12]

Late 2011 Delta had to slow down its plans and license-procedure as it had problems finding investors due to the economic crisis. This crisis had also created an overcapacity in the energy market resulting in low energy prices, shaking-up the business model of Borssele 2. Furthermore – although this was not mentioned as an argument - in March 2011 the Fukushima-disaster in Japan had taken place, influencing the public perception of nuclear energy.

The delay announced by Delta late in 2011 tempted 69 academic professors in the fields of economics, environment and sustainability to write an open letter to the company asking to

[11] See: https://www.kernenergieinnederland.nl

[12] ‘Vrijheid en verantwoordelijkheid. Regeerakkoord CDA-VVD’, (2010), 12-13.

withdraw the plans for Borssele 2 definitely. Their main arguments: were that the reactor was not necessary for Dutch energy consumption, the building costs would far exceed the estimations, the exploitation would not be profitable, and last but not least, there was still no solution for the nuclear waste and this problem should not be passed on to future generations.[13] In January 2012 Delta announced to stop its plans for Borssele 2 all together for the time being.

Next to private plans for one or more new nuclear reactors, initiatives were taken in the early 21th century to renew two research reactors. A committee of experts did advise the Minister to replace the almost 40 years old High Flux Reactor at ECN in Petten (see event 5).

1.3 Presentation of main actors[14]

Science and Research

- FOM [Foundation for Fundamental Research on Matter], since April 1946

  Founders: G. v.d. Leeuw, H.A.Kramers, J. Clay, J.M.W. Milatz, H.J. Reinink and H. Bruining. Researchers (amongst others) and since 1949 head of FOM-Laboratory for Mass-spectography: J. Kistemaker
- IKO [Institute for Research into Nuclear-physics], since June 1946. Participants: FOM, the municipality of Amsterdam and Philips. In 1975 IKO became part of NIKHEF.
- Zeeman Laboratory, Physics laboratory of Amsterdam University, since 1923.
- Kamerlingh Onnes Laboratory, Experimental Physics Laboratory of Leiden University.
- Lorentz Institute, Institute for Theoretical Physics at Leiden University, since 1921.
- ZWO [Organisation for Fundamental Scientific Research], finances scientific research (a.o. FOM).
- TNO [Organisation for Applied Science]
  - Project Group Nuclear Energy, 1965-1977
- RCN [Foundation Reactor Centre Netherlands], since 1955, since 1976: ECN.
- KEMA [joint testing and research institute of the Electricity Sector]

  Researchers (amongst others): J.C. van Staveren, J.J. Went and H. Brinkman
- ECN [Energy Research Centre Netherlands], since 1976 (successor of RCN)

[13] See *Algemeen Dagblad*, 21-12-2011.

[14] See the descriptions of the events for specific actors involved in parts of Dutch nuclear history.

- NIKHEF [Dutch Institute for Nuclear Physics and High-Energy Physics], a cooperation between FOM, IKO and several universities
- NRG, since 1998 the joint nuclear facility of ECN (70%) and KEMA (see electricity sector) (30%). In 2006 KEMA sells its 30% share to ECN.
- Natlab [Philips' central research facility]

Government actors

- Department of Economic Affairs (in Dutch: EZ): - Industrial Council for Nuclear Energy (IRK)
- Department of Education, Arts and Science (in Dutch: OKW): - Scientific Council for Nuclear Energy (WRK); and - Central Council for Nuclear Energy (CRK)
- Department of Social Affairs and Public Health (in Dutch SZV)
- Department of Housing, Spatial Planning and Environment (in Dutch: VROM)
- Interdepartmental Commission for Nuclear Energy (ICK)
- Health Council
- Provinces of Zeeland [location Borssele nuclear reactor and COVRA], - Gelderland [location Dodewaard nuclear reactor], - Overijssel [location Urenco Netherlands], - Noord-Holland [location RCN/ECN], and - Noord-Brabant [intended location of the first nuclear reactor in the Netherlands]
- Municipality of Amsterdam [partner within the exhibition "The Atom" and involved in IKO]

Electricity Sector

- N.V. SEP [cooperating electricity producing companies]
- N.V. GKN [Joint Nuclear Energy Reactor Netherlands, shareholders were the 11 Dutch electricity producing companies], established in 1965]
- VDEN [association of directors of electricity companies]
- PGEM [Electricity company of the province of Gelderland], PZEM [Electricity company of the province of Zeeland], and PNEM [Electricity company of the province of Noord-

Brabant]

Industry

- Philips N.V. [electro-technical company]; - BPM/Shell [oil company]; - Staatsmijnen [Dutch State mining Company]; - Werkspoor N.V. [machine factory]; - Stork N.V.; - the ship building companies: Rotterdamsche Droogdok Maatschappij (RDM) and Rijn Schelde; - Comprimo [engineering contractor]; - VMF [joint machine factories: Stork and Werkspoor]; - N.V. Hollandse Signaalapparaten

- In 1959 a number of the above companies started to cooperate in Neratoom [consortium of companies involved in nuclear technology]. Initial partners were: Philips, Stork, Werkspoor, Machinefabriek Breda [Machine factory Breda], RDM and De Schelde. Later they were joined by the shipbuilding companies: Wilton Fijenoord and Ned. Dok- en Scheepsbouw Maatschappij, and by NUCON [Nuclear Construction] (a subsidiary of Stork), and Comprimo.
- N.V. Dwars, Heederik and Verhey (DHV) [a civil-engineering company]
- UCN N.V. [Ultra Centrifuge Netherlands], established in 1969
- Interfuel
- Van Hasselt and De Koning [a civil-engineering company]
- General Electric (USA) [developer/supplier of the Dodewaard nuclear energy reactor]
- Siemens/Kraftwerk Union (BRD) [Developer/supplier of the Borssele nuclear energy reactor]

Public actors critical or opposed to nuclear energy

- VWO [Association of Scientific Researchers]; - Stroomgroepen Stop Kalkar/Kernenergie (SKK's); - Anti Kalkar Committees (AKK's); - Aktie Strohalm; - Landelijk Energie Komitee (LEK);

- Vereniging Milieu Defensie [environmental organisation] ; - World Information Service on Energy (WISE); - LAKA foundation [documentation- and information centre on nuclear energy], established in 1988; - Greenpeace.

2. Showcase: The Nuclear Reactor in Dodewaard

Towards a 50 MW nuclear energy reactor in Dodewaard in the 1950s and 60s

In the early 1950s the joint research institute of the electricity sector KEMA, the Foundation for Fundamental Research on Matter (FOM), and the Organization for Applied Sciences Research (TNO) discussed with the Ministry of Economic Affairs on how to organize nuclear research in The Netherlands and how to get Dutch industry involved. To the Dutch government the latter was very important as it foresaw a worldwide demand for nuclear technology in future. It wanted Dutch industry to be prepared for this. Although some large private companies such as Philips, Shell and some machine factories showed interest and willingness to invest in nuclear know how and technological development, they wanted the government to pay for a Dutch reactor and take care of the organizational framework first. In 1955 the Dutch Reactor Centre (RCN) was established. Soon after, negotiations started between the electricity producers, Dutch industry and the Ministry of Economic Affairs about a nuclear power reactor (Verbong and Lagaaij, 2000, 239- 240 and 243-245).

Late 1956 KEMA established a study group – the commission-Roodenburg - which would investigate whether a commercial nuclear energy reactor would be technically and economically feasible. The commission asked ten companies - five American, four British and one French – to make an offer (Bakker 1963, E 111), Furthermore, it asked its shareholders to pay 0.03 cents per every kWh electricity sold in 1957 and 1958, to finance the nuclear-activities. While in the Summer of 1957 the commission-Roodenburg was at work and compared reactor-types, the Minister of Economic Affairs presented the Kernenergienota. It expressed the wish of the Dutch Cabinet to realize a nuclear energy reactor in the country as soon as possible. This first reactor was expected to be in operation by 1962 and it would be followed by many. From 1975 onwards all new electricity production facilities would be nuclear, the minister noted (Ministerie van Economische Zaken 1957).

In broad outline the commission-Roodenburg agreed to the Kernenergienota. At that time the commission made plans for provincial electricity company PNEM to build a 150 MW nuclear reactor near Geertruidenberg. It was thought to become critical in 1962. Another reactor of 200

MW was scheduled to be built by the provincial electricity company PGEM near Harderwijk and connected to the grid by 1964. It took the commission-Roodenburg almost two years to present its final report. The selection process took more time than expected. The commission advised to focus on a light-water reactor (either a Pressurized Water Reactor (PWR) or a Boiling Water Reactor (BWR)) but surprisingly did not advise to accept one of the offers. Changed economic circumstances were the reason. Thanks to the discovery of new oil and gas fields the price of electricity was decreasing. For economic reasons nuclear energy was, in the late 1950s less interesting than it was in the mid-1950s. At a yearly basis a 150 MW nuclear reactor would cost six million guilders more than a conventional reactor, the Commission-Roodenburg had calculated. As a result of these figures the electricity sector decided not to buy a nuclear reactor (Lagaaij and Verbong 1999, 41-44; Verbong and Lagaaij 2000, 245-246).

This outcome was disappointing to the Ministry of Economic Affairs, which wanted Dutch industry to be stimulated by investments in nuclear energy facilities. It was also disappointing to the PNEM that had hoped to host the first nuclear reactor in the Netherlands. A third actor that was not amused was Dutch industry. Although the main contractor would be foreign, Dutch industry was meant to deliver parts of the equipment. Some enterprises were preparing to expand their activities in the nuclear sector. In the spring of 1959, just before the negative decision of SEP, a number of companies had established Neratoom (see identification of actors), aiming at developing and constructing complete nuclear reactors. The decision of SEP slowed down these ambitions.

Although this was a setback to some policy makers and stakeholders, it did not end the prospects for Dutch nuclear energy entirely. In September 1959 SEP installed a new commission – Commissie Kernenergiecentrale - to research the possibility of building a cheaper, more competitive reactor (Rietveld 1966, E 99). Cost reductions were possible If Dutch industry was able to build the entire reactor, because the wages in the Netherlands were much lower than in the USA for example. This, however, had some implications. First of all, the necessary know how had to come from abroad. For this reason a SEP-delegation visited the USA in March 1960, where they met with electricity producers, nuclear research institutes, the industry and the Atomic Energy Commission (AEC). They learned that a relative simple reactor design – PWR or BWR – with mediocre power – between 50 and 100 MW – would be the best option. This way the Dutch electricity producers, the research institutes as well as Dutch industry were able, at relatively low costs, to learn and gather know how, which would be vital in future when larger reactors were established. Also, the Dutch delegation encountered the willingness of American companies to sell their know-how and design specifications.

SEP decided for Dodewaard, a small town of 2800 inhabitants at the river Waal, as the location for this relatively small pilot reactor. The area was sparsely populated and predominantly strictly protestant. The river Waal supplied sufficient cooling-water for the condensers of the reactor. Furthermore, about 3.5 km from the proposed reactor was an open air switch-yard station of the national electricity grid. This was important because of the plant's intended base-load function (Wassenaar 1969, 31-32). Next to this, Dodewaard is very close to Arnhem, where SEP and KEMA were at the time working on the development of an experimental suspension reactor (SUSPOP). Asked by a newspaper about SEP's intentions, the municipality of Dodewaard stated not to have any objections as long as 'one can be sure that the installation will not have a deterrent effect to the population.'[15]

Being more self-supporting in building the reactor had implications for the Euratom-relationship. Because SEP wanted the (sub-)contractors to be Dutch, an international open tender as part of the Euratom-agreements was out of the question. This implied some secrecy and confidentiality. Finally SEP had to negotiate with potential Dutch industrial partners. There were some conflicts of interests however. As the ordering party SEP wanted to keep the decision making, especially in the early phase about the reactor-design and specifications to itself and was not willing to negotiate with a too powerful industrial consortium, such as Neratoom. On the other hand, SEP needed Dutch industry for its plans to build an economically feasible nuclear reactor. They were the only ones that were able to deliver a reactor for a competitive price, because of the relatively low labour costs and because of a freedom of tax that SEP hoped to extort from the Dutch government, when choosing Dutch companies (Verbong and Lagaaij 2000, 247).

In the end, the position of SEP proved to be strong enough to get most of its wishes realized. In May 1961 it decided – without Neratoom involvement - to order a pre-design of a 50 MW BWR

[15] *Leeuwarder Courant*, 09-11-1962.

from General Electric (GE). That summer four SEP-engineers went to San José to negotiate and to work on the pre-design with engineers from GE. Next to the 95 million guilders that the electricity producers invested via SEP – about a quarter of this for GE's know-how – there was other funding. Euratom cooperated financially with 18 million guilders because the reactor could also be used for research. Out of the so called Nuclear Industrial Development Fund the Dutch government subsidized Dutch companies that were involved with another 10 million guilders (Lagaaij and Verbong 1998, 106, note 53).

Negotiations with GE took a long time and were harsh (Rietveld 1966, E 103). Finally, the contract between SEP, GE and Euratom was signed in Brussels in April 1963. Six weeks before, a new law – de Kernenergiewet – had come into effect. Part of it was the establishment of three advisory councils: The Central Council for Nuclear Energy (CRK), the Industrial Council for Nuclear Energy (IRK), and the Scientific Council for Nuclear Energy (WRK). Furthermore, new tasks were allocated to the already existant Health Council. These four institutions had to safeguard the different kinds of interest associated with the application of the new technology at national level (Lagaaij and Verbong 1998, 50).

Dutch companies, partly within Neratoom, became engaged in elaborating the GE reactor proposal and the building process. Already in November 1962 two civil-engineering companies, DHV and Van Hasselt and De Koning, were appointed to advise about civil engineering aspects (Rietveld 1966, E 103; Lagaaij and Verbong 1998, 50). In late March 1963 a new SEP-delegation, then consisting of three engineers/physicians from KEMA, two of the provincial electricity producing companies PNEM and PGEM, and one of Neratoom, went to San José to continue the work with GE on the design. A rather small SEP-bureau of about 15 people, that possessed the confidential GE-information about the reactor core, was in charge of the whole process. A much larger industrial bureau was established for the actual engineering and constructing work. Philips, together with research institute RCN designed and produced the fuel-elements. RDM provided the pressure-vessel.

In the Summer of 1963 the local authorities of Dodewaard received a building permission request for a nuclear reactor as part of the public nuisance act. After consulting several parties, such as the Labour Inspection and the National Institute for the Purification of Waste Water

(RIZA), the government allowed building activities to take place in the forelands of the river Waal near Doodewaard from September 1964. That same month the Dutch government asked Euratom to look into the safety aspects of the projected reactor. In December the Euratom panel presented an almost 100 page report which was positive about the safety of the design and siting of the Dodewaard reactor. Soon after the Interdepartmental Commission for Nuclear Energy in the Netherlands - that coordinated all the other different advices regarding authorisation of the project - concluded that no further serious objections were to be expected.

This was the sign for the electricity sector to decide to take off with the first nuclear energy reactor in The Netherlands. Only the issue of judicial responsibilities and possible financial claims had still to be solved. Several laws about these topics were made. Early in 1966 this was settled (Rietveld 1966, E 105; [GKN] 1965, 18). By then SEP had transferred all of its nuclear energy activities to the newly established N.V. Gemeenschappelijke Kernenergiecentrale Nederland (GKN), dating from January 1965. All 11 Dutch electricity producing companies became shareholder of GKN. The amount of shares differed and was determined by electricity production figures of 1960, meaning that the Electricity Company of the province of South Holland (EZH) was the main shareholder. From 1965 to 1968 the reactor was built. In June 1966 GKN and Philips signed a contract for the delivery of the nuclear fuel elements. On January 4th 1968 the reactor vessel arrived in Dodewaard and early April the fuel elements. A year later The Netherlands produced its first electricity generated by nuclear fission on an industrial level (Woldringh 1970, E 117 – E 118).

Dodewaard as a contested icon of modernity in the 1970s and 80s

The establishment of the Dodewaard nuclear energy reactor in the 1960s did not evoke societal protests. Certain aspects, such as a lack of information during the building process or the costs involved, were criticized by individuals but there was no such thing as a significant anti-Dodewaard sentiment (Abma, Jägers, Van Kempen 1981, 146-148). On the contrary, by 1970 Dodewaard was an icon of modern Holland, as were the Delta works, the new Schiphol airport and the rapidly expanding Rotterdam harbour. That would change in the decade to come.

Early 1972 Dutch newspapers reported about the discovery of little leakages in a connection to the pressure vessel of the reactor in Dodewaard. This news and the consequence that the reactor would be out of order for inspections in the short term was initially published by the press in a neutral way.[16] In the same period there were rumours about the establishment of a second much larger - 600 MW - nuclear reactor near Dodewaard. In combination with the leakages that had caused some radioactive pollution, these plans alarmed some inhabitants of Dodewaard. The town council was asked for clarifications about the rumours by the local Protestant-Christian party. Their spokesman pointed at the recent leakages and expressed the fear for a real disaster when something would go wrong with a larger reactor. The community of Dodewaard did not want to host a second reactor, he expressed. Many inhabitants had changed their opinion about nuclear energy from tractability or indifference to fear and suspicion. During the last couple of years the ignorance about the subject had disappeared, the spokesman argued. The people now knew where to get their information. He also demanded public participation in the decision making process when a new reactor would be proposed.[17]

Within two weeks of this debate in the municipality council, the mayor of Dodewaard was confronted by a socialist council member about a bag of nuclear waste which had been found at the local garbage dump at February 10th. The mayor had to admit that he knew about it.[18] While the authorities were still busy trying to trivialize this mistake and the Dodewaard management offered their sincere apologies to the population, new damage was done to the image of Dodewaard and nuclear energy in general. On March 16th 1972 national newspaper *De Volkskrant* published a large article about safety issues with the Dodewaard and Borssele reactors, based on information from anonymous whistle-blowers. It had a serious impact.

First of all for a Dodewaard employee, who got sacked by the management, because he allegedly had spoken to the press. The affair also reached Dutch Parliament, were the Minister was asked to comment to the accusations and the dangers, also regarding nuclear transports. Furthermore, the leakages in the Dodewaard reactor hampered the establishment of the second Dutch nuclear energy reactor in Borssele. There, the building of the pile went smoothly, but the licensing process got delayed by the problems that had occurred in Dodewaard. Only by the

[16] See for example: *NRC Handelsblad*, 03-02-1972 and *De Telegraaf*, 04-02-1972.

[17] See ‘Dorp aan de rivier wacht argwanend af. Dodewaard vreest kerngigant’, in: *Nieuwsblad van het Noorden*, 21-02-1972.

[18] See ‘Radio-actief afval op vuilnisbelt in Dodewaard’, in: *Het Vrije Volk*, 02-03-1972.

end of June 1973 would the Borssele reactor get permission to start. And in the long run, the problems with the reactor in Dodewaard and the media-attention for it were grist to the mill to the growing group of opponents of the government's policy to enlarge Dutch nuclear energy capacity. This policy that contained the installation of 35,000 MWe (!) nuclear energy capacity by the year 2000 was expressed in a new memorandum (Nota Inzake het Kernenergiebeleid 1972, 2). As a reaction, a recently formed anti-nuclear working group that consisted of several critical scientists offered on behalf of an ecologist movement, a counter-memorandum [Antikernenergienota] to Dutch Parliament in September 1972 (Verbong 2000, 257-258).

From about 1973 onward, the nuclear reactor in Dodewaard became a frequent target for the anti-nuclear movements, as were Urenco in Almelo, the fast-breeder reactor in Kalkar, the reactor in Borssele, the KEMA-facilities in Arnhem, and ECN (the successor of RCN) in Petten. In 1974 concerns about unsafe storage of nuclear waste at the site in Dodewaard led to the establishment of the so called 'Stroomgroep Dodewaard'. The absence or inadequacy of the licences regarding the nuclear waste storage at the Dodewaard became a main argument for opponents to the reactor in the late 1970s.

The nuclear accident in Harrisburg in March 1979 gave rise to political deliberations about the safety of both Dutch nuclear reactors. The Ministers of Social Affairs and Health Care announced a re-appraisal of procedures in reactors in which human actions were involved. Despite of severe concerns amongst several parliamentarians, a majority voted against the early closing down of the Dutch reactors, as some parties had asked for. Yet, the Harrisburg accident affected the public opinion about nuclear energy and pressure was put on the provinces of Gelderland (Dodewaard) and Zeeland (Borssele) to close down the reactors (Abma, Jägers, Van Kempen 1981, 166). But also the Provincial Government of Gelderland and the Provincial Council decided to keep Dodewaard open in May and June 1980. In the meantime the anti-nuclear movement prepared for extra-parliamentary actions.

In May 1980 the 'Stroomgroep Dodewaard' organized, together with other 'Stroomgroepen' associated within the 'Gelderse stroomgroepen', a two-day discussion camp about the strategy to get the nuclear energy reactor at Dodewaard closed. Up to 5000 people attended the meeting which took place seven kilometres from the reactor. At this camp the 'Dodewaard Closes Down!'

movement was formed. It announced its intention to block the entrance gates of Dodewaard in October 1980 if the reactor was not closed by then. In the run up to this, several preventive measures were taken by the police. The demonstrations/blockades started with about 15,000 people. Due to the police measures and bad weather the activist-numbers decreased quickly and the blockades were already finished after one day.

A week of blockades and protests that were organised by the anti-nuclear movement in Dodewaard in September 1981 had a different character. There was a grim atmosphere. Employees of the Dodewaard reactor for example received intimidating letters at their home address. There were confrontations between demonstrators and the local community because the latter were angry about havocs and the blockades that hindered them. Molotov-cocktails were thrown and the riot police acted fiercely and with tear gas. The demonstrations got out of control and came to an early end as the organizers decided to break up. A scheduled final meeting in nearby Arnhem to end the protest-week continued however. It attracted several ten thousands of people and went peacefully.

In the 1980s and early 1990s several discussions took place within the national and the provincial parliaments and SEP about closing the reactor in Dodewaard, and about the costs of dismantling it. In October 1996 SEP decided to close Dodewaard in March 1997, seven years earlier than scheduled. According to SEP, this decision was taken because of a lack of nuclear energy policy, due to the growing negative societal attitude towards the subject. Yet, the main function of the Dodewaard reactor was to maintain and enlarge the know-how about nuclear energy production in the Netherlands. This was no longer necessary SEP concluded.[19]

[19] SEP Press release ‘Kencentrale Dodewaard stopt binnenkort productie elektriciteit’, 03-10-1996.

3. Events

The five events that are described and analysed in this section, are selected because they mark and/or illustrate a turning point in Dutch nuclear history and society. They, together with the showcase in section 2 – reflect to a large degree the historical context and periodization made in section 1.

The first event - exhibition “the Atom” in 1957 - is one of the most explicit attempts to prepare the general Dutch public for future civil applications of nuclear technology, as a consequence of Eisenhower’s Atoms for Peace program. The Treaty of Almelo of 1970 – event 2 - shows the big - almost uncontested - ambitions in the 1960s of Dutch government, industry and science to take part in the nuclear age. A turning point in society’s attitude towards nuclear energy is demonstrated by the anti-Kalkar protests in Autumn 1974 – event 3.

Event four is the Broad Societal Discussion on Energy Policy (in Dutch: BMD) in the early 1980s. The BMD that was asked for by some grassroots movements, was a nationally - and probably internationally - unique public participation initiative with regard to nuclear energy, created by the Dutch government. The most recent event that is selected is the prolonged discussion, from the early 21st century onward until now about renewing the 40 year old High Flux Reactor (HFR) at the Energy Research Centre of the Netherlands (ECN) in Petten. Next to ‘traditional issues’ about safety, nuclear waste, costs-benefits et cetera, the event shows new elements in the nuclear discourse.

3.1 Event 1: Exhibition “the Atom” at Schiphol airport, 1957

Description of the event

In the summer of 1957 an exhibition called “The Atom” took place at the Schiphol-airport site near Amsterdam. The official opening was on Friday June 28th by his Royal Highness Prince Bernhard. He was also chairman of the Committee of Honours of the exhibition, that consisted of several Dutch and foreign celebrities. The exhibition ended September 15th 1957.

Type of event

Public communication process

Case history

In a meeting with the president of the Amsterdam Chamber of Commerce in the summer of 1953 G.H. Knap, an Amsterdam-based business-journalist, proposed to organize an international exhibition to promote the commercial function of the city of Amsterdam. Atomic energy and its applications would be a suitable subject, for it greatly impressed people’s imagination in those years. The Chamber of Commerce agreed and so did the municipality. Preparations began for an exhibition initially called “The Atom Amsterdam”. From the start of these preparations, Dutch nuclear scientists were involved (Van Lente 2008, 150).

In July 1955 the plans were announced at a press conference at the Royal Dutch Academy of Sciences. The idea was to organize an exhibition for a broad public about the peaceful applications of atomic energy. The “Atom”-exposition was initially planned for May 1957. Contributors to the exhibition that had already been contacted included the United States, the United Kingdom, France, Canada, Belgium and Norway. Plans to have a reactor at work in the exhibition were not mentioned. Furthermore, funds still had to be raised. A foundation was established to take care of the organizational aspects.[20] These preparations resulted in an exhibition in a newly built hangar at Schiphol airport. It was subsidized by the municipality of Amsterdam for 6.5 million guilders.[21] The location choice of Schiphol had two reasons: the exhibition space could quickly be reused as a hangar for parking airplanes, and secondly, it was hoped that more vistoris would be attracted, because Schiphol was during the summer months a tourist-attraction by itself.

The highlight of the exhibition was a working open-end ‘pool-type reactor’, that the Dutch Ministry of Education, Arts and Science had purchased for apparently one million guilders. After the exhibition it would move to Delft Polytechnic High School (now Delft University of Technology) as a research reactor. The Dutch Reactor Centre RCN (established July 1955) and Delft Polytechnic High School shared the responsibility for operating the reactor, that produced 10 kW of power and that was designed by the A.M.F. Atomics Inc., a subsidiary of the American

[20] *De Telegraaf*, 08-07-1955, 3.

[21] http://www.kernenergieinnederland.nl/node/607

Machine & Foundry Company in New York. Dutch company Philips provided the electronic measuring, regulating and safety system (Van Tol 1957, 253-265).[22]

Goal(s) and means

The initial goal of the exhibition was promoting the city of Amsterdam. *Atomic energy functioned as an icon of modernity*, attracting a lot of potential visitors. In the years towards realization of the exhibition the goal evolved towards creating '*a "healthy atmosphere" for decisions Parliament had yet to take about nuclear energy.*' (Van Lente 2008, 150). So promoting Amsterdam as a commercial capital was no longer the main goal but promoting nuclear energy was. Already at the 1955 press-conference the intention was expressed that the exhibition would be as ground-breaking as the Amsterdam aviation-exhibition ELTA of 1919 had been. The mayor of Amsterdam emphasized in his announcement speech that the exhibition of 1919 heralded a new era in air traffic. The upcoming exhibition should in his view herald the new 'atomic era'.[23] Note that within a week after the opening of the exhibition the Dutch Minister of Economic Affairs, presented the Nota inzake Kernenergie [Memorandum on Nuclear Energy] (July 3th 1957), that proposed a quick transition in the Netherlands towards nuclear energy.

Dutch public should be made acquainted with nuclear technology and the Netherlands had to be made 'atomic minded' by linking nuclear energy to modernity (Verbong and Lagaaij 2000, 239). Therefore the exhibition also showed other symbols of technological progress like a big electronic calculator and modern kitchen equipment. The message that was carried was that all the needed energy for technological devices that would ease modern day life had to be nuclear. In the official visitors guide it said: '*It is to us, the generation of 1957, to determine the future of tomorrow's world. Our future: atomic energy!*' (Verhees 2012, 106).

Another important goal was to get Dutch industry (more) interested in nuclear technology. Therefore an international informative conference was held at the Royal Institute for the Tropics in Amsterdam at the start of the exhibition an (26 – 29 June). This was a follow-up of a conference in Paris (1-6 April 1957) and meant to inform staff-members from public and private companies as well as representatives of employers- organizations and trade unions about the

[22] Here also a description - in Dutch - of the reactor.

[23] See: *De Telegraaf*, 08-07-1955, 3.

possibilities of nuclear energy. After this international opening-conference, three conferences were organized during the exhibition about industrial applications of nuclear energy. The conferences were jointly organized by Foundation “The Atom”, RCN and the energy-commission of three Dutch Employers’ Associations.

These conferences were meant to raise interest amongst Dutch industry for the production of nuclear technology. Speakers were a.o. J.P. Kruseman, director of the KNSM (a shipping company), ir. W.A. De Haas, deputy-secretary of NV Philips and member of the board of RCN, Prof. dr. J.M.W. Milatz, director of RCN, Prof ir. L.H. de Langen, director of the Algemene Kunstzijde Unie, dr. ir. R Houwink, and Prof. F. Boon. At the last conference there was also a plea for a permanent exhibition about Atomic Energy.[24] The companies and organizations that financially warranted for the exhibition (which was not needed because of the success) were asked to donate that money to this permanent institution.

Identification of actors:

The main promoters of the event were the Chamber of Commerce and the municipality of Amsterdam and (mostly Amsterdam based) companies, varying from shipping companies, mechanical industry, insurance companies and electricity companies. These and probably other companies financially warranted for the exhibition that was largely paid for by the municipality.

* In July 1955 The board of the Foundation International Exhibition The Atom Amsterdam consisted of: - Mr. A.J. d’ Ailly, major of Amsterdam; - Prof.dr. A.H.W. Aten Jr., professor in Amsterdam and director of the Centre Européen de Recherches Nucléaires, Geneva; - F. de Boer, Director Nederlandsche Dok en Scheepsbouwmij; - C.J. Baron Collot d’Escury, President Nederlandse Handel Maatschappij; - Ir. M.H. Damme, president-director N.V. Werkspoor; - Mr. D.A. Delprat, chairman Amsterdam Chamber of Commerce; - Ir. J.T. Duyvis, board-member NV Hollandsche Draad- en Kabelfabriek; - G.H. Knap, journalist; - J.M.F.A. van Dijk, Director Ned. Radar Proefstation; - J.P. Kruseman, Director of Kon. Ned. Stoomboot Mij.; - Mr. W.A. Rijk, Director Kas-Associatie NV; - Jhr. J. Six van Hillegom, Director Amstel Brouwery; - Ir. H.W. Slotboom, Dir. Kon. Shell Laboratory; - Ir. L. Vos, Director of Municipal Energy Company.

[24] See: *Het Vrije Volk,* 05-08-1957, 2; *Algemeen Handelsblad*, 05-09-1957, 4; *Java-bode*, 13-08, 1957; *De Tijd*, 03-08-1957.

* Members of the Committee of Honours (ere-comité) of the exhibition were, amongst others: - HRH Prince Bernhard of the Netherlands (chairman); - Lewis L. Strauss, chairman of the Atomic Energy Commission of the US; - Ambassadors of several western countries.

* In June 1957 the Foundation "The Atom" consisted of (amongst others): - mr. D.A. Delprat, Amsterdam Chamber of Commerce (chair); - Mr. A.A. Land (secretary); - C.P.G. van den Handel (2nd secretary); - Ir. L. Vos, (member).

Other Actors involved in the 1957 exhibition 'The Atom':

- Ministry of Education, Arts and Science → paid for the nuclear reactor
- Ministry of Economic Affairs → nuclear energy memorandum / energy transition
- Amsterdam Tourist Office → promoting the exhibition, also abroad
- Delft University of Technology (by then still Polytechnic High School) →operating the reactor and owner of it (after the exhibition)
- the Dutch Reactor Centre RCN in Petten → operating the reactor, co-organizing attached conferences
- Associations of employers → involved in co-organizing attached conferences
- Schiphol Airport → facilitating and owner of the hangar-building after the exhibition
- Engineering company Comprimo →involved in constructing the reactor
- Electro-technical company Philips → involved in constructing the reactor
- Media → covering the event. There was a lot of media-coverage in newspapers, including special-issues, and magazines (see also below).

The exhibition was a public communication process at a national level (the impact at international level seems limited). With 750,000 visitors it reached almost 5% of the population directly and many others indirectly via different media. Furthermore the organizers tried to get certain groups especially interested for the topic, for example the financial world. Members of the Dutch Society for Stock Exchange (Vereeniging voor den Effectenhandel) were invited to the exhibition. They were welcomed with speeches that emphasized the opportunities for investing in nuclear technologies.[25]

Perception, meaning and interpretation of the event

With the mentioned number of visitors the exhibition was seen as a success. In a recent documentary, visitors remembered their enthusiasm and their fascination viewing the reactor. Especially the bleu glimmer of the reactor was an impressive sight. Furthermore, the exhibition stimulated youngsters to study nuclear physics and nuclear technology.[26] The exhibition also generated a lot of attention from the contemporary press. The day before the opening a national newspaper published a four pages special about nuclear energy.[27] Another newspaper called the exposition without doubt 'one of the most important post-war events in Amsterdam.'[28]

The exhibition is seen as very important in Dutch nuclear history. Not only as a successful attempt to link nuclear to peaceful applications and modernity, but also as a proven advertisement of Dutch capabilities in this domain. It was no longer an abstract technology that stood far away in place and time. For this it was important that under supervision of the American Machine & Foundry Company Dutch engineering company Comprimo and electro-technical company Philips had manufactured the reactor on Dutch soil. This Dutch involvement was therefore emphasized in the visitors guide (Verhees 2012, 107-108). Historians do not agree about the meaning of the exhibition in relation to 'a prevailing mood of fear and confusion' in the 1950s or even a causal relation with the upcoming anti-nuclear movement in the early 1970s (see Van Lente 1998, 54 and 154; Verhees 2012, 96; Verbong and Lagaaij 2000, 238-239))

[25] See 'De beurs en Het Atoom'', in *Algemeen Handelsblad*, 26-08-1957, 6.

[26] See the documentary at http://www.npogeschiedenis.nl/andere-tijden/afleveringen/2004-2005/Geloof-in-kernenergie.html. [retrieved 01-07-2016].

[27] See *Algemeen Handelsblad*, 27-06-1957, 9-13.

[28] See *Het Vrije Volk*, 06-08-1957,

3.2 Event 2: The Treaty of Almelo, March 4th 1970

Description of the event

On March 4th 1970 the Governments of the Netherlands, West-Germany and the UK signed a treaty concerning cooperation in developing and exploiting the gas-ultracentrifuge-procedure for producing enriched uranium.

Type of event

Decision making process, without public consultation or participation

Case History

From late 1954 Jakob Kistemaker at the FOM-laboratory in Amsterdam started working on ultracentrifuge technology to enrich uranium as an alternative to diffusion technology. About 1957 FOM had ideas to cooperate internationally in ultracentrifuge research. Possible partners were the West-German company Degussa and the American company General Electric. The Scientific Advisory board of RCN, who paid for the research at FOM, was positive about cooperation but wanted results first, making the position of the Dutch stronger in the negotiation process (Lagaaij and Verbong 1998, 60-61; Kistemaker 1991, 8-14).

In April 1960 the Minister of Economic Affairs appointed a commission to study the possibilities of nuclear technology for Dutch industry. This Commission was positive about the ultracentrifuge project and was asked by the Minster to do further research into the economic and technical possibilities of the project. In two (secret) reports it concluded that an ultracentrifuge industry would be economically interesting for the Netherlands, if the performances of the centrifuge could be further improved. The research funds were raised but because the US-government in the meantime had declared ultracentrifuge technology and research as classified, FOM stopped its research and RCN took over from July 1st 1962 (Kistemaker 1991, 18-19; Lagaaij and Verbong 1998, 62; Verbong and Lagaaij 2000, 253-254).

In 1965 the research-project ended. The Industrial Council for Nuclear Energy (IRK) that was established in 1962 to look after the interests of Dutch Industry with regards to nuclear technology, and the Scientific Council for Nuclear Energy (WRK), urged RCN-to do an evaluation of the project. The evaluation-commission advised RCN in February 1962 to continue the research for four more years, despite disappointing results so far. Nevertheless if the upcoming research would be successful a large experimental ultracentrifuge factory by 1970 would be possible, the commission concluded in February 1966 (until then 11 million guilders were invested in research) (Lagaaij and Verbong 1998, 62-63 and 82).

For political reasons the project got obstructed in 1965 and 1966. Cooperation with West-Germany bounced, because the Dutch Minister of Foreign Affairs had objections proliferating ultracentrifuge knowledge. This hampered also the decision-making about the advice for continuing the research-project. A new evaluation commanded by the Ministry of Economic Affairs was done in summer 1967 (Kistemaker 1991, 21-22). About the same time it became clear that due to several projected nuclear initiatives in Europe and the US the need for enriched uranium would legitimate investments in large industrial enrichment facilities. So in 1967 the French proposed to the European partners in Euratom a substantial enlargement of their diffusion-factory in Pierrelatte. However the UK and West-Germany were also aiming at building an enrichment facility. The latter however was bound by international agreements after WW2 and was not allowed to produce key-materials for atomic weapons on its territory. The trump-card that the Netherlands had was its technological knowledge about ultracentrifuge (estimated to be 3 to 4 years ahead to West-Germany). Because of competitive arguments, the Netherlands did not want to share this knowledge within Euratom. The most interesting option for the country would be cooperation with West-Germany (Lagaaij and Verbong 1998, 84).

At a conference in October 1968 in Torino, Italy, the Netherlands announced its plans to build a 25 tonne uranium separation plant (Kistemaker 1991, 23). The next month negotiations started with West-Germany about forms of cooperation. As soon as the US heard about these negotiations, they were eager to get the UK involved in the talks (Tolsma 2004). By March 1969 the three countries came to an agreement. This agreement was officially confirmed on March 4th 1970 in the Treaty of Almelo. As a result of the treaty, the Uranium Enrichment Company ltd. (URENCO) was established in the UK. A ‘Joint Committee’, with representatives of the governments of the three countries, supervises aspects of safety, security, export of technology and products, non-proliferation and related issues (Kistemaker 1991, 25-26).[29]

In the initial phase every country would build its own ultracentrifuge test plant, all with different types of ultracentrifuge technology. Dutch participant in URENCO was Ultra-Centrifuge Nederland NV (UCN) in Almelo. This company was established in November 1969. The West-German test plant arose on Dutch soil as well to bypass the countries international ban on producing key-materials for atomic weapons. Both Dutch and German test-plants had a capacity of 25 tons a year. The UK test-plant in Capenhurst had a capacity of 50 tons a year. By the end of 1973 UCN Almelo produced its first enriched uranium. In the Autumn of 1977 the production plants in Almelo and Capenhurst started to produce enriched uranium at a commercial base, in August 1985 the German plant followed (Bannink and Diehl 2014,13-14).

Identification of actors

Actors involved in ultracentrifuge-technology research, 1954 – 1970:

- FOM-laboratory: Research up to July 1962 under supervision of prof. J. Kistemaker.
- Reactor Research Centre Netherlands (RCN): pays for the research at the FOM-laboratory. In July 1962 it took over the research-project from FOM.
- Werkspoor N.V.: providing machines and equipment to the project.
- Staatsmijnen: subsidises the materials-research and supervision of the project.
- Philips N.V., involved in the research and in supervision of the project at FOM/RCN.
- Comprimo, an engineering contractor, involved in the research at FOM/RCN.
- Delft University of technology, involved in supervision of the uc project at FOM
- University of Utrecht, involved in supervision of the uc project at FOM.
- University of Leiden, involved in supervision of the uc project at FOM.

Note: The electricity companies were (in the 1950s) sceptical about the project. They found it economically not feasible (Lagaaij and Verbong 1998, 58).

[29] See also: *Proceedings of the Dutch Parliament*, Tweede Kamer 1971-1972, nr. 11785 sub 2, 28.

Evaluating commissions concerning the Ultracentrifuge technology:

- Commission to study the technical and economical evaluation of the ultracentrifuge project in 1960 (Commission-Tromp), reports in 1961 and 1962:
  - Sub-commission on economy: Van der Pols (chair), Bogaardt and Went
  - Sub-commission on technology: Members: J. H. de Boer (chair). He was director of the Laboratory of the state mining company Staatsmijnen, and chair of the Scientific Council for Nuclear Energy and the Central Council for Nuclear Technology. Other members: specialists from Philips, Werkspoor, RCN, TNO and Comprimo
  - Sub-commission on patent-situation
- RCN-Commission to evaluate the progress of the Ultracentrifuge project installed 1965, report February 1966:
  - Instigator: Industrial Council for Nuclear Energy (IRK) of Min. of Econ.
  - Instigator: Scientific Council for Nuclear Energy (WRK), of Ministry of Education
  - Chair: Prof. H.W. Slotboom, director of Shell-laboratories in Amsterdam
- Commission to evaluate the research ultracentrifuge research project installed by the Ministry of Economic Affairs, summer 1967, (report was classified). Executed by Shell.

Participants in Ultra-Centrifuge Nederland NV (UCN), Nov. 1969:

- The Dutch state (55%); - the National Mining Company [DSM] (10%); - Shell (10%); - Philips (10%); - Rijn Schelde (7.5%); - Verenigde Machinefabrieken NV (VMF) (7.5%)

Board of UCN NV, Nov. 1969

- Th.P. Tromp (Philips), chairman; - H. Hoog (Shell), vice-chairman; - L.G. Wansink, J.A.M.Molkenboer and O.W. Vos (the Dutch State); - K. Over (Staatsmijnen); - A. Meyer (Verenigde Machinefabrieken); - J. Bout (Rijn Schelde); - E.L.Kramer and R.W.R. Dee (ECN)

Organizations cooperating in the 'Almelo Information Bulletin' (opposed to expansion of UCN/URENCO), Oct. 1977:

Landelijk Energie Komitee (LEK) [National Energy Committee]

- A cooperation between:
  - Vereeniging Milieudefensie (an environmental organization)
  - Stroomgroep Stop Kalkar/Kernenergie (an anti-nuclear group)
  - Aktie Strohalm (an anti-nuclear group)
  - NIVON (Dutch branch of the International Friends of Nature)
  - VWO (Association of Scientific Researchers)
  - Gezamenlijke Energiekomitees Zuid Nederland (cooperating Energy Committees in the South of the Netherlands)
  - PPR (small left-wing political party)
  - PSP (small left wing pacifist political party)

- Brazilië-komitee [Brazil-Committee]
- XminY beweging (movement for the support of social movements worldwide)
- Kerk en Vrede [Church and Peace]
- CLAT (Organization for solidarity with Latin-America)

Perception and meaning of the event

With the Treaty of Almelo and the establishment of URENCO the Netherlands gained a substantial role in the worldwide fuel chain for nuclear energy producers. In 2013 URENCO Netherlands possessed the second largest uranium enrichment capacity in the world with 5,500 tSWU/y. URENCO (in total) had a market share of about 30%. 46% of its customers are within the USA, 37% in Europe and 17% in the rest of the world (Bannink and Diehl 2014, 15 and 20). At the 40th anniversary of the treaty in 2010 URENCO itself concluded that it had '*realised the original vision of the Treaty of Almelo, becoming a model of international co-operation ensuring a safe, secure and commercially attractive supply of nuclear fuel for the peaceful production of nuclear power*.'[30]

[30] See: http://www.urenco.com/about-us/history/treaty-of-almelo/ (retrieved 6-7-2016).

In about 1970 there was some resistance to the ultracentrifuge project, the building of UCN and the signing of the Treaty of Almelo. Young scientists in the Northern part of the country, who were members of the socio-critical Association of Scientific Researchers protested against the plans. A ‘working group Ultracentrifuge’ was founded by young scientists in Groningen and Twente. They published a critical report in 1970 (Verbong and Van Selm 2001, 42). Out of this group ‘Urania’ – a group very critical towards nuclear energy – resulted in the same year. Five days after the signing of the Treaty a small group of about 50 people demonstrated in Almelo against it. In May 1970 there is also a demonstration against the Treaty at an annual encampment of a socialist youth organization (ANJV) that took place in Almelo (co-incidentally). Early in 1971 Wim Klinkenberg, a Dutch journalist and communist, published a book about the history of the ultracentrifuge, in which he accused Dutch scientist Kistemaker of cooperating with Nazi-scientists (Klinkenberg 1971). This publication led to questions in Dutch Parliament and articles in newspapers and magazines.

As the anti-nuclear movement grew - especially after ‘Kalkar’ in 1974 - protests against URENCO also became louder. The opening of the UCN production plant in Almelo in 1977 and with licensing procedures for expansion of the capacity at the table, the anti-nuclear movement started focusing on preventing UCN/URENCO from expanding. A number of anti-nuclear organizations jointly published an ‘Almelo-information bulletin’ in October 1977. Part of the bulletin was a concept-manifesto, containing 11 arguments against expansion that can be summarized by: 1. Nuclear energy leads to proliferation of nuclear arms; 2. Expansion does not lead to growth of employment in the region; 3. Only West-Germany needs expansion and profits because of an export-contract the country had signed with Brazil. This way Brazil gets knowledge to build an atomic bomb and West-Germany gets access to Brazilian natural uranium and can safeguard its own nuclear energy program; 4. Brazil is a military dictatorship, entangled in an arms race with Argentina. It is not in the interest of stability in Latin America; 5. Brazil did not sign the Non-Proliferation Treaty (which is not-effective after all); 6. It can lead to expansion of nuclear energy in (dictatorial) third world countries, which is not in the interest of the people; 7. It can lead to West-Germany as a third European Atomic Power; 8. Expansion of URENCO stimulates more nuclear energy in the Netherlands, the UK and West-Germany, which is undesirable as long as there is no nuclear-waste solution; 9. It leads to undesirable safety-measures in society and measures of monitoring and control of people, transports and objects; 10. Policy makers should stimulate energy saving and development of alternative energy sources; and 11. The money should be invested in research into alternative energy sources.[31] The Information Bulletin also announced a demonstration to be held in Almelo. This protest mars against the expansion plans of URENCO's uranium-enrichment facility took place on March 4th 1978. About 50,000 attended and gained a lot of media attention but had little effects as Almelo was expanded.

As the Treaty of Almelo lasted for 10 years (article 15) the three parties involved could end the agreement from 1981 onward. The anti-nuclear movement used this momentum to urge the Netherlands to end its participation in URENCO. It was argued that the Treaty had proved its failure in prohibiting proliferation of uranium enrichment knowledge to dubious states and regimes. They pointed at the 'Khan' espionage-affair. Working with FDO Stork, Pakistani Abdul Kahir Kahn had access to crucial knowledge about ultracentrifuge technology at UCN. This knowledge was used for the Pakistani atom bomb program and probably also sold to other countries. Also the contract between URENCO-Germany and the Brazilian Government to deliver enriched uranium was seen as a failure of the non-proliferation aim of the Treaty.[32]

Another argument that became important in the societal perception of URENCO was the origin of the Uranium. In the 1970s and 80s West-German mining companies were active in Namibia, a country that was occupied by South-Africa under the Apartheids-regime. By its URENCO connections the Netherlands also took part in this 'contaminated' business, according to opponents, and should end it as soon as possible (De Beer 1988, 124-135). In May 1985 the Executive Committee of the Council for Namibia of the United Nations accused the Netherlands of violating article 1 of the Namibia-decree that prohibits Uranium-imports from Namibia. In September 1987 the Dutch State, UCN and URENCO were summoned by the UN for importing Uranium from Namibia. The trial was adjourned sometimes and ended with South-African

[31] 'Almelo Information Bulletin', 27 October 1977; digitalized by Laka, see: http://www.laka.org/docu/tijdschriften/almelo-bulletin/almelo01.pdf#page=4 (retrieved 11-7-2016).

[32] See for example a special issue ('Belicht') about UCN and the Treaty of Almelo of *Allicht*, the journal of the cooperating anti-nuclear Energy-committee's in the South of the Netherlands (about 1981), digitalized by Laka, see: http://www.laka.org/docu/tijdschriften/allicht/allicht01-02k.pdf (retrieved 11-7-2016)

withdrawal from Namibia in 1990. Nevertheless the opaqueness of the uranium-chain and the circumstances and consequences of uranium mining in especially African countries are arguments URENCO-critics use these days. Others point at financial speculations with uranium prices, leading to undesirable transports (to and from Tenex-Russia) and storage of uranium, in which URENCO played a role (Bannink and Diehl 2014, passim; Crezee 2016).[33]

3.3 Event 3: Opposition to fast breeder reactor at Kalkar

Description of the event

In the autumn of 1974 about 10,000 Dutch protested at the Kalkar-site, just across the Dutch-German Border, against the building of a fast breeder reactor, a co-operation between Germany, Belgium and the Netherlands. Some weeks later the Dutch Parliament was offered a petition calling for the end of the Kalkar project. It was signed by 155,000 civilians.

Type of event

Public participation process

Case history

Fast breeder reactors that can ‘breed’ new fuel while producing power were seen as a very promising new reactor type in the 1960s. Dutch research-institutes TNO and RCN started respectively in 1961 and in 1962 research into technology for these types of reactors, especially the possibilities of Natrium for cooling. In 1962 also NV Neratoom joined in. Neratoom was a joint-venture of Dutch companies working together at the nuclear field (see identification of actors). In 1965 The Netherlands reached an association agreement for three years with Euratom that paid 40% of the costs of the research. In the contract it was agreed that, because of the scope and importance of fast breeder reactors for European energy-supply, Euratom-countries would cooperate in research and development (under the Euratom-umbrella). Therefore the Netherlands started talks with West-Germany and France. The latter asked for a

[33] See also: http://www.greenpeace.nl/campaigns/archief/kernenergie/wat-is-kernenergie/kernenergieketen-van-grondsto/uraniumwinning/ (retrieved 11-7-2016)

(too) big Dutch financial contribution. Germany was more cooperative (Van den Bosch 2006, 74-75).

From 1966 onward Dutch, German and Belgian (and Luxemburg) government-representatives talked about jointly developing and building a fast-breeder reactor (bypassing the Euratom wish to work together with all six Euratom countries in building a fast breeder reactor). After some political hiccups in the Netherlands - Dutch interim-government in February 1967 decided to withdraw from the project, but the letter to the partners was never sent (!) – the newly elected right-wing government continued the cooperation and the preparations started. In January 1968 a German-Belgium-Dutch industrial consortium (INB) was established for developing and building a prototype fast breeder reactor. The Dutch contribution was mainly cooling technology, pumps, heat exchangers and steam kettles. The German, Dutch and Belgian electricity companies formed a consortium (SBK) that was the principal-commander of the project. The project-management was with the *Projektgruppe Schnelle Brüter* (PSB), located at the Kernforschungszentrum in Karsruhe, Germany. The PSB was since 1966 extended with representatives of all involved parties. Germany, Belgium and the Netherlands participated in the project on a 70-15-15 formula. This meant that the involved electricity contributed 84, 18 and 18 million DM. In May 1973 a fourth partner got involved (for 2 million DM): the British General Electric Generating Board (Verbong and Lagaaij 2000, 254; Van den Bosch 2006, 83-84).

The reactor was initially projected in the German city Weissweiler, near Cologne. But because the area was too densely populated (over 40,000 within a circle of 10 km) and there was a higher risk of earthquakes, no permit was provided by the federal state. During 1971 it became public that the reactor would arise in Kalkar close to the Dutch-German border near Nijmegen, leading to protests of locals. In Kalkar the Bürgerinitiative [Civil Initiative] ‘Interessegemeinschaft gegen radioactive Verseuchung’ was founded on 11 June 1971 by worried civilians. The ‘Interessegemeinschaft’ organized a first larger protest-meeting in a local bar in Kalkar at January 20th 1972. Two weeks later, on February 4th 1972, the Dutch government officially decided to take part in the project. Government-committees of the three countries signed the agreement on March 7th. That same month a public hearing was organized in Kalkar, which was accompanied by protests of locals and petitions (8500 signatures were gathered against the reactor). The Board of the Catholic church in Kalkar that owned the ground where the reactor was projected allowed the SBK to do test-drillings.[34] In spite of protests of local farmers, who rented lands from the board of the church, and of the board itself, the building of the plant started on April 24th 1973 (Van den Bosch 2006, 89-90). The estimated costs for the project had raised over 1.5 billon DM, of which the Netherlands had to pay 212 million. By 1969 the total costs for the project were estimated at 740 million (Verbong 2000, 261). While in Germany the protests against Kalkar were fairly local/regional, in the Netherlands 'Kalkar' became the key target of a national anti-nuclear movement.

To finance the Dutch contribution to the experimental fast breeder reactor in Kalkar the Dutch government decided to a 3% increase of the electricity-bill of every citizen. This 'Kalkar levy', mentioned as such on the actual electricity bill sent to customers, '*led to societal outrage and resulted in the emergence of many small local groups that either opposed the levy or the project.*' (Verhees 2012, 118). Many civilians (encouraged and supported by the local groups) acted disobediently and refused to pay for the levy. As a consequence, they were threatened with disconnection from the electricity-grid, which was sometimes executed. To inform and help each other, local groups got connected and a national protest organization Stop Kalkar was formed (LSSK, see below). A bit earlier also left-wing political parties had organized themselves in their anti-Kalkar protest (AKK). This up-scaling of the anti-nuclear protest movements to a national level resulted in the first large-scale anti-nuclear power protest. At September 28th about 10,000 mostly Dutch protesters gathered at the Marketplace in the German village of Kalkar. About three weeks later, October 22th, Minister R. Lubbers of Economic Affairs was presented 155,000 signatures on a petition that demanded a Dutch withdrawal from the Kalkar-project.

Identification of actors

Dutch actors involved in research about fast-breeder technology, especially Natrium cooling (from 1961 onward):

- The Netherlands Organization for Applied Scientific Research (TNO)
- Reactor Centre of the Netherlands (RCN), established 1955

[34] See also: http://www.kernenergieinnederland.nl/faceted_search/results/Kalkar?page=1 (retrieved, 2-7-2016).

- NV Neratoom, an industrial consortium focused on nuclear technology, established in May 1959, members (see section 1.3).

The *Internationale Natrium-Brutreaktor-Bau-Gesellschaft* (INB), the German-Belgium-Dutch Industrial consortium, involved in the development and building of the fast breeder reactor in Kalkar, established January 1968: - Siemens/Interatom (Germany); - Belgo Nucléaire (Belgium) and Neratoom (Netherlands).

The Schnelle Brüter Kernkraftwerksgesellschaft (SBK), the German-Dutch-Belgian cooperating electricity companies, the principle of the project 'Kalkar': - Rheinish Westphälishes Elektrizitätswerk (RWE) (German), 70% participation; - Synatom (Belgium), 15%; - the Dutch Samenwerkende Electriciteits Producenten (SEP), 15%; In May 1973 extend with: General Electric Generating Board.

In the project-managing Projektgruppe Schnelle Brüter (PSB), nuclear research centres from Germany (Karsruhe), the Netherlands (Petten) and Belgium (Mol) were represented.

Other actors in decision making:

- The German Federal State of Nordrhein-Westphalen (licencing)
- The Reaktor Sicherheits Commission (RSC), The German advisory council on security of nuclear energy (licensing)
- The board of the Catholic church in Kalkar (owner of the land, were the reactor hat to arise)

The demonstrations in September 1974 were jointly organized by the Landelijke Stroomgroep Stop Kalkar (LSSK) (established spring 1973) and the Anti-Kalkar-Komitee (AKK) (established 1972).

- LSSK was the national umbrella organization of the local 'stroomgroepen' that opposed the Kalkar Levy and the project. These local 'stroomgroepen' were often established by environmental groups. There were about 80 local 'stroomgroepen'. From late 1973 the LSSK organized meetings in Utrecht (Van den Broek and Meijen 1977, 6).
- The AKK was a cooperation of the political parties that had voted against the Kalkar levy in Parliament. It was an initiative of the Progressive Party of Radicals (PPR), a left-

wing political party with roots in the Catholic Peoples Party (KVP). The parties that joint the AKK were the Socialist Party (PvdA), the Communist Party (CPN), the Liberal Democrats (D'66) and the Pacifist-Socialist Party (PSP). The AKK distinguished itself from the LSKK because it did not want to encourage citizens to civil disobedience, by not paying (part of) the electricity bill. Local staff-members of the Communist party formed the backbone of most AKK-groups.

- End 1975 the AKK was dissolved (Van den Broek and Meijnen 1977, 7).

Perception and meaning of the event

The Dutch participation in the (expensive) Kalkar-project - and the Kalkar levy as a result of this - boosted the anti-nuclear movement in the Netherlands (Abma, Jägers and Van Kempen 1981, 149; Verbong and Van Selm 2001, 40-48)). The costs of the project, the levy that was introduced, the civil disobedience to which it led, and the reaction to this by the electricity companies (warnings and disconnection from the grid) caused a lot of media-attention and discussions on radio and TV (Verhees 2012, 118), which, in its turn, had a mobilizing effect. An increasingly broader public began to judge nuclear energy as a controversial issue. The number of people willing to take action (for example by being disobedient, taking part in protest marches, or signing an anti-nuclear petition) grew. Research shows that between 1973 and 1975 the number of people that were worried about nuclear energy increased substantially (Verbong 2000, 261).

In retrospect, the Kalkar levy is judged as the biggest mistake the pro-nuclear lobby could have made. It reinforced the anti-nuclear movement, which was by 1973 still relatively small. The LSSK announced 1975 as the 'year against nuclear energy', generating a lot of attention for the subject. During 1976 and 1977 a number of anti-nuclear demonstrations would take place, such as:

- 17th January 1976: in Dodewaard, where the first Dutch nuclear energy reactor was established in 1969. (several hundred attendants)
- Late Jan., early Feb. 1976: in Borssele and surroundings. Here the second Dutch pile was established in 1973 and another was planned. (several hundreds of attendants)

- Early February 1977: in the province of Groningen, protesting against nuclear waste storage in salt-domes in the province. (about 5000 attendants)
- April 1977: in Almelo, where UCN, the Dutch nuclear enrichment facility was established between 1970 and 1973. (about 10,000 attendants)
- September 1977: in Kalkar. (about 60,000 attendants) (Van den Bosch 2006, 160).

The growth of the anti-nuclear movement also originated problems within the movement, especially after the Kalkar-demonstration of 1977. Discussions about goals, strategies, action-methods et cetera resulted in conflicts and schisms (Van den Broek and Meijnen 1977, 6-10; Van den Bosch 2006, 179-185; Abma, Jägers and Van Kempen 1981, 150-158).

3.4 Event 4: The Broad Societal Discussion [Brede Maatschappelijke Discussie] on Energy-policy, 1980-1984

Description of the event

In the late 1970s the national government decided to organize a societal debate on energy matters: the Broad Societal Discussion on Energy Policies. A steering committee was installed to organize this debate and report to the government the outcomes of it. Many discussion-meetings all over the country took place. Early 1984 the steering committee presented its end-report. The main conclusion was that a majority of the Dutch people did not want new nuclear reactors.

Type of event

Publication participation process

Case history

In 1974 the Minister of Economic Affairs R. Lubbers of the centre-left-wing cabinet-den Uyl (1973-1977) published a Memorandum on Energy [Eerste Energienota], containing the intention [beginselbesluit] to build three new nuclear reactors. This decision met societal opposition. In the procedure the public had a say in the decision regarding the impact on the location. But at these participation-meetings the growing anti-nuclear movement in the Netherlands (see also the Kalkar-event) that had organized and included critical-scientists and a growing amount of left-wing politicians, questioned the need for nuclear energy at all. Middle ground organizations, starting with The Dutch Reformed Church, encouraged the government to start a societal discussion about the desirability of nuclear energy. This idea was soon embraced by others such as the Federation of Dutch Labour Unions (FNV) and the Association of Dutch Municipalities (VNG) (Hagendijk and Terpstra 2004, 13-14).[35]

The formation of a new cabinet after the elections of 1977 was difficult. Although not the main issue, nuclear energy divided the political parties. There was serious political and societal impasse regarding energy matters and especially the role of nuclear energy. While opposition grew, others such as right-wing parties (Christian-democrats, liberals), leading policy makers at the Department of Economic Affairs, important parts of industry and the electricity sector still favoured nuclear energy. The oil-crises in that decade emphasized the need for a firm energy policy and choices to be made to ensure the countries energy supply (Verbong 2000, 261).

During the attempts to form a centre-left-wing coalition-cabinet of Christian-democrats, socialists and liberal-democrats in the fall of 1977, it was agreed that the government would take initiatives to organize a broad –based societal discussion about the applications of nuclear energy.[36] The forming of this cabinet failed however and a centre-right-wing cabinet (Christian-Democrats and liberals) was formed. It would be in place until 1981. Facing the above mentioned stalemate when it came to energy policy, Minister Van Aardenne of Economic Affairs (liberal) announced his intention (‘agreement in principle’) to organize a broad societal discussion. He did so in a policy-letter of July 17th 1978. He asked the Energy Council [Algemene Energie Raad] to present a format for the consulting-project. In August 1979 the Dutch Parliament received a report from the Minister about the plan of the BMD [‘opzet nota’].

According to this report the BMD would start in the autumn of 1979 as the third part (about nuclear energy) of the Second Memorandum on Energy [Tweede Energienota] was published by the government. The end-report about the project was expected in the fall of 1981.[37]

[35] See also *Proceedings of the Dutch Parliament,* 1979-1980, 15802, nr. 11-12, 274-275.

[36] *Proceedings of the Dutch Parliament,* 1977-1978, 14600, nr.4 p. 52.

[37] *Proceedings of the Dutch Parliament*, 1978-1979, 15100, nr. 18, p. 7.

However, it took until mid-July 1980 before the third part of the Memorandum was made public. In the meantime the ‘opzet nota’ was discussed in parliament in February 1980. Only at July 28th 1981 a steering committee was installed by Queen Beatrix, marking the actual start of the BMD.

The BMD was split up in two phases: an ‘information phase’ from September 1981 until October 1982) and a ‘discussion phase’ from January 1983 until December 1984. The first phase consisted of consulting specialist, stakeholders and the broad public, which was encouraged to express its opinions through a full-paged ‘bulletin’ in all large newspapers. The information that was gathered, was divided by the steering group into four topics: 1) costs of nuclear energy, 2) the structure of the electricity provision, 3) risk analysis and perception, and 4) processing and storing of radioactive waste. The information phase would end with four different scenarios for social-economic, energy and environmental policies. All over the country 13 controversy hearings about these topics were held. The scenarios functioned as input for the discussion phase.[38] At the end of the first phase the steering committee published 50,000 copies of an extensive progress report, which was summarized ‘newsletter’-edition of 1.1 million copies (Hagendijk and Terpstra 2004, 28).

In the ‘discussion phase’ the four scenarios were discussed in hundreds of moderated discussions all over the country. Three kinds of discussions took place: 1) local discussions organized by municipalities (1811 meetings), 2) organizational discussions, organized by non-governmental organizations (1120 meetings), and 3) school debates. With about 62% of all the questionnaires that were distributed, filled in, the participation was quite impressive (Hagendijk and Terpstra 2004, 31). Nevertheless, for different reasons the discussion phase and therefore the entire BMD was judged all but a success (see below).

[38] See the interim-report of the Steering Committee, called *Energie. Te belangrijk om alleen aan de deskundigen over te laten* [Energy. Too important to leave to specialists alone] (1983), (for the scenarios see 157-158).

Goal of the BMD

The formulated goal of the BMD was 'to involve the public in opinion-making on energy problems in general and the problem of nuclear energy in particular, based on information that is as complete as possible and checked on reliability.'[39] In 1979 the Minister of Economic Affairs emphasized however that there should be no doubt that the final decision had to be made by government and parliament. In 1980 Prime Minister van Agt even announced in public that he was convinced about the necessity of nuclear energy for the Netherlands, and that the BMD was only necessary to convince the Dutch public on this.[40]

Identification of actors

Middle ground organizations plead for a BMD in the mid-1970s. The initiatives came from:

- The Dutch Reformed Church; - The Federation of Dutch Labour Unions (FNV); -The Association of Dutch Municipalities (VNG)

Involved in organizing the BMD:

- The Ministry of Economic Affairs (financer of the BMD and primarily responsible)
- The Ministry of Healthcare and Environment (co-signer of the 'opzet nota')
- The Ministry of Social Affairs (co-signer of the 'opzet nota')
- The Ministry of Housing and Spatial Planning (co-signer of the 'opzet nota')
- The Common Energy Council (AER) (Algemene Energie Raad (AER)) (consulted by the Ministry of Economic Affairs about the layout of the BMD)
- Initiative Energy Discussion Group (Initiatiefgroep Energiediscussie)
    - This group consisted of oppositional members of Parliament and members of the anti-nuclear movement. They wrote a note with a procedure and layout for a new form of civil participation in decision making. The AER proposal for a layout drew heavily on this not note of the Initiative Group (Hagendijk and Terpstra 2004, 14-15).

- Steering group Maatschappelijke discussie Energiebeleid, members:

[39] *Proceedings of the Dutch Parliament*, 1978-1979, 15100, nr. 18, p.2.
[40] *Trouw*, 14-06-1980.

- Jhr. mr. M.L. de Brauw (chair), former-Minister and member of Parliament (his political preference had changed from liberal (VVD) to liberal-democrat (D'66)). He was a proponent of nuclear energy (Hagendijk and Terpstra 2004, 18).
- Dr. ir. H. Hoog, chemical engineer, former chair of the board of directors of Energy-research Centre ECN (former RCN) in Petten.
- Dr. ir. J.L.A. Jansen, chemical engineer, former member of Parliament (left-wing, PPR), member of the Foundation Energy and Society.
- Prof. dr. Th. C.M.J. van de Klundert, economy-professor in Tilburg
- Prof.dr. A.J.F. Köbben, anthropologist, head of the Centre for Research of Societal Opposition [centrum voor Onderzoek van Maatschappelijke tegenstellingen] at Leiden University.
- Prof. dr. L.M. Putten, physician, professor for applied radiology in Leiden.
- Ms. Drs. N.Rempt-Halmmans de Jongh, former member of Parliament (VVD).
- A. Schravemade, former-secretary of a trade union for industry-employees [Industriebond FNV] and from 1977 to 1980 member of the Energy-committee of the European Labour Union.
- Ms. Mr. C.A. Terwee-Van Hilten, judge at the court of justice in Haarlem.

The steering group was carefully composed with proponents, opponents and doubters of nuclear energy. There were five political denominations represented in the Steering group. There were scientific staffs to the Committee's disposal (Hagendijk and Terpstra 2004, 17).

In the 'information phase' the Steering group gathered information and views about the topic from nuclear specialists, stakeholders and critics. The work on two of the four scenarios that were elaborated in this phase of the BMD had already started before 1981:

- The Centre for Energy Savings worked on the 'Scenario for preservation of environment and welfare' (using an economic model of the Foundation for Economic Research [Stichting SEO])
- The Ministry of Economic Affairs worked on the so called 'Reference-scenario' (using the economic model of the Central Plan Bureau (CPB). Also the other two scenarios used this model).

The Steering group consulted 260 institutes and groups in total about their opinion on energy issues. Amongst them were energy producers, energy researchers, and anti-nuclear organizations. Furthermore, organizations were subsidized to further develop their views on energy policies. For example the industrial consortium for nuclear technology Neratoom was subsidized for 1.7 million guilders.

The anti-nuclear movement was divided about contributing to the BMD (see meaning and perception below). It split the umbrella organization Anti Kernenergie Beweging (AKB) in two. Amongst the bigger organizations that joined were:

- The Landelijk Energie Kommittee [National Energy Committee] (LEK)
- The Werkgroep Energie Discussie [Working Group Energy Discussion](WED)
    - It was however very critical about the biased-character of the scenario-approach and refused to organize discussion-meetings following the format of the steering group on the ‘discussion-phase’.
- Milieu Defensie [Environmental Defence]

In the discussion phase the steering committee approached municipalities, as well as organizations that took part in the information phase and schools to organize local discussion meetings.

Perception, meaning and interpretation of the event.

The BMD met a lot of scepticism at the start. Many right-wing politicians did not want such a form of public participation about the topic. Left-wing politicians and the anti-nuclear movement had doubts about the fairness of the process and the way the government would take care of the outcomes. These doubts had several grounds. For example The Initiative Energy Discussion Group pleaded for an ‘open start’ of the BMD, but the Ministry wanted its Second Memorandum on Energy as a point of departure for the discussions. Also statements e.g. from the Prime Minister as mentioned above did not contribute to faith in an open debate. Some activists were afraid that the BMD was ‘*a clever tactical move to take the wind out of the sails of the anti-nuclear movement.*’(Hagendijk and Terpstra 2004, 15-16).

Some measures were taken by the Steering group to overcome this scepticism from the anti-nuclear movement. One was broadening the scope of the BMD to opinions about the already existing nuclear facilities. Another was quitting the government Memorandum on Energy as a starting point for the discussion. Nevertheless, scepticism remained among anti-nuclear activists. Other actions of the Steering group however stirred up the distrust. For example the subsidizing instrument. The fact that the industrial consortium Neratoom and the right-wing liberal party VVD - that was no proponent of the BMD – were subsidized, while the anti-nuclear WED (see above) received only have the amount it had asked for, were seen as examples of a prejudiced steering group (Hagendijk and Terpstra 2004, 24). Also the fact that some groups were and others were not invited to the 'controversial discussions', as well as the changed procedures during these meetings, caused sometimes crabbedness and distrust.[41]

Hagendijk and Terpstra conclude that during the 'discussion phase' a wide gap revealed itself between the 'broad social discussion' and the 'Broad Social Discussion'. The issues the broader public wanted to debate about, were not represented in the four scenarios- discussions. The way the steering group tried to manage things lead to irritations. Middle group initiators, such as the FNV and the VNG, did not cooperate in the discussion phase in the way the steering group wanted. Participants with scepticism from the start, such as the WED, refused to organize discussions about the scenarios. Also new societal issues, such as fast growing unemployment, the stationing of nuclear missiles in the Netherlands, and, amongst students, a new system of study-finance, distracted the attention from societal groups and the public rapidly. Furthermore, the new right-wing Government, seemed to take even more distance from the BMD (Hagendijk and Terpstra 2004, 35).

The conclusions of the BMD were clearly in favour of the anti-nuclear movement. The discussions had proved that the majority of the participants did not want new nuclear reactors. An immediate closure of the two existing reactors (Dodewaard and Borssele) was however not desired. Anti-nuclear organizations as the WED and the LEK, that were cooperative but sceptical about the BMD from the start, were pleasantly surprised by this outcome. Now it was

[41] See: H. Damveld '1981-1984: Brede Maatschappelijke Discussie' (mei 2016); at www.radioactiefafval.nl (retrieved 08-07-2016).

the pro-nuclear lobby's turn to criticize the way the steering committee had operated. After a short pause, the government nevertheless, decided in January 1985 to reject the conclusions of the BMD and planned for new nuclear plants. It was backed up in its decision by the AER, who also rejected the conclusions of the BMD. This of course endorsed the anti-nuclear movement in its opinion that the Government together with nuclear industry already had decided in favour of nuclear energy and that the BMD was just window dressing. Except for some indignation with certain participants in the BMD, the Governments rejection of the conclusion did not lead to large protests (Verhees 2012, 133-134; Hagendijk and Terpstra 2004, 38-39).

In retrospect, the BMD is seen as a failure. There was little exchange of ideas. Verbong states that the BMD was a result of the 1960s desire for more openness and public participation in decision making. However, in the early 1980s the opinions about nuclear energy were so polarized in society that genuine discussions about the topic were impossible (Verbong 2000, 262). Using comparable arguments, others qualified the BMD a very expensive opinion-poll (Van Hengel 2007). Furthermore, the conclusions were rejected by political decision makers, confirming or even enlarging the gap between politics and society.

3.5 Event 5: Renewing the High Flux Reactor at ECN in Petten

Description of the event

News of safety problems with the High Flux Reactor (HFR) at NRG in Petten from 2001 onward, led to advice to the Deputy Minister for the Environment to renew the HFR. That year the research reactor was over 40 years old and at the end of its life span. From the advice of the task force until the present day there is discussion about replacing the HFR with a new up-to-date reactor called Pallas.

Type of event

Decision making process, with forms of public consultation and participation

Case history

Late in 1961 the High Flux Reactor (HFR) for research purposes at the Dutch Reactor Centre (RCN) in Petten went critical. The HFR was based on the Oak Ridge Research Reactor. On July

25th of that year the Netherlands had agreed to hand over the HFR to Euratom as part of their Gemeenschappelijk Centrum voor Onderzoek (GCO). Euratom paid 40% of the cost. RCN became judicially and organizational responsible for the HFR. The capacity of the reactor was gradually enlarged from 20 MW thermal power to 30 MW in 1966 and to 45 MW in 1970. Until 2005 the reactor worked with high enriched uranium (HEU) supplied for by the US, and thereafter with low enriched uranium (LEU).[42]

Since 1972, due to an overcapacity of ‘national’ nuclear research facilities in the Euratom-countries, the HFR did not participate in any common European research-projects. The Netherlands, West-Germany and Belgium) took over the costs for the exploitation-of the HFR, in a so called additional Euratom-program.[43] In the mid 1970’s the left-wing government decided to broaden the scope of RCN. The institute was also entrusted research into other energy sources and in 1976 RCN was transformed to Energy Research Centre of the Netherlands (ECN). Nuclear research within ECN faced difficult years, especially because of budget-cuttings and a deadlock in decision making (see event 4). Non-nuclear research at ECN rose from 7% in 1975 to over 30% in 1979 (Verbong, Berkers and Taanman 2005, 14-23).

In October 1979 ECN published a report with its views about the future of the HFR: *Nederland en de HFR*. By then (1980) the European Commission contributed about 7 million guilders to the HFR, The Netherlands and West-Germany together, about 33 million guilders. The Dutch contribution to the HFR was fully paid out of funds for energy research from the Ministry of Economic affairs. The HFR was used for research by the Netherlands (33%), West-Germany (45%), the joint European Program (GCO-P) (7%), and for the (commercial) production of (medical) Isotopes (7%) (Verbong, Berkers and Taanman 2005, 134-143). 8% of the use was not specified. The Dutch government reconsidered its contribution to the HFR in the early

[42] H. Damveld, ‘Hoge Flux Reactor te Petten een overzicht’, at: http://www.laka.org/nieuws/bijlagen/2013/04/04-HFR.pdf (retrieved 15-07-2016); ‘De ontwikkelingen bij NRG, de markt voor medische isotopen en het vooruitzicht op PALLAS’ (NRG-publication June 2014), 14.

[43] *Proceedings of the Dutch Parliament*, Tweede Kamer (1981), 17014, nr. 4, 2-3.

1980s. Because of this reconsideration the necessary replacement of the 21-year old reactor vessel was postponed.[44] Finally in 1985 the reactor vessel was replaced.

By 1990 the research at the HFR was still to a large degree (approx. 80%, 75 million guilders each) financed by the Netherlands (Ministry of Economic Affairs) and Germany. The additional financing was from European research-programs and a growing part from third-party research.[45] The production of medical isotopes in the meanwhile had increased to 15%. In 1992 a new program for the HFR was established that would last until 1995.[46] On March 30th 1992 ECN and the US-company Mallinckrodt signed a long-term agreement for the production of Molybdeen-99 (Mo-99). Mallinckrodt sells Technetium-99 (a MO-99 isotope) for medical purposes. The production of Molybdeen at ECN started in April 1996. For ECN these commercial activities of the HFR became very important, especially because Germany decided to gradually withdraw from the HFR (Verbong, Berkers and Taanman 2005, 136). In 1998 ECN decides to accommodate all its nuclear activities at the Nuclear Research and Consultancy Group (NRG), partly owned by ECN and by KEMA, the research facility of the electricity sector. In 2006 KEMA sold its share to ECN, making NRG an integral subsidiary of ECN.

In the Autumn of 2001 negative reports about bad conduct of business and violations of safety regulations at the HFR appeared in the press. The responsible Minister asked for an inspection by the Kern Physische Dienst (KFD). Early in February 2002 the Minister decided to close down the HFR temporarily (until March 2002), not because the situation is unsafe but to give NRG time to put things in order, it is communicated. Furthermore the Minister decided to ask a workgroup to advise about the importance of the HFR for the supply of medical isotopes. The workgroup presented its report in February 2003. It recommended the building of a new reactor '*in Europe*' as a replacement for the HFR, '*preferably at a location that possess also the other production facilities*.' The commission legitimated this recommendation because this way a total

[44] *Proceedings of the Dutch Parliament*, Tweede Kamer (1981), 17014, nr. 4, 4; See here for more details about the research at the HFR by 1980.

[45] *Proceedings of the Dutch Parliament*, Tweede Kamer (1991-1992), 21666, nr. 5, 18.

[46] *Proceedings of the Dutch Parliament*, Tweede Kamer (1991-1992), 21666, nr. 5, 3.

dependency of Canada and South-Africa for certain medical isotopes in case of closure of the HFR is avoided.[47]

In September 2003 a police raid took place at the ECN-site in Petten, because the Public Prosecutor expected violations of safety and environmental laws and regulations with ECN, NRG, Mallinckrodt and GCO (the subsidiary of the European Commission). It proved that Euratom could not be prosecuted because of international law. Shortly after, in December 2003, Euratom/NRG (the license-holders) asked for a new license for the HFR because they planned to convert from high-enriched Uranium (HEU) to low-enriched Uranium (LEU) as fuel. This was desired for by the US since the late 1970s. In January 2005 NRG obtained this new license for the HFR and in 2006 the HFR began operating on LEU.

Already in 2004 NRG had announced its ideas for a new, HFR-replacing reactor called 'Pallas'. In June 2005 an information meeting for neighbours of NRG is organized about 'Pallas'. Amongst other arguments, NRG pointed to economic spin-off and stimulation of employment for the region. One of the opponents of the new 'Pallas' reactor, who spoke at the information evening, was Diederik Samsom, since 2003 member of Parliament for the Dutch labour-party PvdA.[48] He had studied nuclear physics at Delft University. In 2012 Samsom became the leader of the PvdA. Despite opposition, NRG launched the tender for the building of the new Pallas reactor in February 2006. Two years later, in February 2008, three consortia were invited to present a 'conceptual design' for the planned new Pallas reactor in Petten.

From August 2008 until February 2009 the HFR was closed down temporarily because of problems with the cooling system. Although the problem was not solved in February 2009, NRG got a special permit to restart the production of medical isotopes, because other producers had planned maintenance stops, and the worldwide supply of medical isotopes was endangered.

[47] [Report of the workgroup] 'Medische Isotopen en de Hoge Flux Reactor in Petten' (The Hague, february 2003), 17.
[48] See: http://www.kernenergieinnederland.nl/ (retrieved 16-07-2016)

From November 2012 and June 2013 and from November 15th 2013 and February 15th 2014 the HFR was again out of use because of problems and precautionary measures.[49]

In November 2009 NRG a report that was in fact the procedural start for the new Pallas reactor. Argentinian-Spanish combination INVAP-Isolux was chosen to build the reactor. The plan was to build a reactor with an adjustable thermal power from 30 to 80 MW. It was however not clear by then where the reactor would be sited: most likely in Petten or in Vlissingen (near Borssele nuclear reactor). Initially it was hoped that the Pallas-reactor would be the first privately financed and commercially exploited reactor in the world. But because not enough interested partners were found NRG had to turn to the national and regional governments for funding the first stage (in February 2010 negotiations with INVAP-Isolux were cancelled because of this). Meanwhile preparations went on. In the Spring of 2011 for example inhabitants and entrepreneurs in the region were invited to two meetings with landscape-architects to browse about fitting the new reactor in the coastal landscape.

In January and July 2012 the national Government and the Province of North-Holland agreed to pay 40 million euros each for the Pallas reactor. In December 2013 a Foundation for the Preparation of the Pallas reactor [Stichting Voorbereiding Pallas-reactor] was formed, taking over the preparation work from NRG. At their website (http://www.pallasreactor.com) information and updates of the Pallas-project are published (also in English).

Identification of actors

Members of the workgroup to advice the Minister about the HFR in relation to the production of medical isotopes (Feb. 2003), representatives of:

- the Ministry of VROM (Ministry of Housing, Spatial Planning and Environment);
- the Ministry of VWS (Ministry of Health, Well-being and Sports);
- the Ministry of EZ (Ministry of Economic Affairs);
- the Ministry of the Dutch Association of Nuclear Medical professionals (NVNG).

Actors involved in replacing the HFR in Petten:

[49] For the special permit see: http://www.kernenergieinnederland.nl/files/20090212-beschikking.pdf (retrieved 16-07-2016); for the problems from 2012 onward see: the NRG-publication ‘De ontwikkelingen bij NRG, de markt voor medische isotopen en het vooruitzicht op PALLAS’ (June 2014).

- Euratom, owner of the HFR (and until 2005 co-license holder)
- NRG, license-holder and operator of the HFR (Until December 16th 2013 'Pallas' was a project under the NRG-umbrella)
- Foundation ECN Nuclear, shareholder of NRG
- Stichting Voorbereiding Pallas-reactor; Foundation that took over the Pallas-project from NRG on December 16th 2013.
- Ministries involved in licensing (they all signed the special production-permit for 2009-2010): - VROM (Housing, Spatial Planning and Environment); - VWS (Health, Well-being and Sports); - EZ (Economic Affairs); - SZW (Social Affairs and Employment); V and W (Traffic and Watermanagement); - LNV (Ministry of Agriculture, Nature and Food quality) and Justice
- Province of North-Holland, licensing and co-financing of the Pallas reactor
- Kernfysische Dienst (KFD), inspection of the safety of the HFR.
- INVAP-Isolux, Argentinean-Spanish constructing combination, initially chosen to develop and build the Pallas reactor
- Tractebel Engineering (GDF Suez) is appointed Owner's Engineer of 'Pallas'
- LAKA-Foundation, opposes the replacement of the HFR and 'Pallas'

Perception and meaning of the event

Updating or replacing the HFR in Petten and the building of the Pallas reactor is strongly legitimized by proponents because of the reactor's role in the worldwide supply of medical isotopes. The availability of isotopes for medical diagnostics and therapy would be endangered if the HFR would not be replaced. Opponents however criticize the nuclear production of medical isotopes, arguing that cyclotrons can produce radioisotopes as well, much cheaper and without creating a nuclear waste problem. Furthermore the decentralized production with cyclotrons is claimed a better assurance for the supply of medical isotopes as centralized production in nuclear reactors. By publishing factsheets and counter-reports, especially the LAKA Foundation tried and tries to prevent policy makers from replacing the HFR with the Pallas reactor. Possible private investors in Pallas are also acted upon, mentioning the uncertainties and the possible saturation in the market for nuclear produced medical isotopes in the long run, and therefore the feeble business case Pallas is built on. [50] With the creation of a website (http://pallasproject.nl) and a Pallas-newsletter by the LAKA Foundation, preventing the replacement of the HFR seems a spearhead for the anti-nuclear movement in the Netherlands nowadays.

[50] See for example: 'Sluiting HFR-Petten? Alternatieve productiemethodes technetium-99m'(LAKA-factsheet July 21st 2000); H. van der Keur, 'Medical Radioisotopes production without a nuclear reactor'(Report of the LAKA-Foundation, May 22nd 2010); H. van der Keur, 'De Pallas business case tussen droom en werkelijkheid (Report LAKA-Foundation, April 2013); H. van der Keur', 'Pallasreactor of deeltjesversneller. De toekomst van medische isotopenproductie in Nederland' (Report LAKA- Foundation, October 2014).

4. Facts and figures

4.1 Data summary

- In 2017 there is one operating nuclear power reactor in the Netherlands, located in: Borssele. It produces yearly about 4 billion kWh or 3% of Dutch electricity production.
- The Netherlands imports nuclear energy from France and Germany.
- In 2009 plans were presented to build a second reactor in Borssele. These were put on hold in 2012. Now there are no plans for new nuclear reactors.
- The closure of Borssele is scheduled for 2033.

4.2 Key dates and abbreviations

1946	Establishing FOM
1951	Start bilateral collaboration between the Netherlands and Norway in the JEEP-project
1955	Establishment of the Foundation Dutch Reactor Centre (RCN) in Petten.
1957	The Netherlands sign the Euratom-agreement.
1957	Exhibition 'The Atom' at Schiphol.
1957	Publication of the Memorandum on Nuclear Energy.
1963	Law on Nuclear Energy.
1965	Establishment of the GKN.
1969	Opening of the first nuclear power plant in the Netherlands in Dodewaard.
1969	Establishment of UCN in Almelo
1970	Signing of the Treaty of Almelo between the Netherlands, the UK and West-Germany leading to Urenco
1971	Founding of the anti-nuclear grassroots Werkgroep Atoom
1972	License asked for the fast breeder reactor at Kalkar
1972	Kernenergienota [Government Memorandum on nuclear power policy]
1972	Anti-Kernenergienota [Memorandum against nuclear power policy].
1973	Opening of the second nuclear power plant in the Netherlands in Borssele.
1973	The Kalkar-levy on the electricity bill is introduced

1974	Establishment of the anti-nuclear 'Stroomgroep Dodewaard'
1974	Eerste Energienota [First Memorandum on Energy]. A counter-memorandum was published by the Bezinningsgroep Energiebeleid.
1974	The first large-scale anti-nuclear power protest (10,000 participants) by mostly Dutch people at the Kalkar site
1978	Large protest march in Almelo. About 50,000 attended.
1980-1984	Broad Societal Discussion on energy policy.
1982	Establishment COVRA
1990	PINC is launched.
1991	The Kalkar fast-breeder project is stopped.
1996	ECN and Mallinckrodt start the commercial production of Molybdeen (medical isotope).
1997	The Dodewaard nuclear energy reactor is closed down
2003	Police raid at the ECN-site in Petten, because violations of safety and environmental laws.
2003	Opening HABOG at the Covra-site for storage of highly radioactive material.
2008	Temporary close down of the HFR in Petten (restart in 2009)
2012	The national government and the province of North-Holland decide to subsidise a new reactor at ECN in Petten
2013	The government decides to keep the Borssele pile open until 2033

Abbreviations:

BMD	Broad Societal Discussion on energy policy
COVRA	Central Organisation for Radioactive Waste
ECN	Energy Research Centre Netherlands
FOM	Foundation for Fundamental Research into Matter
GKN	Joint Nuclear Energy Reactor Netherlands
IKO	Institute for Nuclear Physics Research

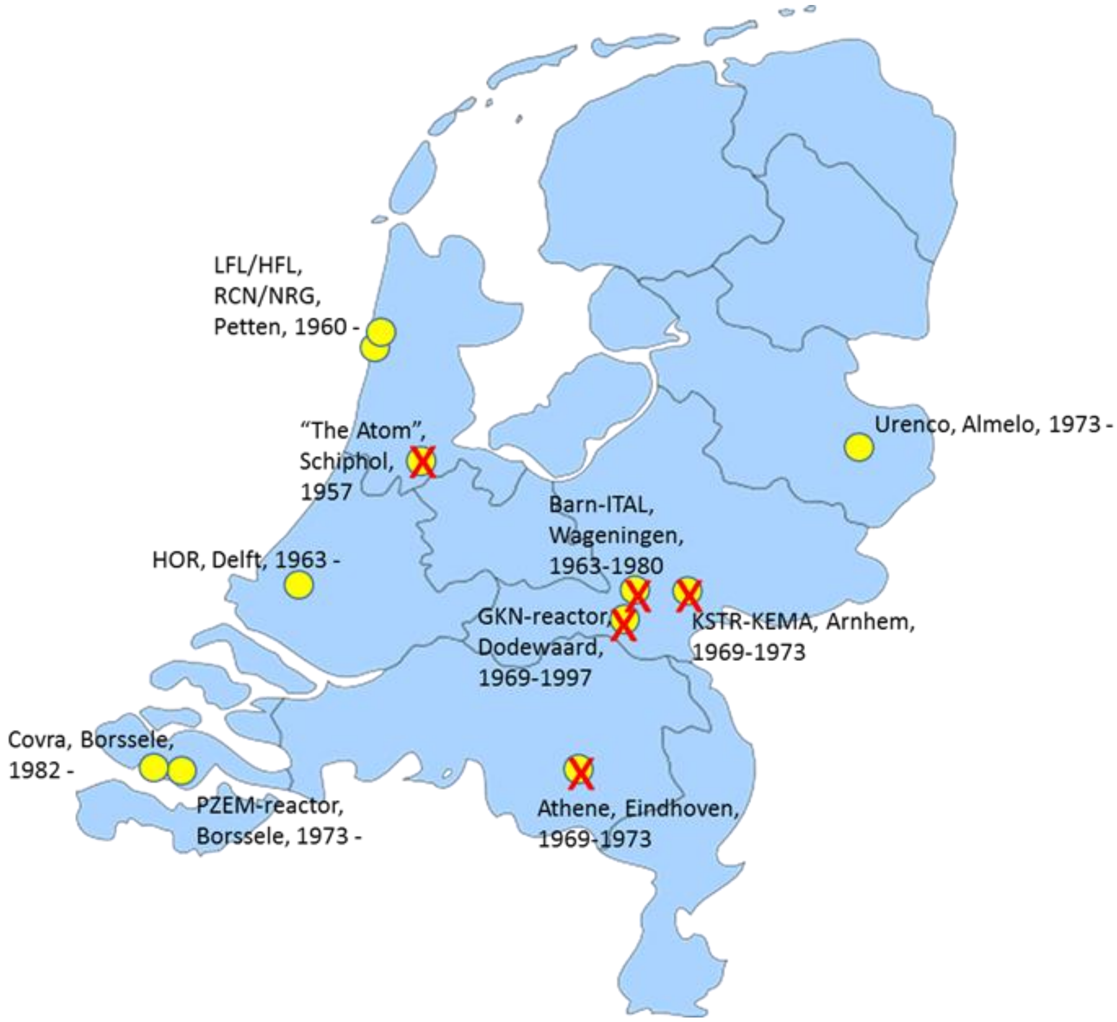
PINC Program for the Preservation of Nuclear Competences

RCN Reactor Centre Netherlands

UCN Ultra Centrifuge Netherlands

4.3 Map of nuclear power plants and facilities

Figure 1 – A map of closed-down and active nuclear facilities in The Netherlands. The nuclear power reactor for energy still in production is the PZEM-reactor in the South-West.



4.4 List of reactors and technical, chronological details

	GKN Dodewaard	PZEM/EPZ Borssele
Construction start	01 May 1965	01 July 1969
First criticality	24 June 1968	20 June 1973
First grid connection	18 October 1968	04 July 1973
First commercial operation	26 March 1969	26 October 1973
Permanent shutdown	26 March 1997	-
Planned operation until	-	2033
Reactor Type	Boiling Water Reactor (BWR)	Pressurized Water Reactor (PWR)
Design/ Model	General Electric	Siemens/ Krafwerk Union (Siemens AEG) 2-loops
Design Net Capacity	54 MW_e	495 MW_e Since 2006: 510 MW_e
Thermic power	183 MW	1365 MW
Owner	BV GKN (cooperating electricity companies)	PZEM (provincial electricity company) Since 1990: NV EPZ (owned by DELTA and RWE)
Building costs	Ab. 140 million guilders	Ab. 250 million guilders
(Co)Financers	-cooperating electricity companies -Ministry of Economic Affairs (11.5 million + 5 million tax-restitution) -Euratom (18 million)	
Location choice made by	Committee of the cooperating electricity companies (KEMA-committee Roodenburg)	PZEM
Fuel	Light enriched UO_2	Light enriched UO_2
Fuel rods	NUKEM (Germany)	
Fuel elements	Philips (Netherlands), later from UK	
Fuel reprocessing	Until 1974: Eurochemic (Belgium), from 1978: BFNL Sellafield (UK)	Cogema (France)
Waste fuel storage	COVRA (The Netherlands)	COVRA (The Netherlands)

4.5 Periodization of nuclear development

Figure 2 – A timeline of main nuclear facilities in The Netherlands

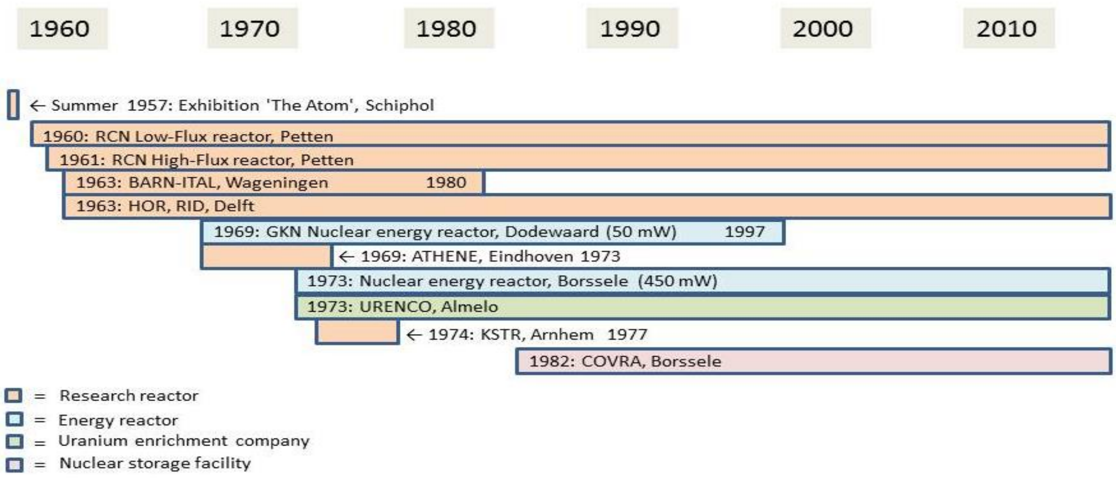


Table 1 - Outcomes of opinion-polls about nuclear energy in the Netherlands,1975 – 2011

Year	Positive	Negative	'don't know'/ status quo/ neutral (see note below)	negative according to the Eurobarometer[51]
1975		(50%)		
1979 (after Harrisburg)		(85%)		
1982				48%
1984				47%
1985	26%	58%	16%	
1986 (after Chernobyl)		(85%)		57%
1987				54%
1989				58%
1991	21%	29%	45%	29%
1993				32%
1996				37%
2002		(80%)		

[51] See: (Dekker, De Goede en Van der Pligt 2010, 31).

2005	51%	44%	5%	43%
2006	31%	51%	15%	
2007	29%	46%	25%	
2008	55%	41%	3%	42%
2010	38%	33%	29%	
2011 (after Fukushima)	29%	51%	20%	

Note: For the years 1985, 2007, 2010 and 2011 the question was: '*Are you pro or against the building of new nuclear reactors in the Netherlands?*' (N = 1000 citizens of voting age). The data for the years 1975, 1979, 1986 and 2002 are from a paper-presentation (see below), with no further sources mentioned. Therefore they are placed between brackets.)
In 1991 the question to the respondents was (according to the Dutch Minister of Economic Affairs who presented the outcomes to Parliament (see sources below)) whether the respondents found nuclear energy acceptable, non-acceptable or were in favour of a 'status quo'.
For 2005 and 2008 the question was 'Are you entirely pro, a bit pro [here interpreted as 'positive', auth.], a bit against or entirely against [here interpreted as 'negative', auth.] producing nuclear energy?' In 2006 it was also possible to vote 'neural'.
For the other years the exact question is unknown.

Sources:

1985, 2007, 2010 and 2011: Synovate (2011), 3; **2005, 2006 and 2008:** Dekker, De Goede en Van der Pligt (2010), 30; **1975, 1979, 1986, 2002**: W. Turkenburg (2003), 47; **1991**: Proceedings of the Dutch Parliament 1991-1992), 21666, nr. 5, 4.

5. References

5.1 General remarks

Much is written about the history of nuclear energy and society in the Netherlands. Many books and articles provide an overview of a certain period or from a certain angle or cover subthemes. Below a selection of the literature is presented. For the overall topic of this short country report the PhD-thesis of Verhees (2012) and the publications of Lagaaij and Verbong (1998) and Verbong (2000) were especially useful, as they provide long term scientific analyses. For the contextual historical narrative I frequently made use of these three.

Next to these, useful publications about specific topics are: Van Lente (2008) and Roodenburg (2016) about the public image of nuclear technology in the post-war years, including the exhibition “The Atom” in 1957. For Dutch nuclear policy from before WW 2 until the late 1950s - including the Dutch-Norwegian JEEP-project - see especially Van Splunter (1994). Detailed and inside information about the history of the enrichment-project and about Urenco Netherlands provide Kistemaker (1991) and Andriesse (2000). While Boskma and co-workers (1975), De Beer (1988) and Van den Bosch (2006) are very useful in understanding the opposition against Urenco and the fast-breeder project in Kalkar. Hagendijk and Terpstra (2004) is a good starter for studying the Broad Societal Discussion on energy policy.

The LAKA-foundation – Documentation and Research Centre on Nuclear Energy – has a large collection of documents about the history of nuclear energy in the Netherlands, which is partly digitized and online available (see http://www.laka.org/ and http://www.kernenergieinnederland.nl/) Although very useful the information provided is somewhat anti-nuclear biased.

Other important sources of information for this Country Report were the Proceedings of Dutch Parliament that are digitally available at http://www.statengeneraaldigitaal.nl/ and the online historical newspaper-archive from the Royal Library http://www.delpher.nl/nl/kranten. The latter is especially useful to determine – or at least get a feeling about - the impact of certain events.

5.2 Sources and literature about Nuclear Energy and Civil Society in the Netherlands

Archives:

There are several public archives that contain interesting material on the history of nuclear energy and society in the Netherlands. The list below is far from complete. Note that some archives/ documents have restrictions for consulting.

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    - Archive of the Department of Infrastructure and Water management: Bureau Co-ordination Nuclear Energy-affairs, (1960) 1964-1978.
    - Archive of the Department of Economic Affairs, directorate Nuclear Energy, mainly 1956-1971
    - Archive of the Dutch Parliament, especially archive no: 4.1.2.6.6: Archive of the Parliamentary Commission on Nuclear Energy, 1953-1982.
    - Code-Archive of the Ministry van Foreign Affairs, 1945-1954 and 1965-1974. Especially: no.'s 20761-20773 about the Advisory Committee on Nuclear Research and no.'s 20802-20803 about Industrial Policy regarding nuclear energy.
    - Archive of the Health Counsel [Gezondheidsraad], (1953) 1957-1990. Amongst others no. 3.3.81 about the Nuclear Energy Commission.
    - Archive of the Ministry of Science and Education: Archive of the Central Council for Nuclear Energy, 1963-1973
- Gelders Archive in Arnhem, Archive no. 1154: Archive of GKN Nuclear Reactor Dodewaard 1.
- Historic Centre Overijssel in Zwolle, Archive no. 0025.6: Provincial Government of Overijssel, no. 2357. Amongst others about the Urenco Enrichment Reactor in Almelo, 1975-1987.
- Regional Archive Rivierenland in Tiel, Archive no. 1488: Municipality of Dodewaard, no. 222888 on nuclear energy and the Dodewaard Reactor. [including files about civil protests].

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- Gronings Archive in Groningen, Archive no. 2479: Collection of publicist and activist H. Damveld about nuclear energy, 1968 - 2007.

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WP2

Portugal

Short Country Report

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BENEFICIARY

UPF

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HoNESt History of Nuclear Energy and Society

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CONTENTS

Executive summary

This report belongs to a collection of 20 short country reports on the History of Nuclear Energy and Society (HoNESt, project Ref.662268). The reports tackle the complex sociotechnical system around nuclear energy. Nuclear developments, notably nuclear energy, are closely intertwined with social, economic, environmental, political and cultural spheres. Nuclear energy is also a globalized system involving transnational transfers of knowledge, materials, technologies, people and products including electrical power, medical elements, toxic wastes and other environmental hazards, materials, capacities and knowledge that must be carefully safeguarded. Nuclear energy is a complex social and technological phenomenon that influences societies but is also shaped by societies.

The short country reports are designed to assemble information and research results on the history of the relations between nuclear energy and society about all the different country cases in an accessible manner, and to document the findings with references.

The purpose of the country reports is threefold, addressing three different audiences:

1. to provide basic elements of narrative and analysis for further historical research by HoNESt researchers,
2. to provide information, context and background for further analysis for HoNESt's social science researchers,
3. to provide accessible information on nuclear-societal relations in the various countries for the purposes of outreach and communication with stakeholders (civil society, industry, associations, policy makers, journalists).

This report focuses on the history of the relations between nuclear energy and society in *Portugal.* The main findings are:

Possessing uranium deposits was decisive for Portugal to enter the nuclear age. In 1949 and 1956, major agreements involved Portugal and the Combined Development Agency (a UK/US alliance) for the sale of uranium oxide. The outcome was the export of 1,250 tons to the US until 1962.

Portugal participated in the US Atoms for Peace programme (see USA Short Country Report) by signing the American-Portuguese Bilateral Agreement to acquire a nuclear experimental reactor, in 1955. To house the reactor, a Laboratory for Nuclear Physics and Engineering was inaugurated in 1961. This Laboratory was crucial for the training of technical and scientific experts. Recently it was attached to the University of Lisbon.

CPIN, Companhia Portuguesa de Indústrias Nucleares, was created in 1958 to launch a project to implement nuclear power but, failing this goal, proclaimed its bankruptcy in 1964. Despite this early start promoted by the private sector, all subsequent projects to build a nuclear power plant failed, including the latest attempt in 2006.

Relationships between the nuclear industry and society were only possible after the April 1974 Democratic Revolution which ended a forty-eight year dictatorship.

In March 1976, an attempt at installing a nuclear power plant at the village of Ferrel, in the coastal centre of Portugal, was received with fierce opposition by the local population. This was the first and last case of an uprising against nuclear power.

This incident became a milestone for the Portuguese anti-nuclear movement. This and the difficulty to find an adequate site to install the nuclear power plant led the utility to abandon the decision to build the nuclear power plant.

After the incident at Chernobyl on 26 April 1986, the nuclear power programme was shelved by the government.

Evocation of the Ferrel incident in the media is still evoked as a shorthand for Portugal’s anti-nuclear stance.

Mostly hydro and wind but also solar PV, biomass and geothermal energies are gaining ground, presently. However, the instability of wind and hydro power supply still require, in dry years, imports of electricity from (and through) Spain, a country equipped with nuclear power capacity (see Spain Short Country Report).

1. Historical context (narrative)

1.1. Introduction to the historical context

Until April 1974, Portugal was a dictatorship known as Estado Novo (New State), in power from1933, ruled by António de Oliveira Salazar (1889-1970) and succeeded by Marcelo Alves Caetano (1906-1980), on 27 September 1968. Freedom of speech and association was denied and placed under the control of a political police, censorship was applied to the press and all published material. This means that interactions within society only became visible after the Democratic Revolution of 25 April 1974, after which Portugal entered slowly into the tempo of regular democratic procedures.

Viriato Soromenho-Marques (n. 1957) argues that, in those times "the expansion of the environmental association movement bears a complex relationship with the construction of a representative democratic regime." The reason for this is that, on the one hand, by the April 1974 Revolution the new constitutional and institutional conditions of liberty of press and association created a climate that favoured the establishment of environmental organizations, opening the way for the participation of citizens in decisions affecting their lives. On the other hand, the need to launch an urgent process to construct the basic foundations of the democratic state relegated the environmental causes to second plan in this scale of priorities, particularly in the first decade of democracy (Soromenho-Marques 2005: 3-4).

Nevertheless, the confrontation between the democratic state's option for nuclear power and the environmental organizations started early in November 1974, when a member of the Provisional Government announced the nuclear option as a strategic goal to reach energy autonomy. This stance was the spark that set off a process of civilian engagement from which sprang an environmental movement which was profoundly anti-nuclear (Soromenho-Marques 2005: 4).

In March 1976, the Ferrel incident was the first and last case of uprising against the installation of a nuclear power plant. The historical context was peculiar. A new wave of understanding that people could speak for themselves, and that their problems mattered swept the country. Activists of the emergent environmental movement were on the spot to underline this understanding, gaining political influence in their turn. The result was that the successive governments' nuclear power programme faced several difficulties in its implementation and it was abandoned after Chernobyl, in 1986.

However, the nuclear option still divides the country, as shown after June 2005, when an entrepreneur, Patrick Monteiro de Barros, announced at a Lisbon press conference his proposal to install a nuclear power plant. The nuclear debate on a new energy model for Portugal ensued with the participation of stakeholders for and against nuclear power. However, the government put an end to the debate by announcing that during the parliamentary term ending in 2009, the nuclear option was not contemplated (Rodrigues 2006: 26). No further initiative followed since then.

1.2. Contextual narrative

The uranium drive

As shown in *Table 1, section 4. Facts and Figures*, there has been a remarkable persistence of attempts to implement nuclear power in Portugal. Firstly, the country possessed and still possesses a great number of small uranium deposits scattered over a vast region, although of poor quality. Secondly, scientists and engineers, mostly, were aroused by this background to nurture hopes of a brighter future for their country and for their careers. Yet, are these conditions sufficient to explain the persistence? What were the social, economic, and political contexts and the role played by uranium? How did the interplay of different actors result in the failure to implement nuclear power? This narrative aims at enlightening the circumstances that brought about the nuclear power impossibility.

After 1939, the British government, alarmed by the prospect that Germany might get hold of Portuguese uranium ore, delineated a pre-emptive policy (Perrin 1942) which involved the United States after 1943. This policy was expanded by the Anglo-American Declaration of Trust, of June 1944, which institutionalised the Combined Development Trust (CDT) ("Anglo-American Declaration of Trust" 1984). The consequence of this co-operation was the CDT's request for negotiations with the Portuguese Government, in 1947, ending in the first major agreement of 1949 to acquire 700 tons of uranium oxide until 31 December 1957 (Gaspar 2014: Section 2.3)

Both parties, the Combined Development Trust (named Combined Development Agency, CDA, in 1948) and the Portuguese Government were disappointed with this agreement. The first considered too short both the quantity and the period of the contract; the latter were vexed by the extraordinary low price paid by the CDT/CDA. The result was a revision of the first agreement, signed in 1956, for the uranium oxide export of 1,325 tons to the United States, till the end of 1962, paying an export tax of £3.03 per kg instead of 4.5 shillings (Gaspar 2014: Section 3.3).

The expectations of the scientific and technological community saw light at the end of the tunnel after two institutions, the Comissão de Estudos de Energia Nuclear (Commission for Nuclear Energy Studies, henceforth Commission), introduced tentatively in 1952, and the Junta de Energia Nuclear (Nuclear Energy Board, henceforth Board), were established in March 1954. This technical-scientific framework developed a nuclear programme, electing as their starting points the training of nuclear specialists and a wide geological survey of uranium deposits. In 1955, Portugal participated in the American Atoms for Peace plan which offered Bilateral Agreements to acquire nuclear experimental reactors. Building LFEN, Laboratório de Física e Energia Nucleares (Laboratory for Nuclear Physics and Engineering, henceforth Laboratory) was the consequence of acquiring a nuclear experimental reactor. In sum, the nuclear programme began its implementation because the funds were available from the uranium oxide exported to the United States. Simultaneously, on 29 July 1957, Portugal became founding member of the International Atomic Energy Agency, qualifying as uranium oxide producer (Gaspar 2014: Section 3.4.2). Thus, the Portuguese nuclear programme had two components, one external and one internal, both propelled by uranium, a Latourian non-human agent. The government's internal policy was to implement the conditions that would favour the training of nuclear experts, both abroad and at home by the Commission and by the Laboratory after inauguration in 1961, opening the way for the involvement of nuclear experts in projects at home.

The private sector's intervention

CPIN, Companhia Portuguesa de Indústrias Nucleares, was created in April 1958 to advance proposals to favour the nuclear alternative over thermal energy based on national coal, both intending to complement the announced exhaustion of the hydro-power option and the hydro-power shortages in years of dry weather. CPIN's programme aimed to study the uses of nuclear energy, the implementation of projects resulting from those studies and, as a whole, to promote, create, develop and coordinate activities regarding the production or application of nuclear energy. The leader of this initiative was the nuclear physicist, Armando Gibert (1914-1985), well connected with the industrialists and with the technological and scientific community. CPIN's people were also in contact with the leadership of the Board. CPIN's shareholders were private companies and individuals. Ten electrical utilities, representing more than 40% of the capital, were responsible for 99% of electricity production and distribution, in 1959. Thirteen came from the industrial sector producing a high percentage of chemicals, electrical cables and conductors, high and low tension electrical equipment, electrical motors and transformers, ferrous and non-ferrous metallurgic products, among others. Three shipping companies and one bank (Banco Burnay, SARL) completed the shareholders' private association (*A Companhia Portuguesa* 1961). However, the statutes were clear in preventing CPIN, or their representatives, to engage in electricity production by means of nuclear reactors. This task was reserved for the utilities.

During six years CPIN deployed intense activity, particularly investigating: the promotion of nuclear power production, electricity production and the market, as well as, supporting the training of technicians for the nuclear power plants' operation. In 1962, this activity terminated in a project for a 460 MW experimental nuclear power plant (Gibert 1962; Gibert 1961), but the whole project came to an end in 1964, with CPIN declaring bankruptcy after the government's decision to build a 750 MW thermal power plant at Carregado (north of Lisbon), to burn fuel oil and giving the concession to ETP, Empresa Termoeléctrica Portuguesa (Cabral 2001). Thus, the government showed no interest in the nuclear option in the 1960s. This is understandable considering that the electrification of the country was based on hydroelectric dam construction complemented with thermal energy to run on national coal even though this would soon be exhausted. As far as nuclear technology was concerned it involved great risk because of its novelty and, in addition, it required a huge investment at a time when Portugal was engaged in a colonial war which consumed the nation's resources. Notwithstanding the close contact of CPIN with the Board and the support of its engineers, the dictatorial government ignored all pressure to face the change to nuclear technology.

On 30 June 2005, little more than forty years after CPIN's insolvency, an entrepreneur, Patrick Monteiro de Barros, announced at a Lisbon press conference his proposition to install a nuclear power plant. Barros's main supporter was Pedro Sampaio Nunes, secretary of State for Science and Innovation in the previous government. A nuclear debate on a new energy model for Portugal was launched but without consequence, because José Sócrates Pinto de Sousa (b. 1957), the Prime Minister from 12 March 2005 to 26 October 2009, declared that the nuclear option was not anticipated during the parliamentary term ending in 2009 (Rodrigues 2006: 26). Recently, in March 2016, Sampaio Nunes seemed that the nuclear debate was over, stating that for Portugal the nuclear was "dead and buried, above all because of its costs" (Cipriano 2016).

The dictatorial state's intervention

In 1973, the trend was for Direcção-Geral de Combustíveis e Reactores Nucleares Industriais (General-Directorate for Fuel and Industrial Nuclear Reactors), a department of the Board, to have limited intervention in nuclear power, engaging in their licensing and inspection. Industrial promotion of the plants was to be left to the respective department in the Ministry of Economy. In March, CPE, Companhia Portuguesa de Electricidade, the successor of Empresa Termoeléctrica Portuguesa, was already involved in planning the construction of a nuclear power plant, requesting the Board to study possible locations which included Ferrel, close to the fishing town of Peniche on the coastal centre of Portugal (Oliveira 2002: 48).

Finally, the dictatorial government decided to launch a nuclear power plant programme which was included in the Developmental Plan for the period of 1974 to 1979, anticipating the construction of the first Portuguese nuclear power plant (*IV Plano de Fomento* 1974: 509–12).

The democratic state's intervention

The Democratic Revolution of April 1974, resulting from a peaceful military intervention, represented a deep change from dictatorship to the new democratic rule. However, this did not apply to nuclear power because the supporters of the nuclear endeavour soon found their way into the government. This was the case of José de Melo Torres de Campos, appointed Secretary of State for Industry and Energy in the first three Provisional Governments from 17 May 1974 to 26 March 1975 (Oliveira 2002: 52, 57, 60). In November 1974, he borrowed the nuclear option from the dictatorship government's Developmental Plan, announcing that it was one of the aims of the government in the struggle for energy self-sufficiency (Soromenho-Marques 2005: 4).

After March 1975, a wave of nationalizations, including banks, insurance companies, and the energy sector, swept the country and is evidence for leftist drift of the government. Another peaceful military intervention, on 25 November, set the stage for a return to normalization during the sixth Provisional Government (19 September 1975 to 23 July 1976) (Telo 2007: 122–6, 169–72). Walter Ruivo Gomes Rosa (b.1919), another key supporter of the nuclear option, was appointed minister for Industry and Technology, on 6 January 1976 (Oliveira 2002: 87). An ex-senior officer of CPE, he had been responsible for conventional thermal plants since the 1960s (Domingos 1978: 120).

In 1975, all companies involved in production, transport and distribution of electric energy were nationalized ("Decree-Law nº 205–G/75" 1975) and, during the sixth Provisional Government, CPE had the means to launch their nuclear programme. In January 1976, they applied to Direcção-Geral dos Serviços Eléctricos (Directorate General of Electrical Services) to install the first nuclear power plant at Ferrel, attaching a "Preliminary Study and of the Site for the First Portuguese Nuclear Power Plant" (Oliveira 2002: 261, n. 156). Prospective work for its installation started, but, on 15 March, a local uprising became a serious threat to the project, though this was not the main obstacle.

The First Constitutional Government (23 July 1976 to 7 December 1977) led by the socialist Mário Soares, included Rosa, a key supporter of the nuclear option, who remained in office as Minister of Industry and Technology until 7 January 1977, and Joaquim Rocha Cabral as

Secretary of State for Energy and Mines another ex-officer of CPE and previous head of their nuclear project (Oliveira 2002: 93, 105). A new policy was adopted for the energy sector intended to stimulate national resources, hydropower and national uranium, for electricity production and to reduce the dependency on thermal electricity, namely imported fuel oil (“Programa do Governo” 1976: 58–60; Oliveira 2002: 93). Meanwhile, in June 1976, CPE was succeeded by Electricidade de Portugal (EDP) to exclusively manage the public service of production, transport and distribution of electricity (“Decree-Law nº 502/76” 1976).

On 31 December 1977, after the fall of the government, the Ministry for Industry and Technology was reorganized and a Gabinete de Protecção e Segurança Nuclear, GPSN, (Bureau for Nuclear Protection and Safety) was set up to supervise nuclear power plants and reactors in all instances (“Decree-Law nº 548/77” 1977; Oliveira 2002: 187–8). Mário Soares was again Prime Minister of the short lived Second Constitutional Government (23 January 1978 to 27 July 1978) with Cabral as Secretary of State for Energy and Base Industries (Oliveira 2002: 141). The governmental programme included the construction of the first nuclear power plant and another thermal plant to burn fuel oil or coal (Oliveira 2002: 254, n.115). The installation of the nuclear power plant project at Ferrel by EDP, Electricidade de Portugal, was then submitted to GPSN. They concluded that the study on which EDP based their plan was unacceptable due to deficiency of fundamental details. GPSN summoned local experts who included those from Geological Services, National Laboratory of Civil Engineering, and National Institute of Meteorology and Geophysics. They argued that EDP’s studies were generally “more descriptive than corroborated, their conclusions were partly omitted and were not substantiated.” Therefore, it would be impossible to license Ferrel without “complementary geological and seismological studies.” (Oliveira 2002: 188). In early 1979, experts of the International Atomic Energy Agency, confirmed GPSN’s conclusions. In March, the Three Mile Island accident did not help the Ferrel case, with movements engaging in the promotion of a better environment (Oliveira 2002: 172).

By 1985, EDP had been unable to present a coherent study to enable the selection of sites to install the nuclear power plant (Oliveira 2002: 177). The Portuguese nuclear power plant programme headed by EDP was not credible and it was for a long time in a blind alley. Its end was anticipated earlier, in 1978, by Alfeu Fernandes Forte, an engineer of EDP, and former technical employee of the company CPIN. He considered that dispersion of technicians, both of this company and of the Board, into other institutions would thwart the gathering of specialists to participate in the project, the construction, the assembling, and the supervision of a nuclear power plant (Forte 1978: 125–6).

At the end of the ninth Constitutional Government (9 June 1983 to 6 November 1985), headed by Mário Soares, it was perceived that the nuclear programme was unsustainable, “particularly because it lacked the motivation to face the pressure of environmentalists.” The next government headed by Aníbal Cavaco Silva (n. 1945) chose coal for thermoelectric plants and encouraged the development of hydroelectric sources still available (Oliveira 2002: 177). The incident at Chernobyl on 26 April 1986 dealt the final blow to the nuclear programme’s chances of recovery (Oliveira 2002: 180).

Nuclear cooperation between Portugal and Spain

CPIN’s drawback did not discourage nuclear power supporters, particularly some of the engineers who kept the pressure inside and outside the Nuclear Energy Board. In 1967, a joint proposal of the Spanish Compañía Sevillana de Electricidad and Empresa Termoeléctrica Portuguesa (which had assumed the responsibility to lead the nuclear power plants issue in 1963) was conveyed to both governments to construct a 600 MW nuclear Spanish-Portuguese power plant at the southern border, close to river Guadiana, around 1975. The Board’s experts were summoned to participate in the respective studies but, apparently, the proposal was disregarded, at least, by the Portuguese government (Videira 1969: 3; Simão 2005: 398). In 1969, members of the two Boards (Portuguese and Spanish) engaged in conversations for the Portuguese participation in the Spanish Almaraz nuclear power plant and, again, no consequence ensued (Videira 1969: 3–4).

These conversations were followed by the “General Convention of Scientific and Technological Cooperation between Portugal and Spain” held in Madrid, on 22 May 1970. A document signed by both parties, titled “Agreement between the Government of Portugal and the Government of Spain for the Cooperation on the Uses of Nuclear Energy for Pacific Purposes” waited until 15 March 1971 to be “approved for endorsement” (“Decree-Law nº 118/71” 1971). This agreement had no consequence. It was followed, nine years later, by the “Portuguese-Spanish Agreement about Co-Operation on Safety Matters of Border Nuclear Installations," of 31 March 1980. The circumstance of its application was a project to build a nuclear power plant at Sayago, located in the northern province of Zamora on the river Douro hydrographic basin, near the Portuguese border. For this undertaking the Portuguese member of the Technical Permanent Commission, received two reports, "Preliminary Security Report" and the "Analytical and Radiological Study" which assessment was concluded in 1982 (Oliveira 2002: 189, 261–2 n.157). No information was found if these documents had any impact on the fact that this nuclear plant advanced no further than the planned stage.

At the time GPSN, was also called to intervene when several accidents occurred during the installation of the Spanish Almaraz nuclear power plant (Oliveira 2002: 189-90), cooled by the international river Tagus, 100 km from the Portuguese border in the Cáceres province of western Spain. The plant has two reactors of 930 MW: Almaraz I began construction in 1973 and became operational in 1982; Almaraz II began construction in 1974 and became operational in 1984. In March 2016, Almaraz nuclear power plants involved environmentalists and political parties in Parliament claiming that it should be closed-down because its useful period had expired ("Ambientalistas e partidos" 2016). The Parliamentary Commission for Environment of Assembleia da República (Portuguese Parliament) questioned the Portuguese government about the nuclear risk and were reassured by the minister for Environment that the matter was being followed and that Madrid guaranteed the plant to be "operating under absolute safety conditions" (Tomás 2016). Finding their claims had not been fulfilled, on 11 June 2016, more than twenty Portuguese associations participated in a joint Portuguese and Spanish demonstration at Cáceres calling for the closure of Almaraz nuclear power plant ("Manifestação Ibérica" 2016). Presently, as reported by the media, the Almaraz nuclear power plants' incident is still a matter for concern in Portugal without a satisfactory response from Spain (see Spain Short Country Report).

Investing in the renewables' alternative

At the end of World War II, the electrification programme of Portugal based on hydro-power with the necessary complement of national coal, was a late decision of the dictatorial government of Salazar, expecting to promote energy independence (Rollo 1996: 349–50). However, by the end of the 1970s, hydro-power totalled 2,268 MW (58%) against 1,632 MW (42%) of thermal-power, which was gaining ground to reach 3,555 MW (54%) against 3,069 MW (46%) of hydro-power, end of the 1980s. Thermal electricity production was gaining momentum and to beat it new renewable energies (wind, low hydro-power, photovoltaic, and biomass) entered the market with high hopes on wind energy. In 2015, the renewable energies' share was 48.1% against thermal's 47.3% however Portugal still imports electric energy in times of drought which is of nuclear origin.

Conclusion

The nuclear power quest started in Portugal in 1958 and was pursued in the following decades (*Table 1, section 4. Facts and Figures*). It was a sequential failure, and joint ventures with Spain were not successful either, even after an agreement of cooperation was signed in 1971. The Ferrel event has a twofold meaning. On the one hand, it stands for the tentative effort of EDP to install a nuclear power plant in Portugal and on the other hand, it was strongly connected with the emerging environmentalist movement in Portugal, which made the anti-nuclear option their banner. Finally, after 1985, the government of Cavaco Silva decided to abandon the nuclear power plants programme. The successive persistence and failure in implementing a nuclear power programme in Portugal withered away with time.

In the long run, the nuclear energy alternative does not seem to be an option for Portugal, even in a scenery of electric mobility to substitute oil derivatives in transports, because the growing consumption of electricity may be covered by gas thermo-plants and by developing the renewables. From last 7 May to 11 May, during 107 hours, electricity consumption was totally covered by renewables, as reported widely in the press. Besides, an estimate of net consumption of 100% renewable electric energy has been advanced for 2040, by António Sá Costa, leader of APREN-Association for Renewable Energies (Azevedo 2016). Nuclear fusion is the greatest hope for clean and abundant energy but is still a distant possibility because the first tests have only been anticipated for 2025 ("Reactor de fusão nuclear" 2016).

The Democratic Revolution of 1974 set off a stage of difficult times for the Laboratory of Nuclear Physics and Engineering but a low-profile operation has been safeguarded to the present. On December 22, 2011, the government decided to integrate it in Instituto Superior Técnico (Higher Technical Institute) of the University of Lisbon, as IST/Instituto Tecnológico e Nuclear ("Notas Históricas" 2016).

At present, a reflection of the earlier policy of supporting nuclear expertise is the participation in the EURATOM Fusion Programme through Instituto de Plasmas e Fusão Nuclear, an institution attached to the Higher Technical Institute ("About Instituto de Plasmas" 2016).

1.3. Presentation of main actors

Companhia Portuguesa de Indústrias Nucleares (CPIN)

CPIN was created in April 1958 to advance proposals to favour the nuclear alternative over thermal energy based on national coal, both intending to complement the announced exhaustion of the hydro-power option and the hydro-power shortages in years of dry weather. The leader of this initiative was the nuclear physicist, Armando Gibert (1914-1985), well connected with the industrialists and with the technological and scientific community. CPIN's people were also in contact with the leadership of the Board. CPIN's shareholders were private companies and individuals.

During six years CPIN deployed intense activity, particularly investigating: the promotion of nuclear power production, electricity production and the consuming market, as well as, supporting the training of technicians in the operation of nuclear power plants. In 1962, this activity terminated in a project for a 460 MW experimental nuclear power plant (Gibert 1962; Gibert 1961), but the whole project came to an end in 1964, with CPIN declaring bankruptcy after the government's decision to build a 750 MW power thermal plant at Carregado (north of Lisbon), to burn fuel oil and giving the concession to ETP, Empresa Termoeléctrica Portuguesa (Cabral 2001). Thus, the government showed no interest in the nuclear option in the 1960s. This is understandable considering that the electrification of the country was based on hydroelectric dam construction complemented with thermal energy to run on national coal even though this would soon be exhausted. As far as nuclear technology was concerned it was seen to involve great risk because of its novelty in addition to the huge capital investment required at a time when Portugal was engaged in a colonial war which consumed the nation’s resources.

Laboratory for Nuclear Physics and Engineering

The expectations of the scientific and technological community saw light at the end of the tunnel after two institutions, the Comissão de Estudos de Energia Nuclear (Commission for Nuclear Energy Studies, henceforth Commission), introduced tentatively in 1952, and the Junta de Energia Nuclear (Nuclear Energy Board, henceforth Board), were established in March 1954. This technical-scientific framework developed a nuclear programme, electing as their starting points the training of nuclear specialists and a wide geological survey of uranium deposits. In 1955, Portugal participated in the American Atoms for Peace plan which offered Bilateral Agreements to acquire nuclear experimental reactors. Building LFEN, Laboratório de Física e Energia Nucleares (Laboratory for Nuclear Physics and Engineering, henceforth Laboratory) was the consequence of acquiring a nuclear experimental reactor. The government’s internal policy was to implement the conditions that would favour the training of nuclear experts, both abroad and at home by the Commission and by the Laboratory after inauguration in 1961, opening the way for the involvement of nuclear experts in projects at home.

The Democratic Revolution of 1974 set off a stage of difficult times for the Laboratory but a low-profile operation has been safeguarded to the present. On December 22, 2011, the government decided to integrate it in Instituto Superior Técnico (Higher Technical Institute) of the University of Lisbon, as IST/Instituto Tecnológico e Nuclear (“Notas Históricas” 2016).

The democratic state’s nuclear intervention

After the Democratic Revolution of 1974, the First Constitutional Government (23 July 1976 to 7 December 1977), led by the socialist Mário Soares, adopted a new policy for the energy sector intended to stimulate national resources, hydropower and national uranium for electricity production, and to reduce the dependency on thermal electricity, namely imported fuel oil ("Programa do Governo" 1976: 58–60; Oliveira 2002: 93). Meanwhile, in June 1976, Electricidade de Portugal (EDP) had been appointed to superintend, exclusively, the public service of production, transport and distribution of electrical energy ("Decree-Law nº 502/76" 1976).

Mário Soares was again prime minister of the short lived Second Constitutional Government (23 January 1978 to 27 July 1978). The governmental programme included the construction of the first nuclear power plant and another thermal plant to burn fuel oil or carbon (Oliveira 2002: 254, n.115). A project for the installation of a nuclear power plant at Ferrel was then submitted by EDP to the government but it was rejected on technical grounds. In March 1979, the Three Mile Island accident did not help the Ferrel case, with movements campaigning for a better environment (Oliveira 2002: 172).

By 1985, EDP had been unable to present a coherent study to enable the selection of sites to install the nuclear power plant (Oliveira 2002: 177). The nuclear incident at Chernobyl on 26 April 1986 dealt the final blow to the nuclear programme's chances of recovery (Oliveira 2002: 180).

2. Showcase

In the Portuguese case, the nuclear industry had practically no existence because it did not develop beyond the phase of the search for a site to install the nuclear power plant. The interaction between nuclear industry and civil society advanced during the narrow lapse of time during which preliminary devices were installed, such as a 100 meter high tower with a meteorological aerial to measure winds, temperature and moisture. On the morning of 15 March 1976, on their way to work, people gathered at the churchyard decided to stop these preliminary works and to damage the premises (Cipriano 2016).

The question is how were the local citizens, mostly small farmers, informed about the purpose of the tower and about nuclear power. A description of this event is found in *Arado, Jornal Popular do Concelho de Peniche (The Plough, Popular Newspaper of the County of Peniche).* A leaflet, titled "To the population – Communiqué" had been distributed to the people informing about the dangers "environmental pollution with severe health dangers (increasing cancer incidence, etc.), death of marine species (algae and fish)", affecting the agricultural and fishing activities of the county ("O povo de Ferrel" 1976). This was indeed alarming information which touched the local people's most cherished interests. Their main concern, and that of the villages around Peniche, was losing their farms and fishing craft, as well as the means of their activity and subsistence. Therefore, they marched against the tower erected by CPE carrying their work tools – hoes, pitchforks, rakes, and sickles – menacing to destroy the tower if CPE continued their work to install the nuclear power plant (Cipriano 2016). They could see no alternative.

The leaflet contained other type of information. The construction of a nuclear power plant at Ferrel had been programmed seven years before, in 1969 (the year was in fact 1973, see above section 1.2, under subtitle "The dictatorial state's intervention", p.9). On 5 March 1976, a "Committee of Ferrel's residents" had sent telegrams to CPE, Companhia Portuguesa de Electricidade, and the Prime Minister; Radio and TV were also contacted. The telegrams announced the protest "against the installation of the nuclear power plant" and that "all legal means" would be used to prevent it from being constructed. The media were criticised for not disseminating the information contained in this telegram (A população de Ferrel 1976). No reply was received.

Therefore, the nuclear industry was perceived by the local citizens through information spread through the local press which involved environmental activists, not from experience. The first attempt to install a nuclear power plant, in 1976, engaged the local citizens in contact with an embryonic environmental movement producing a resonance that favoured the image of this movement in detriment to the promotion of nuclear power. This was the first and last participation of Ferrel's people in the struggle against CPE's (and their successor EDP) nuclear power plant, particularly, because no solution was found by the latter for the local seismological problems and other technical difficulties. EDP 's problem was aggravated by the fact that they could not find another site to substitute Ferrel and this was in fact the end of their nuclear power ambition (above section 1.2, pp.12-13).

The newspaper *O Século* (*The Century*) a Lisbon newspaper printed the *Arado* report to illustrate their article "A guerra do átomo 'pacífico'" (The war of the 'pacific' atom), on 30 March 1976 ("A guerra do átomo" 1976). The environmentalists were fascinated by the Ferrel event and aimed at creating a large movement against the nuclear option, mainly through their journals, of which the following are an example. An instance of spreading the protest occurred on 8 June 1976, by *Cadernos de Ecologia e Sociedade* (*Notebooks on Ecology and Society*) supervised by José Carlos Costa Marques (b. 1945). Its Editorial Note titled "Somos todos moradores de Ferrel" ("We are all Ferrel's residents") evoked John F. Kennedy's speech "I am a Berliner" of 26 June 1963. It claimed that "Ferrel is already the trenches which will divide the Portuguese people in two new 'parties': on one side the party of the dead and, on the other side supporting Ferrel's residents the party of life" ("Somos todos moradores" 1976). Another important contribution to the anti-nuclear debate was given by *Raiz e Utopia*, a quarterly journal, edited by António José Saraiva and Carlos L. Medeiros. In 1977, it published a round-table about nuclear issues (Silva 1977) and a Manifesto on Energy Policy – For a National Debate on Nuclear Energy, signed by over 100 scientists and engineers ("Manifesto" 1977).

Scientists, engineers, and economists, obviously, participated in the nuclear debate. In 1977, the "Manifesto on Energy Policy" was signed by a group of 110 persons, of which 74 were technicians of EDP, and among them some belonged to its Project Team of the Nuclear Power Plant and to the Central Planning Board. Carlos Matos Ferreira (1948–2014), physics professor of IST, headed this group calling for a national debate about the nuclear option (Ferreira 1977: 151-2). A year later, the group had grown to 200 individuals and a "Commission for Promoting the National Debate on the Nuclear Option" was led by two Higher Technical Institute professors, Matos Fereira and Tito Mendonça. In a press conference, the group demanded that a White Paper be made public and announced their interest in participating in study groups on nuclear energy issues, "safety, the fuel cycle, economics, the participation of national industries, alternative energies and the biological effects of radiations" (Delicado 2013: 200).

In 1978, a collective authored book on nuclear technical issues was published with the participation of mostly researchers of LFEN, Laboratório de Física e Engenharia Nucleares, as well as other engineers and economists (*O que é a Energia Nuclear* 1978).

However, the peak of mass mobilization was the Festival "Pela Vida e Contra o Nuclear" (For Life and Against Nuclear) staged at nearby Caldas da Rainha on 21 and 22 January 1978. The newspaper *Gazeta das Caldas* and its supplement *Pela Vida* (*For Life*), first published in November 1977, organized the festival which was transmitted abroad and was popularly attended, including a few foreign activists (Eloy 2015, 32). The festivities included a march to the site at Ferrel where the nuclear power plant was to be installed and Portuguese ecologists and anti-nuclear activists were involved in debates (Nascimento 1978). Despite the enthusiasm, the Festival was an urban event, mainly attended by people from Lisbon (Barca 2016: 512-13).

The site of Ferrel was abandoned by EDP – Electricidade de Portugal, the successor of CPE, and no substitute was found. The Ferrel incident became a milestone for the Portuguese anti-nuclear movement and its evocation by the media has invigorated its memory.

Thirty years after the event, March 2006, the nuclear debate was energised because of Barros's proposition to install a nuclear power plant in Portugal (above, section 1.2, under subtitle "The private sector's intervention", p.9). The date was a pretext for the SIC TV news programme to recall Ferrel ("Ferrel e o protesto" 2006). On March 15, 2011, thirty-five years later, a speech was recorded to commemorate Ferrel by Domingos (Domingos 2011). On 21 March 2012, *Jornal das Caldas* celebrated the 36 years of Ferrel (Gomes 2012). The most recent commemoration was the 40th anniversary, in March 2016 (Cipriano 2016). TSF, radio FM also participated with the chronicle, “40 anos da Marcha do Povo de Ferrel contra a Central Nuclear” (“40 years of Ferrel’s people march against the Nuclear Power Plant”) (“40 anos da Marcha do Povo” 2016).

The media, generally, contributed to keep the Ferrel incident alive to the present day, its attraction owes much to the people’s spontaneous and vivid action.

3. Events

Note: Ferrel was the only event demonstrating the interaction between nuclear industry and civil society and therefore it was selected for the Showcase (section 2).

4. Facts and figures

Note: Portugal did not implement any nuclear power programme. Electricity production in Portugal is based on fossil and renewable energy sources. Therefore, the Facts and Figures section does not apply to the Portugal Short Country Report.

4.1. Key dates and abbreviations

Key dates:

Table 1 – Persistent attempts at installing nuclear power plants

Year/period	Description
1958–1964	Creation of CPIN, a business association involving electricity utilities, industrial and shipping companies, a bank, and several individuals. After six years of intense activity, the company declared bankruptcy for lack of governmental support.
1960s	The dictatorial government appointed ETP, Empresa Termoeléctrica Portuguesa [Portuguese Thermoelectric Company], to lead the nuclear power plants issue.
1967	Spanish Compañía Sevillana de Electricidad and ETP proposed to respective governments the construction of a 600 MW nuclear Spanish-Portuguese power plant at the southern border close to river Guadiana, around 1975. Portuguese government disregarded it.
1969	Conversations held between the two JENs (Portuguese and Spanish) for the Portuguese participation in the Spanish Almaraz nuclear power plant. They had no consequence.
December 1969	Fusion of five companies of hydro-energy, thermal-energy (ETP) and energy transport led to a new company named CPE, Companhia Portuguesa de Electricidade). It succeeded ETP in all matters connected with nuclear issues.
1974–1979	Developmental Plan anticipated the construction of first Portuguese nuclear power plant. April 1974 democratic revolution prevented the Plan from seeing day light.
1976	CPE promoted prospective work for installing a nuclear power plant at Ferrel,

	near the fishing port of Peniche, north of Lisbon. March 15, a local uprising was reported in the press, leading to hot debates against nuclear power.
June 30, 1976	EDP, Electricidade de Portugal, was assigned the management of the totally nationalised electricity sector, succeeding CPE's nuclear commitment.
Late 1970s and 1980s	Constitutional governments tried to adopt a nuclear power plants program but the social climate was discouraging.
2005–2006	Supporters of nuclear option launched a debate on a new energetic model for Portugal with no consequence.

Abbreviations:

CDA	Combined Development Agency
CDT	Combined Development Trust
CPE	Companhia Portuguesa de Electricidade [Portuguese Company of Electricity]
CPIN	Companhia Portuguesa de Indústrias Nucleares [Portuguese Company for Nuclear Industries]
EDP	Eletricidade de Portugal
ETP	Empresa Termoeléctrica Portuguesa [Portuguese Thermoelectric Company]
GPSN	Gabinete de Protecção e Segurança Nuclear, [Bureau for Nuclear Protection and Safety]
IST	- Instituto Superior Técnico [(Higher Technical Institute]
JEN	Junta de Energia Nuclear [Nuclear Energy Board] is the common name of the respective Spanish and Portuguese institution.
LFEN	Laboratório de Física e Energia Nucleares [Nuclear Physics and Energy Laboratory]

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Russia

Short Country Report

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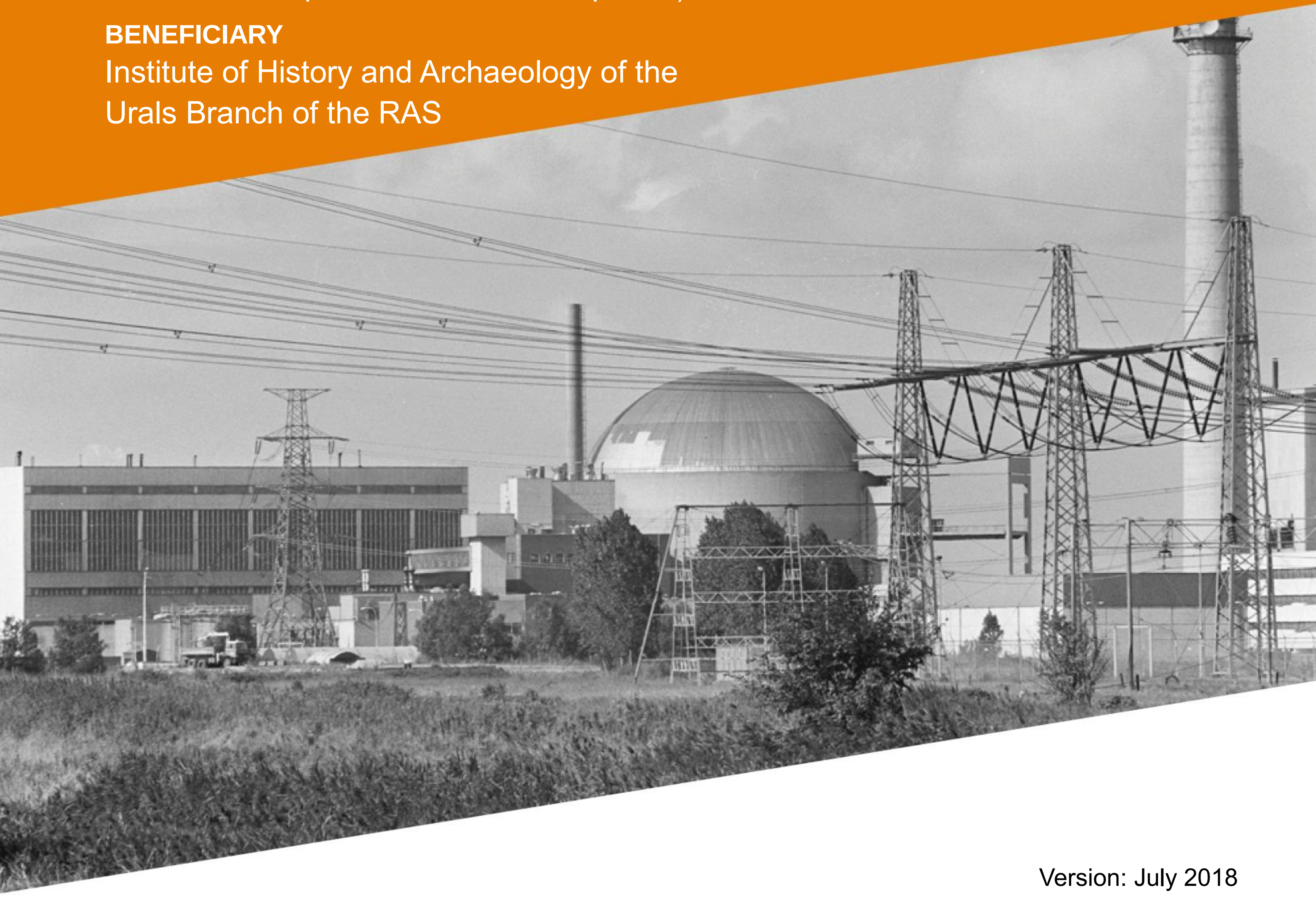

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HoNESt History of Nuclear Energy and Society

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DIALOGIK

EHU Europos humanitarinis universitetas

TU/e Technische Universiteit Eindhoven University of Technology

Friedrich-Schiller-Universität Jena

Swedish Defence University

GRE

KTH

LUT Lappeenranta University of Technology

upna Universidad Pública de Navarra Nafarroako Unibertsitate Publikoa

UPMC Sorbonne Universités

The University Of Sheffield.

Science Museum

spi Sociedade Portuguesa de Inovação

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Executive summary

This report belongs to a collection of 20 short country reports on the History of Nuclear Energy and Society (HoNESt, project Ref.662268). The reports tackle the complex sociotechnical system around nuclear energy. Nuclear developments, notably nuclear energy, are closely intertwined with social, economic, environmental, political and cultural spheres. Nuclear energy is also a globalized system involving transnational transfers of knowledge, materials, technologies, people and products including electrical power, medical elements, toxic wastes and other environmental hazards, materials, capacities and knowledge that must be carefully safeguarded. Nuclear energy is a complex social and technological phenomenon that influences societies but is also shaped by societies.

The short country reports are designed to assemble information and research results on the history of the relations between nuclear energy and society about all the different country cases in an accessible manner, and to document the findings with references.

The purpose of the country reports is threefold, addressing three different audiences:

1. to provide basic elements of narrative and analysis for further historical research by HoNESt researchers;
2. to provide information, context and background for further analysis for HoNESt's social science researchers;
3. to provide accessible information on nuclear-societal relations in the various countries for the purposes of outreach and communication with stakeholders (civil society, industry, associations, policy makers, journalists).

This report focuses on the history of the relations between nuclear energy and society in Russia. The main findings are as follows.

From the first days of the evolution of nuclear engineering industry Russia positioned itself as a nuclear power. Throughout its history the nuclear industry has been a state sector. Over that period state policy (and hence the position of the nuclear industry) underwent an evolution from a tight blanket of secrecy with regard to all information about any possible/actual nuclear power

engineering related problems or accidents to complete openness and transparency in this area, wide public involvement and various forms of dialog with society. An important milestone in the evolution of relationship between nuclear power engineering and society in Russia was the Chernobyl accident. It became a catalyst for "nuclear" transparency and public involvement. Peaks of public activism in Russia were observed in the early 1990s and 2000s - a time of dramatic political and economic transformations. Apparently the protest movement was to a certain extent a consequence of the general weakening of the state and slackening of government control during those relatively unstable periods.

On the whole the influence of society on decision making processes in the sphere of nuclear power engineering in Russia has never been particularly strong. Both active supporters and opponents of nuclear power engineering represented a minority of Russian society. The characteristic attitude of the majority towards the industry was rather complex and ambivalent. It could be described as balancing between the fear of anything "nuclear" and a favorable attitude towards nuclear energy as a sustainable source of power. The subject of nuclear power engineering risks has always been brought to the foreground in society in response to crisis situations at nuclear facilities. At such moments nuclear engineering industry appeared a relatively less attractive option. However public opinion, as a rule, quickly returned to the “normal” situation described above. In standard everyday life situations the rational perception of nuclear energy and industry got the upper hand over the emotional one. Moreover, the 'nuclear' topic (like many other environmental problems) was not part of the immediate routine concerns or value orientations of Russians. For a population under the conditions of various economic crises over the past several decades their material wellbeing was much more important than problems that were perceived to be global. Given the relatively scarce manifestation of anti-nuclear public opinion (which were often initiated and supported by foreign anti-nuclear organizations) it may be assumed with a high degree of probability that this technology has good development prospects in Russia.

Nuclear history in Russia is 70 years old and rich in various developments, with a mature nuclear industry that gained priority status in the national economy contribute, and this explains the fact that this report has outgrown its set limits.

1. Historical context (narrative)

1.1. Introduction to the historical context

The history of the relationship between nuclear power engineering and society in Russia went through several development stages. They were closely related to the evolution of political institutions, state priorities, stages of nuclear power engineering industry development, its crises and victories.

The initial stage (1945–55) was a period of assessment of nuclear power's potential. This task was considered supplementary to a more important part of the Soviet nuclear project - the creation of nuclear weapons. A major outcome of this stage was the construction and commissioning of a nuclear power plant in Obninsk. The very fact of its existence became a source of pride in the country's successes for both the state and the people. Nuclear power engineering was a welcome development.

At the stage of capacity build up (1955–86) further growth of nuclear power became one of the top priorities of Soviet economic policy. A large number of nuclear power plants was built both within the USSR and abroad, there was an active growth in the nuclear engineering industry, uranium ore mining, nuclear fuel production, and intensive development of associated hi-tech sectors. All information about accidents at nuclear facilities was hidden from the general public. Discussion of nuclear power engineering issues was limited to the official, state authorities level, discourse. No large scale criticism of the industry was allowed. Society acted as a passive supporter of the nuclear power engineering development. By 1985 the share of nuclear power plants in the Russian (RSFSR) power generation went up to 10%.

The stage of crisis of the existing model (1986 – early 2000s) began with the Chernobyl accident, the consequences of which were additionally aggravated by the radical transformation of political and economic relations. As a result, the government abandoned its policy of accelerated new nuclear power plant (NPP) construction. Priority shifted towards their safe operation. The rate and scale of economic and political reforms in the state had a negative effect on the condition of nuclear power engineering. Decline of production became a reality. At the same time the future of the nuclear industry became the focus of public interest. These issues were actively discussed by the media and rose high in the agenda of various political parties' debates. Anti- and pro-nuclear movements and organizations were formed. There were two major peaks in the public activist movements: in the early 1990s in the form of referendums against NPP construction, and in the early 2000s against the import and processing of nuclear waste. Both the state and the nuclear industry took steps towards building relationships with the public and raising the prestige of nuclear power engineering.

The present period is associated with the return to a policy of active development of the nuclear power sector. The contributing factors include both national economy stabilization (even despite the current crisis phenomena), and international trends (the "nuclear renaissance"). A state corporation, 'Rosatom,' has gained great authority and resources. Today it ranks second in the world in terms of uranium reserves and third in terms of uranium production; it is second in the world in terms of nuclear power generation, controls 36% the global uranium enrichment services market, and 17% of the nuclear fuel market. Rosatom is engaged in active educational campaigns, promotion of the industry's companies, their environmental and technological safety. The nuclear industry and the environmental activists are looking for potential cooperation options. Over the past ten years there have been no serious large scale anti-nuclear social protests in Russia. Both active supporters and opponents of nuclear power engineering represent a minority of the Russian society. The prevailing attitude of the majority is somewhere between the fear of nuclear accidents and the acceptance of nuclear power engineering as a high-potential energy supply source.

1.2. Contextual narrative

Historically the evolution and development of nuclear power generation in Russia was closely and inseparably connected with the efforts to obtain nuclear and thermonuclear weapons. The construction of nuclear power generation units became a second major focus of the Soviet nuclear project in parallel with the work on nuclear weapons. On 16 May 1949 the Government issued a resolution on the start of the first nuclear power plant design project. The entities involved in these projects were Laboratory "V" (State Scientific Center ‘Institute for Physics and Power Engineering’, Obninsk) and Laboratory № 2 (National Research Center 'Kurchatov Institute', Moscow). The scientific supervisor of the project was the leader of the Soviet atomic bomb project, Igor Kurchatov, and the chief design engineer of the reactor was engineer Nikolay Dollezhal.

On 27 June 1954 the first nuclear power plant in the world, with a capacity of 5 MW, was commissioned in Russia. The uranium-graphite channel-type water cooled reactor was given the name AM-1, meaning "Atom Mirny (Peaceful) - first" (see Event 1).

The Soviet state definitely positioned itself as a nuclear power placing its stakes on the development of nuclear power engineering and industry. The period before 1986 in the USSR was a period of nuclear power engineering triumph. This was the time of evolution of the industry administrative structure, technological improvement, commissioning of new NPPs, and transfer of the nuclear engineering technologies developed in the USSR to other countries. Throughout the whole nuclear power development period before Chernobyl catastrophe the centralized organization structures demonstrated their positive role providing for the concentration and use of accumulated experience and R&D potential which helped to maintain the required standard of all projects.

On 1 July 1953 the Ministry of Medium Machine Building (MSM) was established. It was responsible for the administration of nuclear power units construction as well as the general technical supervision of projects. It relied on the leading research and design organizations and controlled all major technical solutions. The works on design and construction of the first commercial nuclear power plants was supervised by the organizations of the Ministry of Power Plants Construction set up in 1953 (later the Ministry of Power and Electrification of the USSR or Minenergo). In 1964 the first 210 MW VVER-1 (PWR) power unit (the Novo-Voronezh NPP) was commissioned. From August 1966 the power plants from MSM were transferred to the Ministry of Energy framework, where a special Directorate on Nuclear Power – Glavatomenergo was set up combining within its structure the stages of design and operation of nuclear power plants including the two already operating and all the new plants in various stages of design and construction. In 1973 the first fast-neutron reactor in the world BN-350 was commissioned in Shevchenko (today Aktau, Kazakhstan). In 1974 the first 1000 MW RBMK power plantwas put into operation at the Leningrad NPP. In 1978 the All-Union Nuclear Power Engineering Industry Group "Soyuzatomenergo" was set up. It was a single specialized industrial and economic nuclear power engineering group comprising nuclear power plants, nuclear power plants research and commissioning organizations, maintenance and repair companies, as well as manufacturers of maintenance equipment and components for the NPPs, and specialized educational institutions for training NPP operational personnel. The Group was assigned the responsibility for pursuing a uniform R&D policy in nuclear power engineering and ensuring on-time commissioning and safe operation of NPPs.

By 1986 10 NPPs were built in the territory of Russia. Their combined capacity amounted to 38 million kW, and their share of total generation reached 10%. The development program for 1981–90 provided for raising the combined NPP capacity to 100 million kW.

Since the MSM was a classified agency the government set up the State Committee of the USSR Council of Ministers on the Use of Nuclear Power (1956-65, also called the State Committee on Atomic Energy) for the purpose of legalization of all peaceful uses of nuclear power projects to making possible international cooperation in this area. In 1955 the MSM Minister Efim Slavsky drafted an Appeal of the Soviet Government to the East European Nations in which the USSR invited other countries for cooperation, exchange of expertise and construction of nuclear power plants (Kozlov 2001: 13, 19). This was a period of large scale international cooperation in nuclear engineering. In 1957–67 25 nuclear power units and equipment were built in the countries of Eastern Europe, Asia and Africa with the participation of the USSR, including 10 NPP reactors, 7 accelerators, 8 isotope and physical laboratories. These included the Rheinsberg NPP in the GDR (see GDR SCR), the Kozloduy NPP in Bulgaria (see Bulgaria SCR), the Loviisa NPP in Finland (see Finland SCR), the Ignalina NPP in Lithuania (see Lithuania SCR), the Paks NPP in Hungary (see Hungary SCR), and the Dukovany NPP in the Czech Republic. In addition to assistance in the design and construction of power plants, the USSR also guaranteed fuel supply for the whole period of the plant’s operation and the return of spent nuclear fuel. In cases when the country had its own natural uranium the USSR made nuclear fuel from the customer's ore.

From the time of the commissioning of the first Soviet NPP and until the Chernobyl accident, nuclear power in the USSR the industry brought the country's citizens great pride. Successes of Soviet nuclear power were discussed at government forums, in mass media, on the pages of popular periodicals, in fiction movies and documentaries. All publications about the nuclear industry were censored in order to protect the secret technologies, and allow only information carefully checked by highly qualified specialists to be made available to the general public. This representation of nuclear research shaped a positive image of both the industry itself and atomic scientists. In the Soviet discourse nuclear power was described as close by, easily available, safe and a vitally important source of energy for the Soviet people (Nikiforova 2010: 11). High authorities of the Soviet nuclear research and industry supported the people's confidence in the safety of the peaceful atom for the population and the environment. Information about "nuclear" accidents (e.g. the 1957 Kyshtym accident, see Event 2) was kept secret from society.

The prevailing mood was technocratic optimism - the general belief in harnessing nuclear energy, the positive-enthusiastic determination to achieve higher control over nature, its submission to human will, and the ultimate belief in the advanced nature of nuclear technologies. Thus the main actors in respect of nuclear power at this stage were the state, the researchers, the representatives of the nuclear industry, and mass media. The general public simply perceived the translated ideas from what can be described as a passive supporter standpoint.

Chernobyl (1986) (see Ukraine SCR and Event 3) became one of the most severe man-made disasters in history. It is believed that the Soviet leadership of that period made a wrong administrative decision on the transfer of the NPPs from the Ministry of Medium Machine-Building to Minenergo. This decision had two fatal consequences. First the transfer of the "peaceful atom" projects to Minenergo excluded academia from the decision making process. Second, the staff of Minenergo was not ready for supervising nuclear power plants operation and had no idea about nuclear safety, since until then it focused on entirely different problems.

The accident slowed down the development of the Russian nuclear power engineering sector, and in the 1990s the nuclear industry of Russia went through a period of stagnation. One of the consequences of the Chernobyl accident - a fear of the nuclear energy in general - proved to be the most persistent, and even more important than the immediate practical effects.

The sudden awareness of a huge potential danger of nuclear energy forced people to assume a more active attitude. The first 10-15 years following the Chernobyl accident manifested a period of increasing and active involvement of the Russian public in discussing issues of nuclear energy and nuclear industry affairs. During that period the media, the general public and the state became the leading actors in the nuclear energy problem field. The media under the effect of a precipitate liberation from the state censorship of the Soviet type took an offensive stance with regard to Russian nuclear power.

After the accident and until 1989 nuclear research and industry coverage in mass media was focused exclusively on the events of Chernobyl (Novikov et al. 2003: 330). Beginning from 1989 other radiation incidents, events related to nuclear explosions (both military and peaceful), and accidents (including the 1957 accident at Mayak chemical works) began to be disclosed. All discussions focused on humans within the context of environmental problems. Interests of the state, including ensuring energy supply security were completely left out from the discussions. Propaganda of the Russian nuclear research and technologies achievements practically disappeared from mass media coverage. The media in fact assumed a position of strong opposition to nuclear power. Expert knowledge (of scientists who represented the nuclear industry who were widely broadcast in the previous historical stage) in this communication model was replaced by pseudo-knowledge based on the use of myths and stereotypes that the media eagerly translated without attempting to maintain objectivity. "Nuclear" political discourse became dramatically expressive. Militant metaphors depicting nuclear power as an enemy dominated. Widely used metaphors included: the genie let out of the technological bottle; the devil in nuclear disguise; the radioactive bear killing us in its deadly embrace; and 'morbid' metaphors (a plague on the body of the Earth, the never healing wound, the societal heart attack, the bleeding consciousness, carcinoma on nature's living body, a tapped abscess) (Nikiforova 2010: 11, 16). As a result, rational views were far outweighed by the emotional perceptions that persisted in the public mind for the next twenty years.

In mass media and even in academic publications of the early 1990s many individuals believed that this credibility crisis helped form a negative attitude of the Russian population towards nuclear power. However, the opinion polls of that period give evidence of the fact that the Russians' attitude towards nuclear power engineering could not be described as expressly negative or even unambiguous in general. In 1989–92 a series of opinion polls was conducted in the regions where the existing NPPs were in operation and in the regions where NPP construction was planned (Ermakov, Sarkisov 1993). Average data from all regions demonstrated that the percentage of positively and negatively minded respondents with regard to nuclear power was almost equal - 28.5 and 29 % respectively. At the same time in the regions of planned NPP construction a greater number of people spoke of their negative attitude towards nuclear power (38%) compared to the regions in which facilities were already opertaing (20%). On average 19% of all respondents voted for the decommissioning of all NPP (22% in the regions of presence and 16% in the planned construction regions). Thirty percent of the respondents supported maintaining the existing number of NPPs, and 27 % supported the construction of new safe NPPs. However, in the regions of planned construction there were a few more supporters of building new safe NPPs than in the regions of presence (30% vs 24%). Thus in the planned construction regions the share of supporters of the new NPP construction was twice as high as the percentage of their decommissioning advocates. Over one half of the respondents noted the negative effects of NPPs on health and environment under normal operation conditions (52.5 %), about 80% of the respondents admitted fear of possible "nuclear" accidents. It may be said that in the popular mind nuclear power (as some abstract notion) appeared to be more dangerous than the specific plants (in this case NPPs).

During that period various national and regional anti-nuclear environmental NGOs mushroomed throughout country. They initiated protest movements and referendums against the use of nuclear energy. A series of this type of referendums in various cities of Russia was organized successfully in 1989-93.

At the institutional level the state also responded to the growing public concern with regard to the use of nuclear power. The main directions of activity of the state in matters of nuclear energy at this stage were to protect the prestige of the industry, uphold the values of atomic energy, and expand openness of information. Toward this end, in 1988 the government made a decision to establish the Interdepartmental Council on Information and Public Relations. The Council was made up of representatives from state committees for supervision of safety of work in industry and nuclear power engineering, committees on hydrometeorology, environmental protection, mass media, television and radio broadcasting, the USSR Academy of Sciences, the Ministries of Nuclear Power Engineering and Industry, Ministry of Healthcare, and so on. Its purpose was ensuring the transparency and raising public awareness about nuclear power engineering issues. The working body of the Council was the Public Information Center or the CNIIatominform[1]. The Center had regional offices in the territories of existing NPPs or at sites of ongoing construction projects. The

[1] This body was established in 1967 as the Central Research Institute of Information and Feasibility Studies in Nuclear Research and Power Engineering (CNIIatominform) of the Ministry of Medium Machine Building of the USSR. It was involved in the work on nuclear industry informatization. Since 1991 it has undergone several reorganizations.

Center commenced an active information and educational campaign via the central media, its own publication, the "Information Bulletin", participation in the production of popular science documentaries and TV programs, round table discussions and conferences, and public opinion surveys (Romanov 1990: 21-23). These projects were actively supported by specialists from the Kurchatov Nuclear Power Institute, the USSR Academy of Sciences, the MSU, IAEA, and so on. The state was seeking to move from the mere distribution of information to bilateral symmetrical communication, to reach understanding with the general public, and to balance the interests of the state and the society.

The interests of the state in these matters were supported by several newly formed pro-nuclear organizations (e.g. the Nuclear Society of Russia, 1989).

From the point of view of state interests nuclear power remained a priority industry, and it invested heavily in its further development. At the same time greater emphasis was made on ensuring nuclear and radiation safety, as well as the building of a positive image of nuclear power and nuclear industry companies.

For the purposes of fundamental research and independent analysis of nuclear and radiation safety issues a dedicated research unit was set up capable of providing expert support to the companies and organizations of nuclear industry, namely the Institute of Safe Nuclear Power Engineering Development Problems (1988)[2].

The Soviet nuclear ministry also underwent a series of reorganizations. In 1989 the Ministry of Medium Machine Building was merged with the Ministry of Atomic Energy into a single Ministry of Atomic Energy and Industry USSR. After the break up of the Soviet Union in 1992 it was reorganized into the Ministry of Atomic Energy (Minatom) with about 80 % of the companies of the former Soviet Union ministry, including 9 NPPs with 28 reactors. The Ministry existed under this name till 2004 when it became Rosatom. In its framework the concern "Rosenergoatom" was set up. It controlled the operation of all nuclear power plants from a single center.

[2] Today the Nuclear Safety Institute of the Russian Academy of Sciences (IBRAE), see official webpage: http://www.ibrae.ac.ru.

Minatom's public relations strategy was aimed at "maintaining adequate level of confidence in the actions of Rosatom and supporting high prestige of its companies" (Yakovlev 2004). During the first half of the 2000s this function was performed by the Communication with Authorities and Information Policy Administration. In the regions its work was based on public relations departments of Minatom's companies and organizations.

By the beginning of the 2000s the wave of anti-nuclear power referendums died out (including owing to procedural difficulties with their organization). However, public involvement during that period was manifested in the campaign against the import of spent nuclear fuel from other countries to Russia. (see Event 4). Environmental activists led several campaigns beginning in 2000-03 that helped to bring spent nuclear fuel and radioactive waste issues to public attention. Activists succeeded in mobilizing the public against allowing the import of foreign spent nuclear fuel (SNF) for money. In 2000 alone there were more than 40 protests in thirty cities (Nikiforov 2001; Katys 2001). In the history of relations between nuclear power and society in Russia this is the second clear example of truly massive anti-nuclear protests (after the referenda in the first half of the 1990s against the construction of nuclear power plants). This maintained the overall trend in Russia when a broad layer of the public expressed its opinion through opinion polls or put signatures on protest petitions, but did not participate in public demonstrations. Though the geography of meetings was quite wide they did not attract a large number of people; although exact numbers are impossible to protest. The range seems to be 30, 100, up to 300 individuals, and quite often a small number.

One of the most important events was a national referendum. On 25 July 2000 the initiative group of the "Yabloko" party registered an initiative for holding a national environmental referendum on nuclear waste treatment. Over a three-month period they collected roughly 2.5 million signatures (according to some estimates 2.8 million) in support of the referendum. However, the referendum was canceled because the Central Election Commission rejected about 600,000 signatures[3]. In

[3] The signatures were rejected on the grounds that the individuals who collected them while stating their place of residence failed to give the name of the region, their full address, or the passport number.

2001 another signature collection campaign was announced, but by the end of the year "Yabloko's" initiative died down[4].

The parliament eventually adopted the new law in spite of a massive public campaign that led over 90% of Russians to oppose the practice. Even if failing to prevent passage of the law, the campaign heightened public awareness of the unresolved problems of Russian nuclear industry that resulted in continued efforts to monitor the industry, its handling of wastes and spent fuel, and other related environmental and health hazards.

Twenty years after the Chernobyl accident a Russian national public opinion poll (100 communities in 44 federal administrative units and a total of 1,500 respondents) indicated that the percentage of those who believed in the benefits of nuclear power engineering for Russia was higher that the percentage of those who were inclined to think it conveyed more harm than benefits - 39% vs 25% (36% were undecided) (Vovk 2006: 21, 28). At the same time the survey demonstrated a difference between a rational (motivated) and the emotional perception of nuclear power engineering. Its associated perception based on diffuse feeling of threat and danger proved to be more negative than the rational understanding of its harm or benefits. Examples of negative associations with the words "nuclear power engineering" included among others: "those explosions and frightful consequences"; "death to all life"; "poisonous energy"; "mutants"; "dangerous energy"; "terrible evil"; "terror, fear". Only a quarter of the respondents demonstrated positive or neutral associations with the words "nuclear power engineering": "modern power engineering sector"; "civilized means of energy generation"; "cheap energy"; "great achievement of humanity"; "a breakthrough"; “progress in academic research". The image of nuclear power engineering deeply rooted in the minds of the Russian people by the mid-2000s was still characterized by a high degree of ambivalence: perception of deadly threat was mentioned alongside with the admission of its usefulness, necessity and advanced nature of this industry. According to the researchers (Dronishinets 2007: 95) the Russian public believed at the time that the nuclear power industry in Russia was being developed by the government and the power engineering companies unilaterally and lacked the necessary

[4] It is possible that the party's leadership discarded the initial idea since the new amendments to the Federal Law "On Referendums in the RF" proposed by the State Duma would have made the organization of a national referendum an impossible task.

transparency. This generated a lack of trust and general concerns with regard to the nuclear power engineering.

In 2004 by Decree of the President of the Russian Federation, the Ministry of Atomic Energy was reorganized into Rosatom (Federal Atomic Energy Agency), and in 2007 into the State Atomic Energy Corporation "Rosatom" under CEO - Sergei Kirienko. Since that time there has been a visible strengthening of the nuclear industry that indicate it has recovered significantly from the Chernobyl accident. This was the period of strengthening of government support for the industry, its development and recovery of its value in the public mind. The trend commonly referred to as the "nuclear renaissance" has becoming more and more pronounced. A large scale nuclear power development program was adopted. This led to a growth in all segments of the nuclear market from uranium mining to the construction of NPPs and engineering services market.

Rosatom has begun active construction of new power units both in the Russian Federation and abroad. During this period two power units at the Kalinin NPP, two more at the Rostov, and one at the Beloyarskaya NPP were commissioned. Two new power units at the Baltiyskaya NPP, two units at the Leningrad NPP, two - at the Novo-Voronezh, and two more at the Rostov NPP were built. Today the total installed capacity of 35 reactors at 10 Russian nuclear power plants is 26.2 GW; eight further power units are under construction. Russia is a global leader in the construction of nuclear power units abroad. Rosatom has signed contracts for the construction of 36 nuclear power units abroad - in Bangladesh, Belarus, Hungary, Vietnam, India, Iran, Turkey, Finland, and China.

Russia is a global leader in terms of breeder reactors on a closed fuel cycle projects. In the future this should raise the efficiency of both natural uranium and spent nuclear fuel use, and guarantee compliance with the 'Post-Fukushima' safety standards. As for PWRs, the flagship of Rosatom's energy solution is the evolutionary 3+ generation VVER-1200 reactor design.

Other Rosatom companies are crucial actors. Rosenergoatom is the second largest European nuclear power generation company after the French EDF, and the largest national power generation company[5]. One of Rosatom's subsidiaries is "TVEL Fuel Company" a global leader in fuel assemblies manufacturing. The company is a monopoly supplier of nuclear fuel to all nuclear

[5] Rosenergoatom website, http://www.rosenergoatom.ru/stations_projects/russian_nuclear.

power plants, research and marine reactors located in Russia. One sixth of all reactors in the world operate on fuel produced by this Company.

However, forecasts for a power development program from ten years ago proved to be far from reality. Rapid growth of energy consumption in Russia has not happened. Rosatom significantly reduced its construction program of nuclear power plants in Russia in recent years. Today, it sees its main task in the preservation of the existing nuclear power share in the energy mix that is to be achieved through the replacement of retiring nuclear power plants with new ones. The investment program of "Rosenergoatom" adjusted downward.

The newly-developed Energy Strategy of Russia until 2035[6] also considers nuclear power. According to it, NPP power must remain practically at the level reached - about 18%[7]. Management believes this level to be optimal (Lokshin 2016). In doing so the total installed NPP capacity must grow 1.3 times from 26 GW to almost 34 GW.

At the present stage Rosatom has continued its educational campaigns, promotion of the industry's companies, and emphasis of their environmental and technological safety[8]. Rosatom's Public Council was established in 2006[9]. It was set up in order to involve civic organizations in the policy making process for nuclear power utilization, environmental protection, nuclear and radiation safety. The Council is the public control consultative body. Its members are independent experts representing professional and academic associations and organizations, representatives of the federal and the regional non-government organizations, people from the nuclear industry and the Russian Federation Public Chamber. The Council has six offices in Sosnovy Bor, Zelenogorsk, Novouralsk, Zhelesnogorsk, Seversk, and Volgodonsk.

Compared to the turn of the 1980s and early 1990s, in the twenty-first century Russian media have moved away from the alarmist positions in their coverage of nuclear power engineering issues. At present environmental journalists take part in public hearings organized in the territories of nuclear

[6] "Draft Energy Strategy of Russia for the period until 2035," 77, Minenergo website, http://minenergo.gov.ru/node/1920.

[7] The share of nuclear power plants' generation in Russia was in 2015 about 18.6% of the total. At the same time in the European part of the country the share of nuclear power is as high as 30%, and in the North-West - 37 %.

[8] See, e.g.: Conference "Shaping of the Positive Public Opinion on Nuclear Power Engineering and Industry in Russia". 1-2 November, 2005, Moscow, accessed December 6, 2016, http://element114.narod.ru/01-02-11-05.html.

[9] See the official webpage of the Public Council: http://www.osatom.ru.

facilities placement, and participate in discussion of the environmental impact assessment projects. The semantic core of journalists' publications that may criticize the nuclear industry in general is still the risk potentially associated with the nuclear industrial facilities.

Throughout the second half of the 2000s Russians' attitude towards nuclear power engineering remained more or less unchanged, which was demonstrated by opinion polls conducted in 2006-09 conducted by the "Public Opinion" Foundation, the Russian Public Opinion Research Center, the independent research company "CIRCON"[10], and the non-government research organization "Levada Center" (Arefinkina, Melikhova 2010; Razvitie atomnoi energetiki… 2009). The survey data indicated that a plurality (39%) believe that nuclear power gave more benefits to the economy, while 25% of the respondents believe that the risks far outweigh the benefits. At the same time there was some trend towards the growth of the number of supporters of nuclear power as a means of electricity generation. Some Russian sociologists noted that these changes should not be treated as statistically meaningful. Most of the respondents were for the preservation of the existing NPP number (42%). The percentage of the new construction opponents was less than half of that number (19%). By the end of the first decade of the twenty-first century the experts noted that "there was a growth of social acceptability of nuclear power engineering in the country in general" (Razvitie atomnoi energetiki… 2009: 12). However, most of the respondents - over 60% - continued to be afraid of possible accidents.

The subject of nuclear power risks was always brought to the foreground in society in response to any crisis situations at nuclear facilities. Sometimes even insignificant incidents at NPPs were blown up to extreme dimensions. One example was an incident resulting in a shut down of the second power unit of the Balakovskaya NPP on 4 November 2004. It was a short-time shut down caused by a steam generator feed-water leakage. According to the information provided by the advisor to the head of the Ministry of Emergency Situations, Victor Beltsov, background radiation stayed within the normal limits. However some unknown individuals spread false information about radioactive contamination. The people hurried to protect themselves by any available means: e.g. taking drops of iodine dissolved in a glass of water. Because of the panic the price for a drop of iodine at the local markets went up to 10 rubles. To strengthen the effect some people took iodine with vodka,

[10] CIRCON - Center of Intellectual Resources and Cooperation in Social Sciences.

which also immediately disappeared from the local stores. Rumors about closing entrance to Balakovo and moving of "chemical troops" into the area made the population in the nearby cities start preparing for evacuation (Fedorinov 2004; Kabanov 2007). In order to normalize the situation the Rosatom head Sergei Kirienko visited the area in person to confirm the fact that background radiation had not been exceeded. A similar situation was repeated in 2007 in the Krasnodar region because of the rumors about the shut down of a power unit at the Volgodonsk NPP (Volkhonskii B., Enikolopov), in 2008 because of the false information about an accident at the Leningrad NPP[11], and in 2011 and 2014 – at the Rostov NPP. On the one hand, these events demonstrated how strong was the established stereotype belief that any incident at an NPP meant a radiation fallout accident. On the other hand, they show that trust in nuclear power industry has come back – precisely the official statements of the head of Rosatom Kirienko stopped panic over alleged radioactive contamination

In recent years the peak of Russians' negative perception of nuclear power was observed in 2011, the year of the Fukushima accident. At that time 40% of respondents in a national poll voted for phasing out or complete termination of nuclear power programs[12]. This outbreak of negative feelings towards nuclear energy became known as the "Fukushima syndrome". On this wave nuclear power engineering rose to the second position in the list of most serious threats to humanity (26%) after "environmental pollution and the associated global warming" (27%). The survey conducted by the Levada Center demonstrated that the majority of the respondents had the opinion that an accidenton the smae scale as Chernobyl could happen again (only 4% of the respondents were convinced this was practically impossible) (Solianskaia 2011).

[11] "Peterburzhtsy skupili iod v aptekah iz-za psevdoavarii na LAES" (Citizens of St. Petersburg Bought up all the iodine from pharmacies because of a pseudo-accident at the Leningrad NPP), accessed December 20, 2016, http://lenta.ru/news/2008/05/21/iodine; "Slukhi ob avarii na LAES. Rassledovanie" (Rumors about an accident at the Leningrad NPP. Investigation), accessed December 6, 2016, http://ria.ru/trend/...Leningrad...21052008/_currency_March_03032014.

[12] For comparison, in 2008 this number was only 15%. "Rossiiane podderzhivaiut sokhranenie i razvitie atomnoi energetiki" (Russians support nuclear power preservation and development)," Levada Center. Press release. 29 March 2013, accessed December 6, 2016, http://www.levada.ru/old/29-03-2013/rossiyane-podderzhivayut-sokhranenie-i-razvitie-atomnoi-energetiki.

Russian specialists believe that the "Fukushima syndrome" had a stronger effect on Europeans than on Russians[13]. In the following years public opinion in Russia quickly returned to its former perception of nuclear energy. In 2013 72% of the Russian country-wide survey respondents voted for active development or maintaining the existing levels of nuclear power[14]. At the end of the same year Rosatom published the results of the surveys conducted by an independent business research agency "Remarket" in the territories of NPP operation and the surrounding communities. According to these surveys in the Voronezh, Kursk, Leningrad, Murmansk, Sverdlovsk, and Tver regions 76% of the population supported nuclear power development, and in NPP satellite-towns (Novo-Voronezh, Kurchatov, Sosnovy Bor, Polyarnye Zory, Zarechny, Udomlya) this number reached 92% (Kholev 2014).

Over the past 30 years of "nuclear" transparency the attitude of Russian society towards nuclear power engineering has been markedly contradictory. Opinion polls demonstrated that respondents considered nuclear power as both dangerous and indispensable. Perception of a deadly threat was mentioned alongside belief in the usefulness and advanced nature of this industry. The duality of the attitude of Russian citizens towards nuclear power was characteristic not only for the public opinion in general, but also at the level of individual perceptions. However, fear of nuclear accidents was not the main factor influencing a negative attitude towards nuclear power. The respondents were no less concerned about the high background radiation levels resulting, they believed, from NPP operation and nuclear waste. These concerns were fed by a belief (resulting from insufficient information) that Russian NPPs did not comply with safety regulations and neglected technological protection measures. The percentage of those who opposed the very idea of the use of nuclear energy is rather small in Russia. Most of the respondents who are decidedly negatively minded about nuclear power engineering are prepared to admit its usefulness in principle, but they believe that the Russian specialists are not capable of "taming" the relevant risks.

[13] “The sociologists determined that the "post-Fukushima syndrome" was very short-lived in Russia”, *TASS,* 9 March 2012, accessed December 6, 2016, http://tass.ru/obschestvo/503684.

[14] “Russians support nuclear power engineering development”, Levada Center. Press release. 29 March 2013, accessed December 6, 2016, http://www.levada.ru/old/29-03-2013/rossiyane-podderzhivayut-sokhranenie-i-razvitie-atomnoi-energetiki.

Russian social scientists offer different explanations for this ambivalence of perceptions about nuclear power. Some of them see the reason as the fact that Russian opinions on this matter are not always based on logic (Vovk 2006; Dronishinets 2007: 94). The psychological basis of this irrationality may be the fear resulting from the absence of physical perception of immediate radiation effects that may contribute to exaggeration of radiation danger. The supporters of this view believe that public opinion with regard to nuclear power can not be defined by a simple dichotomy "safety" - "necessity". By adding the uneasiness factor to public opinion analysis we get a significant correlation between the extent of uneasiness and "approve/disapprove" responses with regard to nuclear power. When the respondents mentioned only the positive or only the negative aspects of nuclear power the negative attitude dominated, while when providing simultaneous consideration of all 'pros' and 'cons', then the positive attitude prevailed.

Another explanation of the ambivalent perception to nuclear power was entirely pragmatic[15]. This point of view was based on the fact that the nuclear agenda, alongside with other environmental problems, was not part of immediate or routine concerns or value orientations that influence the behavior of the majority of the population. More important for the Russian people were the issues of their material wealth. Global problems were of much less interest, particularly those which might or might not cause problems in some (fairly remote) future. Therefore in the abstract nuclear energy was perceived as dangerous, while the nuclear industry was considered to represent a reasonable and efficient method of power generation, and as a stable, fairly well paid, and as such quite attractive, employment. In 2015 Rosatom was listed as one of the top three most attractive employers in the Russian labor market[16]. Good judgment was for the people in Russia a lot more important than remote and hypothetical threats. The results of opinion polls invariably demonstrating that the longer an NPP was operating in the territory, and the closer to it the people actually lived, the more positive was their perception of nuclear power engineering gave good evidence in favor of this view.

[15] “The sociologists determined that ‘post-Fukushima syndrome’ was very short-lived in Russia”, *TASS,* 9 March 2012, accessed December 6, 2016, http://tass.ru/obschestvo/503684.

[16] Rossiiskoe atomnoe soobshchestvo, “Rosatom voshel v troyku luchshikh rabotodateley Rossii” (Rosatom was listed as one of the top three Russia’s best employers), accessed December 6, 2016, http://www.atomic-energy.ru/news/2016/02/19/63535.

The immediate objectives in building the relationship between the nuclear industry and society in Russia is the formation of partnership between the authorities – the entities directly involved in nuclear industry policy implementation – and environmental NGOs who are warily watching their actions. In the process of decision making with regard to nuclear power the government should develop new optimal communication models to inform the society of their plans, management decisions, and explain NPP and other facilities operational principles to involve the people as much as possible into the process of nuclear industry regulation.

1.3. Presentation of main actors

Name	Role	Actor Category
Stalin, Joseph	Leader of the USSR (end of 1920s – 1953)	Leader
Khrushchev, Nikita	Leader of the USSR (1953-1964)	Leader
Brezhnev, Leonid	Leader of the USSR (1964–1982)	Leader
Andropov, Iurii	Leader of the USSR (1982-1984)	Leader
Chernenko, Konstantin	Leader of the USSR (1984–1985)	Leader
Gorbachev, Mikhail	Leader of the USSR (1985-1991)	Leader
Yeltsin, Boris	President of Russia (1991–1999)	Leader
Putin, Vladimir	President of Russia, (2000–2008, 2012 – present) and prime minister (2008–2012)	Leader
Beria, Lavrenty	Administrative leader of the Soviet nuclear weapon program (1945–1953)	Promoter
Kurchatov, Igor	Nuclear physicist, scientific leader of the atomic program (1943–1960)	Promoter
Vannikov, Boris	Head of the first Main Adminisration (PGU) (1945–1953), acting minister of Minsredmash, (1956–1957)	Promoter
Malyshev Viacheslav	Minister of Minsredmash (1953–1955), deputy chair, Council of Ministers (1954–1955)	Promoter
Zaveniagin, Avraamii	Head of PGU (1953), deputy chair of Council of Ministers and Minister of Minsredmash (1955–1956)	Promoter
Pervukhin, Mikhail	First deputy chair of Council of Ministers, Minister of Minsredmash ((1957)	Promoter
Slavskii, Efim	Minister of Minsredmash (1957–1986)	Promoter

Riabev, Lev	Minister of Minsredmash (1986–1989)	Promoter
Konovalov, Vitalii	Minister of Atomic Energy and Industry (1989–1991)	Promoter
Nikepelov, Boris	Acting Minister of Atomic Energy and Industry (1991–1992)	Promoter
Mikhailov, Viktor	Minister of Russian Federation for Atomic Energy (1992–1998)	Promoter
Adamov, Evgenii	Minster of Russian Federation for Atomic Energy (1998–2001)	Promoter
Rumiantsev, Aleksandr	Minister of Russian Federation for Atomic Energy, head of Federal Agency for Atomic Energy (FAAE) (2001-2005)	Promoter
Kirienko, Sergei	Head FAAE (2005–2008), general director of Roastom, (2008 – present)	Promoter
Iavlinskii, Grigorii	Soviet and Russian politican, leader of the Yabloko party 1993-2008, head of the Yabloko fraction in the first, second and third parliaments of the Russian Federation. Initiator of anti-nuclear protests and corresponding amendments to state law.	Activist
Yablokov, Alexey Sc.D. (1966), corresponding member of RAS (1984).	Russian biologist, specialist in zoology and general ecology, social and political figure. State Counselor on Ecology and Public Health RSFSR (1991), Chair of the RF President Coordination Council on Environmental Policy and the State Counselor on Ecology and Public Health Policy (1992), Counselor to the President of the Russian Federation on Ecology and Public Health and the Chair of the RF President Council on Environmental Policy (1992-1993), Chair of Interagency Commission of the Security Council of the Russian Federation on Environmental Security (1993-1997). Founder and Co-Chair of Greenpeace USSR (1988–1991) Honorary member of GLOBE-International "Legislators for a Balanced Environment". Vice-President of the World Conservation Union Board. Chair of "Green Russia" faction of the Russian United Democratic Party "Yabloko" (from 2005). Head of the Nuclear and Radiation Safety Program of the International Social and Ecological Union.	Activist

Nikitin, Aleksandr	Chair of the Ecological Human RIghts Organization "Bellona"	Activist
Special Committee of the State Committee for Defense (GOKO, GKO)	Directed all projects for atomic energy 1945-53. After the abolishment of GKO in 1945, it was subordinated to the Council of Ministers.	Promoter
First Main Administration (PGU)	The organ in charge of the direct leadership of research, development and design organizations and industrial enterprises for the use of atomic energy of uranium and production of nuclear bombs (1945-1953)	Promoter & Regulator
Ministry of Middle Machine Building (MSM or MinSredMash)	The central organ of state administration of the USSR that carried out the functions of management of the atomic branch of industry and the production of nuclear weapons and munitions (1953–1962, 1965–1989)	Promoter & Regulator
Main Administration for the Use of Atomic Energy (in MSM)	The Office entrusted with the task of designing reactors for nuclear power plants and operation of nuclear power plants that were not included in the system of the USSR Ministry of power; the development of nuclear reactors, motors for ships, aircraft and other transportation needs; experimental stands for experimental engines; the organization of scientific research and experimental work to find new materials for the construction of nuclear reactors; and so on (1956–1960)	Promoter
State Committee of the Council of Ministers on the Use of Atomic Energy (GKUAE)	It was involved in the creation and development of the experimental base of research institutes and design bureaus and industrial enterprises for it (1960-1965)	Promoter
State Production Committee on Middle Machine Building of the USSR	In March 1963 Minsredmash was transformed into the State Committee for Production of Medium m Machine Building of the USSR, which in March 1965 was again renamed Minsredmash USSR (1963-1965)	Promoter, Regulator
Glavatomenergo -- VPO (All-Russian Industrial Association) of 'Soyuzatomenergo'	The Main Adminsitration for the Operation of Nuclear Power Stations was formed within the Ministry of Energy (1966-1976). On the basis of Glavatomenergo was form the All-Russian Industrial Assocation "Soyuzatomenergy" (1976-1986). They were combined to solve two main tasks: to provide electricity and perform the	Promoter

	functions of the customer for the construction of nuclear power plants.	
Ministry of Atomic Energy of the USSR (MAE)	All existing NPPS or those under construction, and design, commissioning , maintenance and other organizations to carry out orders for nuclear power were transferred into this Ministry (1986–1989).	Promoter
Ministry of Atomic Energy and Industry of the USSR (MAEP)	Created on the basis of Minsredmash and Ministry of Atomic Energy (1989-1992).	Promoter
Ministry of the Russian Federation for Atomic Energy (Minatom)	Established on the basis of MAEP USSR. The federal executive body that carried out state policy in the field of development, production and utilization of nuclear weapons and munitions, and nuclear energy, and was responsible for administraiton of nuclear energy (1992-2004).	Promoter
Federal Agency for Atomic Energy (FAAE)	Formed on the basis of the abolished Ministry of Atomic Energy, this federal organ of executive power realized the functions of the administration of the atomic branch of industry of Russia (2004-2007)	Promoter
State Corporation for Atomic Energy 'Rosatom'	Rosatom brings together about 400 companies and research organizations, including all civilian companies, enterprises of the nuclear weapons complex, research organizations and the world's only nuclear-powered icebreaker fleet (2007 – present)	Promoter
Concern 'Rosenergoatom'	The state enterprise 'Russian State Concern for the Production of Electricity and Thermal Energy at Atomic Stations' (1992-2001)	Promoter
'Rosenergoatom', Federal State Unitary Enterprise (FGUP)	The state enterprise 'Rosenergoatom' was transformed into the generating company (FGUP) 'Rosenergoatom' by means of bringing together under its umbrella all existing and under construction nuclear power plants, as well as enterprises that ensure their operation and scientific and technical support. In addition to the functions of the operating organization, the company can independently enter the market for electricity and make sales of electricity from NPPs to solvent customers (2002–2008)	Promoter

'Atomenergoprom', AO	Nuclear power holding company established in 2007 to consolidate over 80 of ROSATOM's civilian facilities operating in all segments of the nuclear fuel cycle (from uranium extraction to NPP construction and power generation)	Promoter
Energoatom, OAO	The concern 'Rosenergoatom' was transformed into a publicly traded stock company the 'concern Energoatom' with the transfer of 100% of stocks into the concern 'Atomenergoatom' (2008–2009)	Promoter
Rosenergoatom, OAO	A Russian company for the production of electrical and thermal energy at atomic power companies, a newly formed public stock company (2009–2015)	Promoter
Rosenergoatom, AO	Power generating company (2015 – present)	Promoter
Rostekhnadzor	Federal Service for Environmental, Technological and Atomic Inspection is the authorized organ of state regulation for safety for nuclear power (2004 – present). Earlier it was Gosatomenergonadzor USSR (1983), Gospromatomenergonadzor USSR (1989), and Gosatomnadzor of the Russian Republic and then Russian Federation (1991)	Regulator
Atomic Reactor Research Institute, Dimitrovgrad	Reactor material science, physics, technology, irradiation technology, safety of atomic reactors, radiochemistry and fuel cycles, radionuclide sources and tracers (from 1955)	Promoter
Bochvar National Research Institute for Inorganic Materials, Moscow	A leading R&D institute, a subsidiary of TVEL Fuel Company, focused on the development and application of composite materials and alloys (including superconducting, high-melting, rare earth and ultra-pure materials)	Promoter
Dollezhal Research and Development Institute of Power Engineering	A major Russian research center established in 1952 to develop reactor technologies and automation systems, concentrates research efforts on reactor physics, thermal physics, hydrodynamics, material engineering, nuclear safety, reactor core optimization, life cycle extension and nuclear decommissioning	Promoter
Karpov Institute of Physical Chemistry, Moscow	Research and development institute established in 1918 to provide expertise in surface chemistry, adsorption, atomization, electrode	Promoter

	processes, corrosion protection, chemical kinetics and catalysis, radiation chemistry and high molecular weight compounds	
NIKIMT Atomstroi (Scientific Research – NII – and Design Institute of Assembly Technology), Moscow	Development and application of installation, maintenance, diagnostic and dismantling technologies for nuclear facilities with a focus on innovation; dismantlement of decommissioned nuclear facilities and construction of new infrastructure for nuclear decommissioning	Promoter
OKB Gidropress, Podolsk	Engineering company with 65+ years' expertise in design and development of VVER reactors, nuclear steam generators and heat exchangers for fast-neutron reactors; its track record includes design of 66 VVER reactors, 49 of them abroad	Promoter
Russian Institute of Precise Chemistry Technology (VNIIHT), Moscow)	Founded in 1951 for raw materials research on nuclear pure metals	Promoter
Russian Research and Development Institute for Nuclear Power Machinery, Moscow	Design and development of power machinery for conventional and nuclear power plants and special-purpose machinery for other industries since 1977	Promoter
Russian Research Institute for Chemical Technology, Moscow	Design and development of uranium and pure metal production technologies since 1951 (ore processing, development of construction materials for the nuclear industry, production of ultra-pure gases for microelectronics and alternative power sources)	Promoter
Russian Research Institute for Experimental Physics, Sarov	One of the two national Federal Nuclear Centers engaged in both military and civilian projects in a variety of fundamental and applied fields (safety and reliability of Russian nuclear weapons, theoretical and mathematical physics, gas dynamics, explosion physics, nuclear and radiation physics, lasers, high density energy, beam physics, and so on)	Promoter
VNIPIpromtechnologii - National Research and Design Institute for Industrial Technology, Moscow	Leading design and research institute specializing in end-to-end design engineering of uranium mining and processing facilities; to be reorganized into an engineering center of ARMZ Uranium Holding	Promoter

Zababakhin Russian Research Institute for Technical Physics, Snezhensk	One of the two national Federal Nuclear Centers engaged in both military and civilian research projects in a variety of fundamental and applied fields (material science, thermonuclear fusion, plasma physics, nuclear safety, nuclear materials management, computer modeling, etc.)	Promoter
Kurchatov Institute National Research Centre, Moscow	Established in 1943 as Laboratory No. 2 of the USSR Academy of Sciences, Kurchatov was tasked with the development of nuclear weapons. Since the 1950s, the Institute also has worked on peaceful nuclear energy technologies.	Promoter
Leipunsky Institute of Physics and Power Engineering, Obninsk	IPPE was established in May 1946 to develop nuclear power technology. The world's first nuclear power plant, AM-1, was commissioned at IPPE on 27 June 1954. The Institute also developed fast breeder reactors, research reactors, space reactors, and naval lead-bismuth liquid metal reactors.	Promoter
The Obninsk Nuclear Power Plant	The first nuclear power station in the USSR and in the world	
Production Group «Mayak», Ozersk	One of the largest enterprises in the world for plutonium production and processing and the site of the Kyshtym disaster in 1957.	Promoter
“TVEL” TK	Combines production and research assets in the field of nuclear fuel fabrication, separation-sublimation complex, as well as the manufacture of gas centrifuges and equipment for them (1996 –present)	Promoter
RosRAO, Moscow	Management of radioactive waste and ionizing radiation sources, including transportation, collection, processing and storage, site rehabilitation, decommissioning of nuclear submarines, radioactive substance and radioactive waste control and accounting activities; operates through two subsidiaries – SevRAO in Ostrovnoy, Murmansk Region, and DalRAO in Vladivostok, Primorsky Krai	Promoter
Tekhsnabexport (TENEX), Moscow	TENEX exports enriched uranium product and uranium conversion and/or enrichment services provided by Russian nuclear industry companies to all of the world’s key geographic markets.	Promoter

	Joint Stock Company TENEX is one of the world's major suppliers of the NFC front end products, which provides a significant share of the uranium enrichment services required for western type nuclear reactors. The Company which has 100% of its share capital owned by JSC Atomenergoprom is managed by ROSATOM's Corporate Development and International Business unit	
Russian United Democratic Party "Yabloko"	Russian left-of-center party, in 1993-2007 the anti-nuclear opposition in the Parliament (Duma), the initiator of a number of anti-nuclear protests and amendments into law. It actively cooperates with environmental organizations.	Receptor
Nuclear Society of USSR/Russia	A pro-nuclear independent self-governing non-profit organization. Until the mid 1990s, when a collective membership was practiced, this organization's membership consisted of about 100 companies or almost 4,000 people. At present according to the organization's data its membership is about 2,000 individual members.	Promoter
Public Information Center of the CNIIatominform	The informational and education organ of Minsredmash and Minatom	Promoter
Nuclear Energy Information Centers	17 multi-functional information & educational and propaganda Centers of Rosatom	Promoter
Public Council of Rosatom	The public control consultative body of Rosatom. It was set up in order to involve civic organizations in the policy-making process for nuclear power utilization, environmental protection, nuclear and radiation safety. Its members are independent experts representing professional and academic associations and organizations, representatives of the federal and the regional non-government organizations, nuclear industry and the Russian Federation Public Chamber.	Receptor
Institute of Nuclear Safety of RAS (IBRAE)	Basic research and independent analysis of nuclear and radiation safety	Promoter
Russian branch of the International Greenpeace	International NGO	Receptor
Russian branch of the Bellona Foundation	International NGO	Receptor

The Greens, Russian Ecology Party	The only political party of Russia with an environmental focus. Regional organizations in 70 different regions have been registered with over 25,000 members.	Receptor
International Social and Ecological Union	An international NGO created in the USSR in 1998 which has more than 10,000 members in 19 countries of Europe, Asia, and North America. The initiator and organization of many anti-nuclear protests in the country.	Receptor
EcoDefense! (Ekozashchita!)	NGO, initiator and organization of many anti-nuclear protests in the country.	Receptor
Others environmental NGOs in Russia	Other NGOs; in 2016 there are almost 300 such NGOs in Russia.	Receptor

2. Showcase "Planeta Nadezhd (Planet of Hopes)". Regional level of anti-nuclear protest.

This case focusing on the regional level is quite indicative in several respects. First, it demonstrates the breaking of the Soviet tradition of suppressing information about radiation incidents and possible nuclear energy related hazards using the example of 1957 Kyshtym accident (see event 2). In discussing "nuclear" issues the state turned towards civil society. Various groups of society (representatives of the government authorities, nuclear engineering professionals, ecologists, human rights activists, journalists, and the general public) participated in discussing these issues in the early 1990s. This was the most productive period from the point of view of social mobilization. The social-nuclear activism grew beyond the limits of the specific Kyshtym accident and began to address wider problems of nuclear power's effect on the people and the environment. This social involvement contributed to the adoption of the first statutory law regulating social support and benefits for the people exposed to radiation as a result of 1957 accident; it also caused suspension of the South-Ural NPP construction project. The quoted results of the regional opinion polls demonstrated the characteristic for an ambivalent attitude towards everything "nuclear" including nuclear power engineering: on the one hand the fear of nuclear accidents, and on the other - general acceptance of nuclear power engineering as priority necessary energy supply source. Another consequence of the social activism of the 1990s was the emergence of the first non-government ecological (anti-nuclear) organizations and movements. A case study of one of such regional organizations – "Planeta Nadezhd (Planet of Hopes)" – demonstrated the range of the addressed problems, the limits within which the environmental-legal NGOs were allowed to operate, and the traditionally strong in Russia regulatory role of the state.

It was only in July 1989 that the facts of the accident at Kyshtym were officially admitted by the USSR Supreme Soviet (Riabev 1998). On 30 July of the same year the Inter-departmental Council for Information and Public Relations in the field of atomic energy published a special bulletin "On 29 September 1957 Accident in the South Ural".

Public disclosure of the very fact of the Ural accident triggered a contentious debate involving the general public, the representatives of central and local authorities, and professional community -

experts in nuclear power engineering and technology, radiation ecology, medicine, and so on. "Nuclear" problems were used as political arguments in the election campaigns of 1990. During the same period the first environmental associations were established: The Democratic "Green" Party, the movement "For nuclear safety", the Association "Kyshtym - 57", the Chelyabinsk "Green" Association, and others.

The authorities were flooded with petitions from the people living in the contaminated territories. The people demanded the same status as the victims of the Chernobyl accident that would have automatically made them eligible for the same package of government benefits and compensations. Almost 40 years after the accident in 1993 the first government act aimed at reducing tensions among the people living in the contaminated territories was adopted. This was the law of the Russian Federation "On Social Protection of The People Exposed to the Radiation Effects Due to the 1957 Accident at Production Group 'Mayak' and the Discharge of Radioactive Waste into the Techa River".

After the disclosure of the 1957 accident, the Russian mass media made frequent references to this subject (Novikov et al. 2003: 328-345). Quite often in the attempts to attract bigger audiences unverified information of a sensational nature was used. "Not far from Kyshtym a secret nuclear weapons manufacturing plant exploded [and] killed more people than the Chernobyl disaster," wrote 'Komsomolskaya Pravda' (Komsomolskaia Pravda, 8 June 1997). 'Trud' newpaper echoed, "This was an experiment involving testing of radiation effects on people in natural environment" (Pisanov 1997: 5). The "Voenno-Istorichesky Zhurnal" (Military history magazine) called the accident the "Chelyabinsk Chernobyl" (Sysoev 1993: 38-43). Replication of various myths and fantasies about the event whipped up tensions and contributed to the spread of radiophobia.

In 1994 the Institute of Economics of the Ural branch of RAS organized the first opinion poll in the territories of the East Urals Radioactive Trace focusing on the associated social problems. Over seventy-four percent of the survey participants said they were definitely dissatisfied with their life (71 % of them were the 1957 accident 'liquidators'). 51.6 % - had a feeling of anxiety with regard to their future, and 23.3 % – of hopelessness. More than half of the participants (51.6 %) believed that the state was in debt to the radiation accident victims (Analiz sotsial’no-economicheskogo razvitiia… 1995; Otchet o sotsialno-economicheskoi reabilitatsii… 1996).

The data of other opinion polls of the general public and the non-government organizations conducted in the mid 1990s evidenced that over 70% of the exposed territories' population believed that the nuclear facilities operations had a negative effect on the environment, 80% were convinced in the possibility of repeated radiation accidents at the "Mayak" facility (Akleev et al. 1997: 22).

Russian researchers (Tolstikov 1998: 243) involved in the study of the social and psychological consequences of radiation effects on the population came to a conclusion that radioactive contamination was perceived as more serious than any other type of environmental pollution. The reasons appeared to lie in the lack of verifiable information and a lack of general understanding of the effects of radiation, hence the inability of the population to develop an adequate adaptive behavior. Radiation effects appeared frightening and strange since their disturbing impacts were not immediately felt by the people, nor could they be controlled. In a situation when information about radiation effects was controversial, scarce, or lacking, understanding was replaced by mythological concepts, exaggerations or distorted representation of hazards that contributed to the development of radiophobia.

The formation of this phobia in Russia at the turn of the 1980s-1990s resulted in strong opposition to any new nuclear projects, particularly in the construction of the South-Ural NPP. The decision for the construction of the South-Ural NPP was made in 1984 by a Resolution of the USSR Council of Ministers. After the break-up of the USSR, financing was terminated, and construction ceased. For more detail on opposition to resuming the construction see (Penyagin 1991). Broad publicity given in Russia to the Chernobyl and Kyshtym accidents (as well as other incidents at "Mayak") brought about wide involvement of the general public in making decisions about the construction of this NPP. In 1991 a referendum was organized in Chelyabinsk, where 76% of the participants voted against the construction of the South-Ural NPP (Kozlova 1998: 105), and as a result the project was frozen.[17] A reverse effect of radiophobia was the psychological habituation of the local population to radioactivity. People fished, planted vegetable gardens in "contaminated" areas, or used them as pastures.

[17] Recently, the South-Ural NPP was included in the 2020 general plan of new power generation facilities to be constructed in the Russian Federation. It is slated for 40 km northwest of Chelyabinsk not far from Ozersk. The planned NPP will consist of three power units with BN-1200 reactors.

By the mid 2000s regional public opinion with regard to nuclear power changed and became more dispassionate. This was confirmed by a public opinion poll in the Chelyabinsk region. It was conducted in 2006 by the Laboratory of Applied Political Science and Sociology of the Chelyabinsk Institute of the Ural Civil Service Academy (Zyryanova 2007). Only 40% of respondents living in the contaminated by radioactivity territories considered nuclear industry sites hazardous facilities (cf. 59% of the respondents in Chelyabinsk). The survey indicated a dependence of the depth of perception of nuclear threat on the respondents' professional occupation. Nuclear industry companies were rated as the highest hazard to the environment by the representatives of NGOs of ethnic cultures (76.5 %). A minimum hazard rating was given to nuclear industry enterprises by the military-patriotic education organizations experts (38.9 %). Over one half of the respondents from the contaminated territories noted that the direct effect of "Mayak" works on the region's ecology was insignificant (every third respondent - 33.3 %) or was not felt at all (every fifth one - 20.0 %). And, finally, 26.7 % of the respondents from the contaminated territories believed that the problem of man-made radiation contamination was non-existent for the population of the Chelyabinsk region, and felt that this problem was simply "blown up by the media".

At the same time over one half of the respondents from the contaminated territories named nuclear power engineering as the priority source of energy for the economic development of the Chelyabinsk region. In spite of this, 61.1 % of the 2006 survey respondents in the Chelyabinsk region continued opposing the construction of the South-Ural NPP.

Russian specialists (sociologists and philosophers among them) identified three possible reasons explaining the apparent loyalty to nuclear power engineering in the territories exposed to nuclear contamination. The first one (generally believed to be the least plausible) was corporate: a number of respondents were professionally involved with the nuclear industry companies. This gave reason to assume that they were concerned about their *esprit de corps*. The second reason was psychological: it was impossible to live and work normally in the immediate proximity to potential and real sources of radioactive contamination being constantly aware of and scared by them. Threats of this type are extremely traumatic to the mind (according to Zigmund Freud) and as such are normally suppressed. The third reason was the availability of information: opinions depended on different levels of the respondents' awareness about the subject of the survey. Thus the adequate perception of reality was transformed into an attitude that supported ordinary life of the people without exposure to a continuous stress caused by fear of radiation.

Even if the protest movement related to Kyshtym disaster became much less powerful in the 2000s, some of the activists and organizations continued their struggle to provide support to the victims. Thus, in 2000, an Ozersk resident Nadezhda Kutepova, created an environmental NGO "Planeta Nadezhd (Planet of Hopes)" with the aim to defend the rights of the Kyshtym accident's victims and of those affected by "Mayak"'s radioactive waste dumps into the Techa River.

Nadezhda Kutepova was born in 1972 in Ozersk. Her grandmother and her father worked at "Mayak". Kutepova graduated from the department of political science and sociology of the Ural State University, studied at the law department of the Ural State Law Academy. As the leader of the environmental organization Kutepova was a member of the Rosatom working group created to address the problems of the population living in the zone of influence of "Mayak" (2006). She was invited to a group dedicated to elaborate new legislation regulating Rosatom "closed cities" (the so-called "closed administrative-territorial formations" related to sensitive military production or research facilities such as Ozersk-Mayak). Kutepova was also a candidate for the State Duma elections from the party "Yabloko", known in Russia in the mid-2000s for its important "environmental" component, as well as advisor to the Commissioner for Human Rights of the Chelyabinsk region (Ponomareva 2007; Kriuchkova 2016).

Nadezhda Kutepova initiated a number of proceedings in the Chelyabinsk regional court to protect the rights of the liquidators of the 1957 accident as well as the rights of their descendants. These cases received wide publicity in the region. Some of the defended victims were the so-called "fetal liquidators"[18] - children of mothers who took part in the emergency operations after the Kyshtym disaster while pregnant. The organization also insisted on isolation of the Techa River from people and environment, on the creation of a sanitary protection zone with proper radioactive waste storage, and on the resettlement of the people from nearby villages. Another important focus of "Planet of Hopes" activity was a struggle for recognition of the cause-and-effect relationship between diseases and radiation exposure of citizens following the 1957 accident and radioactive

[18] According to the NGO "Ecodefense!" about 2,000 pregnant women participated in the liquidation of the accident at "Mayak." This figure is based not on documents, but "Ecodefense"! estimates.

waste dumps into the Techa River, for the establishment of the diagnosis of "chronic radiation sickness" for people who live in contaminated areas or lived there before[19]. The organization, which only had 5 members, had been surprisingly active dealing with a number of very important issues and "high-profile" cases.

The Federal Law of the RF № 121-FZ "O vnesenii izmenenii v otdelnye zakonodatel’nye akty Rossiiskoi Federatsii v chasti regulirovaniia deiatel’nosti nekommercheskikh organizatsii, vypolniaiushchikh funktsii inostrannogo agenta" (On Amendments to Certain Legislative Acts of the Russian Federation in terms of regulating the activities of non-profit organizations that perform functions of a foreign agent) was accepted on 20 July 2012. It entered into force on 21 November 2012. The term 'nonprofit organization functioning as a foreign agent' applies to a Russian nonprofit organization receiving financing and other assets from foreign sources and participating, including in the interests of such foreign sources, in political life and activities in the territory of the Russian Federation.

In 2015, in accordance with this federal law on “foreign agents”, "Planet of Hopes" has been designated by the Ministry of Justice of Russia as a non-profit organization that performs the functions of such an agent. The Ministry of Justice justified this designation by the fact that the organization obtained funding from the National Endowment for Democracy (NED, USA), the Dutch organization "Women in Europe for a Common Future", the Norwegian Bellona, and other western human rights and environmental funds, and that “Planet of Hopes” organized policy-oriented public events in order to create public opinion. The Ministry of Justice sent an official protocol to the Ozersk magistrate court stating that the environmental organization "Planet of Hopes" failed to register as a foreign agent and demanded sanctions in the form of a fine for administrative offense, which was then awarded by the court as an outcome of judicial process. Having received the text of the court ruling stating that the activity of organization "Planet of Hopes" was in conflict with security interests of the RF the organization's leader Kutepova made a decision to liquidate the organization. This event received a wide coverage in the regional printed media and on television. The national TV channel "Rossia" produced a five-minute report on the subject, thus raising the incident to the

[19] Such people generally do not suffer from cancer, but the presence of chromosomal aberrations suggests that they have a chronic radiation syndrome, which leads to the appearance of five to twenty one different human diseases.

national level. Nadezhda Kutepova interpreted the situation as a case of personal persecution[20] by the authorities for her environmental and human rights activism, and in July 2015 left the country for France where she applied for political asylum (Vendik 2016; Kriuchkova 2016).

According to Alexei Sevastyanov, the Chelyabinsk region Human Rights Ombudsman in 2010-2015, prosecution was unlikely. “There is no interest from the law enforcement agencies – her organisation did receive foreign financing, and in a closed town it was thoroughly inspected, so if there had been any questions, they would have been asked by now,” said Sevastyanov[21].

[20] The term 'foreign agent' does have a rather strong negative connotation in the Russian language. In the popular mind this term is associated with such words as "espionage" and "treason against the Motherland" the roots of which, apparently go back to the discourse of Stalinist repressions of the late 1930s.

[21] Human rights activist forced to flee Russia following TV 'witch-hunt', accessed December 6, 2016, https://www.theguardian.com/world/2015/oct/20/russia-activist-flee-nuclear-tv-witch-hunt.

3. Events

The selected events demonstrate the dynamics of the evolution of relationships with regard to nuclear industry between the two principal actors in the Russian environment - the state and the people, and chronologically represent the entire range of different epochs in the Russian history. Their choice was warranted by the following reasons.

The first event opened the peaceful atomic era for humanity - this was the commissioning of the first nuclear power plant not just in the USSR/Russia, but in the world, which came into existence largely as one of the side effects of the Soviet nuclear weapons project. The case vividly demonstrates how deeply the interests of science, industry and politics have been intertwined in the very fact of its existence, which is still true for the Russian nuclear industry.

The second case is focused on the first negative experience of human involvement with the nuclear energy in Russia. The Kyshtym accident of 1957 still remains the largest man-made radiation accident. This case demonstrates the Soviet era suppression of undesirable information (specifically about the radiation hazards) and how the interests and safety of society were a lower priority than technological advancement. Here we may observe the strategies of both the government authorities' and ordinary people's actions in an emergency situation.

The third case is built around the Chernobyl accident - an event the analysis of which is unavoidable in any discussion of the relations between society and nuclear energy in the twentieth century. In Russia this tragic event became a catalyst of wide public involvement in discussing general nuclear energy problems, the emergence of the first anti-nuclear/environmental organizations and movements, and organization of the first anti-nuclear referendums. At the same time it demonstrated the deeply-rooted strong support of nuclear industry development plans in Russia that was manifested not only by the government, but also by the general public.

The fourth case deals with the campaign against import and storage of spent nuclear fuel and radioactive waste. It demonstrates the rejection of this idea by a significant part of the Russian population, the variations and scale of the respective public protest actions. This case offers probably the first example of a split within the ranks of the authorities on the issue of supporting a government decision in the nuclear sphere in Russian history.

The last case referring to the period beginning with the incorporation of "Rosatom" is a review of the current trends in the evolution of relationship between the nuclear industry and society in Russia. On the part of Rosatom this is the search for new forms of contacts with the society and social impact aimed at building up the positive image of the industry. On the part of the anti-nuclear organizations - this is going away from radicalism and provocative actions in favor of searching for the ways of cooperation with the nuclear industry.

On the whole all these cases demonstrate the priority role of nuclear energy and nuclear engineering as an industry in Russia, the decisive role of the state in "nuclear" issues, and the relatively weak public involvement which had its peaks but tended to subside eventually.

3.1. Event 1: Start-up of the first nuclear power station in the USSR in Obninsk, 1954

On June 27, 1954, in Obninsk, Kaluga region, researchers in the Leipunskii Institute of Physics and Power Engineering (Laboratory "B") started the first nuclear power station in the Soviet Union (and the world). It was equipped with a uranium-graphite channel reactor with water coolant called AM-1 (AM meaning "mirnyi atom" or "peaceful atom") with a capacity of 5 MW. By producing the first industrial electric current Obninsk nuclear power plant opened the way for the peaceful uses of nuclear energy.

The start-up the first commercial nuclear power station was for the USSR not only a great achievement of science and industry, but a matter of national importance, woven into the political discourse. These three components - science, industry and politics - appeared in the first official communication about the launch of the Obninsk Nuclear Power Plant by Soviet news agency TASS. The report which was published on the front page of the main Soviet newspaper "Pravda" in the section "In the USSR Council of Ministers" stated: "Owing to the efforts of scientists and engineers, the design and construction of the first industrial atomic energy-powered plant of useful capacity of 5,000 kilowatts were successfully completed in the Soviet Union. On June 27 a nuclear power plant was put into operation and provided electricity for industry and agriculture of the surrounding areas" (Pravda 1954: 1).

From that moment on and for decades to come, the state, scientists (as a source of authoritative opinion), representatives of the nuclear energy industry and media became the main actors in relation to nuclear energy. The start-up of the first nuclear power plant marked the beginning of the development of an active "atomic" discourse in the USSR. Public communication focused on the achievements of the Soviet nuclear power industry described in newspapers, magazines, popular science books, and in films. The existing censorship with regard to publications on nuclear themes aimed at preserving secret technical data and at broadcasting only the information that had been previously verified by highly qualified specialists. That is why on the national level selected science journalists were "accredited" to write on nuclear topics.

One can identify several main themes in the Soviet public discourse on the Obninsk nuclear power plant. First, the station became an object of state pride confirming the superiority of the Soviet regime. The new industry was described as a quickly growing nuclear child born in the close-knit family of Soviet peoples thanks to the care of the founding fathers. It was important for the government to emphasize Soviet "nuclear" successes in comparison with foreign achievements. Newspapers published numerous TASS reports on the reactions of the world community to the news about the launch of the nuclear power in the Soviet Union. The reports emphasized the international significance of the event, the high evaluation of the work of the Soviet scientists, and the absolute leadership of the Soviet Union in the construction and commissioning of NPPs. For example, the Soviet media repeatedly pointed out the time period (2 - 2.5 years) that was needed before nuclear power plants abroad (in the USA or United Kingdom) could be brought on-line.

Second, along with an explanation of how an NPP operated, public communications insisted on the advantages in their use: "Consuming less than two tons of nuclear fuel a year, a nuclear power plant may have a capacity equal to the capacity of the Kuibyshev hydroelectric station which is the greatest in the world" or "the use of nuclear energy will provide an unprecedented growth of industry and agriculture and help to achieve the abundance of life goods." The newspapers reported that the country had all the necessary scientific and industrial potential to solve such problems. Nuclear power plants were presented as the only way to heat the huge country where two-thirds of the population lived and worked in cold climate conditions. Nuclear scientists and engineers sought to convince their audiences that nuclear energy, converted into electricity and heat, would make it possible to create a comfortable environment for people living even in the polar regions. They insisted that nuclear power plants supplying heat and electricity to the population were very cheap. After nuclear technology had been fully mastered the cost of NPP construction would be several million dollars, and the operating costs would be equal to the costs of maintenance of hydropower plants. They could serve people for decades, without harming the environment. Official narratives used a metaphor comparing nuclear reactor to a conventional furnace or oven, no more dangerous than a Tula samovar (the traditional Russian tea-kettle). It emphasized that the main advantage of the NPPs was that they allowed new industries to be built even in northern regions, making their products competitive because of lower costs. Indeed, the significant costs of heat and electricity were one of the factors reducing the competitiveness of the Soviet production on the world markets.

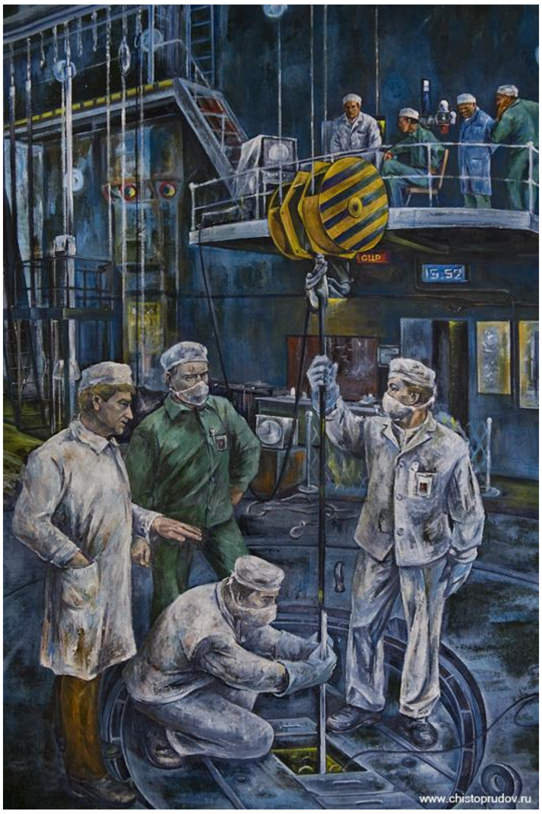
The euphoria from the successful start-up and operation of "the world's first nuclear power plant" served as a foundation for the optimistic plans: from the fast creation of "light boilers for nuclear automobiles" to interplanetary travel. Even scientists inspired by the triumph of reason and "the expansion of the frontiers of knowledge" associated with the nuclear achievments felt compelled to make far-fetched projections of nuclear energy uses. A scientific popular article published in "Ogonek" by the physicist Professor Alexander Kitaigorodskii prophesied the use of atomic energy for "the reconstruction of entire regions of our planet" - greening the deserts, moving mountains, easing the Arctic climate, correcting the outlines of the continents (Kitaigorodskii 1954: 26).

And finally, the Obninsk Nuclear Power Plant, as the embodiment of the Soviet peaceful nuclear energy program, was used to promote a peace-loving policy ("USSR - the initiator of the use of atomic energy for peaceful purposes"). It was a symbol of the technological achievements of Socialism and of the popularization of nuclear energy. Already in 1955 at the First International Conference on Peaceful Uses of Atomic Energy in Geneva, the Director of Physics and Power Engineering Institute, Dmitry Blokhintsev, presented a report on the creation of the first nuclear power plant in the world and on the results of its operation.

Soon after the start-up, the station, which was previously a secret closed site, became open for visitors, including foreigners. Jawaharlal Nehru, Indira Gandhi, Sukarno, Walter Ulbricht, Kim Il-Sung, Josip Broz Tito, Frédéric Joliot-Curie, Glenn Seaborg, Francis Perrin, Sigvard Eklund and other political and public figures and scientists. In total for the first 20 years of Obninsk NPP was visited by about 60,000 people.

Soviet citizens perceived Obninsk NPP through the lenses of the political and popular science discourses, accepting and sharing its values and the value of nuclear energy. Visual representations were also important to ensure public enthusiasm related to the launch of the first nuclear power plant. For example, on postage stamps:

or in paintings:



Representations of nuclear energy and, specifically, of nuclear power plants, that became common in the USSR after the launch of the first NPP in Obninsk, contributed to create a positive image of both the industry and the nuclear scientists. In Soviet discourse nuclear power appeared as a familiar, affordable, safe and vital resource for Soviet people (Nikiforova 2010: 11). The high prestige of the Soviet atomic science and industry supported the public's belief in the safety of the peaceful uses of the nuclear energy for the population and the environment. A technocratic optimism prevailed: a belief in the possibility to harness the atom, positively enthusiastic attitude towards strengthening power of people over nature, their ability to subjugate nature to their will, the belief in the progressive character of nuclear technologies. The public in this situation was in the position of a passive supporter of nuclear energy.

3.2. Event 2: Kyshtym disaster, 1957

On 29 September 1957 a major radiation accident occurred at the chemical combine "Mayak" (Chelyabinsk-40, today - Ozersk, the Chelyabinsk region). Since the town, in which the company was located was "secret" and "closed", the accident became to be known as the "Kyshtym" one, by the name of the nearest town marked on maps. Under the International Nuclear and Radiological Event Scale (INES) it was a level '6' (out of 7 possible) accident, i.e. a serious accident with consequences requiring implementation of planned countermeasures for local radiation protection of the population. This was the largest radiation release in the territory of the USSR/Russia.

The accident was caused by a failed cooling system. As a result a tank containing about 70-80 tons of liquid waste exploded. The explosion released over 20 million curies of radioactivity into the atmosphere. The contaminated territory is commonly referred to as the East Urals Radioactive Trace (VURS). It spread out covering almost 20,000 sq. km. including the Chelyabinsk, Sverdlovsk, Kurgan, and part of the Tyumen regions. However, only 2 million curies were carried over the region of the VURS, while 18 million curies (90%) settled around the production site of "Mayak", in the territories of the local fire department and military unit, and a prison camp (Tolstikov 1998: 163).

An initial estimate of radioactive contamination was made 12 hours after the explosion. On 30 September the evacuation of military personnel and prisoners began, everyone was subject to decontamination and issued clean clothes. On the third day after the accident a commission of the Ministry of Medium Machine-Building Industry (MSM) arrived from Moscow. The Minister Efim Slavsky headed it. From its composition (Novoselov, Tolstokov 1997: 94) it was apparent that the accident was believed to be of the departmental, and not of the national scale. Two central Ministries (of MSM and of Healthcare), as well as the Works itself and local authorities were put in charge of liquidation of the accident's consequences.

Sanitation teams made up of the company and military personnel were employed to work at the contaminated "Mayak" facilities. On average up to 10,000 people were involved in the initial post-accident remediation works at the "Mayak" production sites[22]. They worked without days off in three shifts. A maximum permissible radiation doze was established for remediation team members: not more than 25 Rem over the whole period of the works. However, quite often these limits were exceeded, since the medical and radiation control rules were not complied with (particularly with regard to the military personnel). As a result over 30,000 of the company's employees, construction workers, and military personnel received radiation doses in excess of the 25 Rem limit[23]. At the same time there were numerous instances when overexposure was a result of ignorance and neglecting the safety and hygiene rules, as well as bravado or laziness.

The residential area of the town was much less affected by radiation than the production sites and populated areas covered by EURT. An important factor was the favorable location of the town with regard to prevailing winds and the chemical works location. Nonetheless within 24 hours after the accident the gamma-ray radiation background in the town increased 40 times. To clean the area the streets and transport vehicles were washed daily and residential houses were examined for contamination. In public places (canteens, public bathhouses, shops) radiation gauges were installed. If they registered intensive radiation background the contaminated facility was closed to service.

The accident was widely discussed by the population (in the streets, in department stores, markets, and so on) creating all kinds of rumors and panic. The latter was mostly caused by limited verifiable

[22] Gruppa fondov nauchno-tekhnicheskoi dokumentatsii Proizvodstvennogo Ob”edineniia "Maiak" (hereinafter GF NTD POM). (The Group of PO Mayak Research and technical Documentation Funds), f. 15, op. 1, d. 124, l. 135.

[23] Arkhiv Iuzhno-Uralskogo Upravleniia Stroitel’stva (South-Ural Construction Administration Archive), f. 62, op. 3, d. 10, l. 19.

information about the accident and very vague understanding of radioactivity by the general public. Markedly it was the least informed group of the population that was most susceptible to panic: people who did not work at "Mayak" or members of support staff (cleaners, storekeepers, and so on)[24]. In the absence of sufficient information people were frightened by the remediation team members who walked around with radiation gages, entered houses and apartments and declared that certain things were unfit for further use. Contaminated clothes items were not taken away, people had to dispose of them on their own (Chernetskaya 2007: 193). Many thought it a waste to throw such items away. The people began to sell such clothes to second-hand shops, and at flea markets. In order to stop this practice the local authorities banned sales of manufactured goods at the markets, and re-checked all goods in second-hand shops with radiation counters[25].

A growing number of people wished to retire from the chemical works. Most of them frequently claimed reasons for retirement of low pay and the impossibility to continue working because of poor health (people even collected all kinds of medical evidence to prove this). In rare instances the people openly gave high radiation background as a reason to quit[26]. The accident undermined labor discipline and public order. There were instances when the employees refused to pay their fares on public transport. They claimed that given the exposure and the level of hazard they were no longer obliged to pay[27]. Some people insisted on being given a permit to leave the town. "They just grab me by the throat demanding to let them go!" - wrote one of the local CPSU Committee officials[28]. Others tried to escape from the town thatwas surrounded by barbed wire and strictly guarded. Failing to get a permit to leave many parents tried at least to send children away to their relatives living in other places.

The management of the combine and the town's officials were at first at a loss not knowing what could be done to improve the psychological climate. The recipes included "kicking the panic mongers' teeth in", "driving out such cowards from the town in shame", or, vice versa, "command

[24] Ob"edinennyi Gosudarstvennyi Arkhiv Cheliabinskoi Oblasti (hereafter OGAChO) (United State Archives of the Chelyabinsk oblast), f. 2983, op. 1, d. 6, l. 88.

[25] GF NTD POM, f. 11, op. 30, d. 885, ll. 8-9, 90.

[26] OGAChO, f. 2983, op. 1, d. 6, l. 59.

[27] Ibid., l. 52.

[28] Ibid., l. 59.

them to stay" reminding them of the special trust granted them by the Party and the Government[29]. Finally a decision was made to overcome the "crowdphobia" and explain the situation to the people without going into technical details[30].

Fairly soon life in Ozersk came back to normal. This influenced the state of mind of those people who, succumbing to panic, managed to leave the town. Many of them tried to get back, writing letters to the town's CPSU Committee and the security department: "I acted like a fool, let me back in"[31].

In 1957 the population of the East-Ural Radioactive Trace territory was almost 270,000 people, 10,000 of them in the area with the radioactive contamination density of approximately 2 curies per sq. km. and 2,100 people - with the density of 100 curies per sq. km. (Nikipelov et al. 1989: 75). The most heavily affected areas were the small villages in the immediate proximity to the site of the accident. In Berdyanish village located 12.5 km from the explosion epicenter the effective dose reached 400 μR/sec, in Satlykovo village (18 km away) - 300 μR/sec, and in Galikayevo (23 km from the epicenter) - 170 μR/sec (Tolstikov 1998: 166). Domestic animals, food products, water sources, houses and clothes were exposed to strong contamination with radionuclides. Evacuation of the population from the most contaminated villages started on the 7th – the tenth day after the explosion. Domestic animals and birds were slaughtered. Houses and farm buildings were destroyed, the remains were buried in trenches. All this had a very depressing effect on the local population, who were unwilling to leave their homes, all their belongings and a familiar way of life behind.

The USSR Council of Ministers compelled the MSM to build two-to-three bedroom houses for each of the relocated families, They were entitled for some compensation for the lost property and two year tax benefits (e.g. agricultural tax exemption). However, the local authorities did not hurry to obey these orders. "We've been exposed to nuclear poisoning as a result of some accident in closed town Chelyabinsk-40. Many of us suffer from diseases, and now we are left without any compensation and are kept waiting. We do not know what we are waiting for, we could…perish,"

[29] Ibid., ll. 21, 89, 90.

[30] Ibid., l. 26.

[31] Ibid., l. 89.

complained the people to Nikita Khrushchev[32]. Only in the summer of 1958 after a difficult winter did the residents of the first four relocated villages receive new homes in a summer recreation center and in hastily built frame houses. The same year evacuation from other nearby villages continued. In total over 10,000 people were evacuated from 24 villages of the Chelyabinsk and the Sverdlovsk regions (Tolstikov 1998: 193). Almost 60,000 hectares of land were removed from commercial turnover, 55% of which were agricultural (Zyryanova 2007: 6). Two hundred million rubles was spent on relocation, various compensations and benefits - in those days a tremendous amount. The funds were allocated by the Government, while the specific expense articles were determined by the "Mayak" management and the executive committees of the regional Soviets of the People's Deputies.

After a resolution of the RSFSR Council of Ministers a 700 sq. km sanitary-protection zone with a special security regime was established in 1959. The lands within this territory were declared unsuitable for agriculture. However the boundaries of this territory were regularly trespassed. There were instances when even the restricted territory's guards made hay there, fished, and sold contaminated construction materials.

Information about the accident was not supposed to leak outside the "system" (military-nuclear complex). The general public and mass media were not allowed even to know about the very fact of the explosion. All "liquidators" and evacuated villagers were made to sign letters of non-disclosure and protection of state secret information. This secrecy was maintained till the late 1980s.

3.3. Event 3: The Chernobyl accident (1986) and anti- and pro-nuclear public mobilization (late 1980s- 1990s).

The accident at the fourth power unit of the Chernobyl NPP on 25 April 1986 resulted in the release of a significant amount of radioactive elements into the atmosphere and a long-term contamination of huge territory. The number of 'liquidators' from six republics of the USSR only in 1986 exceeded 300,000, of which 87,722 people were from Russia[33]. In addition to the liquidators there were

[32] GF NTD POM, f. 1, op. 30 v, d. 2, l. 118.

[33] As at 1 March 2011 the Russian State Medico-Dosimetry Register listed 194,333 liquidators of which 39,798 persons (20.5 %) died over the period of 25 years. The most common cause of death was chronic coronary disease (4.4 %) (Shoigu, Bolshov 2011: 57, 152).

507,000 of the local population exposed to the radiation effects (data of 2011). At the same time in 1986 only 186 people from four communities in the Bryansk region were evacuated from the radiation zone.

The fission products and radionuclide fallout occurred mainly within the nearest 30km to the accident site. The most heavily affected areas in the territory of Russia included the Bryansk, Kaluga, Orel, and Tula regions[34]. Increased radioactive contamination levels changed the conditions of life of the local population. The negative social and economic effects of the accident were most significantly manifested in the agricultural sector. In the most heavily affected regions of Russia over 2 million hectares of agricultural lands (about 1% of all agricultural lands in the country) suffered 137Cs radioactive contamination levels over 2 curie per square kilometer (37 kBq/m2). Radioactive contamination of over 1.2 million hectares of forests in Russia resulted in upsetting established forest management practices. There were disruptions in the timber market and a general drop of market turnover, outflow of specialists and qualified labor. In all contaminated territories of Russia various kinds of popular self-discipline were observed - people spent less time in the open air, reduced the personal livestock and poultry population, grew less potatoes, fruit and vegetables, used less locally produced food products, etc.

The Chernobyl accident had a shock effect on the general public in the USSR (Kroz et al. 1993: 65). The late 1980s and early 1990s can definitely be described as the period of anti-nuclear environmental activism in the Russian society. During this time national and regional antinuclear NGOs and associations emerged (in most cases as part of the wider environmental movements and organizations). According to some estimates during 1990–1992 there were over 10,000 environmental NGOs in Russia[35]. The most well known of them were the Russian branch of the International Greenpeace[36], the Russian branch of the Bellona Foundation, political party "Green Russia", national Russian NGO "Green Patrol", the Civil United Green Alternative Movement, the

[34] Maps-diagrams of the territories of Russia contaminated as a result of the Chernobyl accident (Shoigu, Bolshov 2011: 34-35).

[35] Green Russia faction of the Russian United Democratic party Yabloko, “Iabloko Fraktsiia Zelionaia Rossiia” (Yabloko’s Faction Green Russia), accessed December 6, 2016, http://rus-green.ru/about.

[36] For more information about these organizations see their individual websites, for example: http://www.greenpeace.org/russia/ru, http://bellona.ru, http://rus-green.ru, http://greenpatrol.ru/ru, http://www.green-cross.ru.

Russian Green Cross, and others (Golbreikh 2008; Dudnikova, Fedorov 2013). The best known regional organizations included: The Movement for Nuclear Safety (Chelyabinsk), the Environmental Law Center (Tomsk), the Civil Nuclear Nonproliferation Center (Krasnoyarsk), People for Nuclear Safety (Saratov), Scientists of Siberia for Global Responsibility (Novosibirsk), Planet of Hopes (Ozersk), Nature and Youth (Murmansk), Green World (the Leningrad region), the Environmental Coalition (St. Petersburg), EcoDefense! Kaliningrad,[37] and many others (Kofanova, Krotov 1992). Until 2007 the main opponents to many laws and resolutions in support of the nuclear industry development were the representatives of "Yabloko"; the anti-nuclear appeal was one of the main slogans of their election campaign.

The period of 1989 to 1993 was marked by a series of the first ecological referendums triggered in part by concerns related to Chernobyl's impact. The wave of protest rallies in the North and South Urals, the Far East, in Karelia and the central part of Russia resulted in "anti-nuclear" referendums. The most significant protests were in the Komi Republic (1989), Voronezh (1990), Cheliabinsk (1991), Kostroma region (1992 and 1993), Saratov region (1993), Khabarovsk region (1989-1993) (Vorob'ev 2004). Before 1996, five such referenda took place in different regions of Russia, all of which were directed against the construction of nuclear power plants. In all cases, the vast majority of the population voted against the construction of new and expansion of existing nuclear power plants. The results of these referenda were implemented.

After 1996 the authorities started to revise the results of the "anti-nuclear" referendums. Such a precedent was created with regard to Kostroma regional referendum (1996), in which 87.4% of voters who participated voted against resuming construction of an NPP in the Kostroma region (Neznamova 1997). In 1998-1999, the legality of the referendum was contested in the provincial and supreme courts of the Russian Federation; its results were overturned. Despite the fact that in 2000 the Kostroma Regional Duma vetoed the construction of nuclear power plants in the region, the veto was overturned in 2007.[38] Another trend of the government's actions in relation to the anti-

[37] For more information about these organizations see their individual websites, for example: www.nuclearpolicy.ru, http://www.greenworld.org.ru, http://ecodefense.ru.

[38] "Kostromskaia AES, Buiskaia atomnaia stantsiia" (Kostroma NPP, Bui nuclear station), accessed December 6, 2016, http://www.region44.ru/razdel/articles2/one_articles2.php?id=310. At present the Kostroma AES has the status of "planned for construction": "Tsentralnaia AES Rossii – Kostromskaia AES (Buiskaia)" (Central Russian NPP – Kostroma (Bui) NPP), accessed December 6, 2016, http://miraes.ru/kostromskaya-aes-buyskaya-tsentralnaya-aes-rossii.

nuclear referenda became the tightening of the referenda procedures, which ultimately led to their failure. In some cases, authorities refused to register the initiative group or challenged in court the validity of the referendum questions. For example, attempts to hold a new nuclear referenda in Rostov (1998-2000) and Tambov regions (2002) were unsuccessful; all initiative groups were denied registration.

The employees of the nuclear industry and the advocates of further development and use of nuclear power engineering believed in the need to counter the storm of negative information to which the general public became exposed as a result of the Chernobyl accident. Pro-nuclear organizations were set up to counterbalance the anti-nuclear NGOs. They saw their goal in restoring nuclear scientists' prestige and promoting further development of the safe use of nuclear power. One of the first organizations of this type was the USSR Nuclear Society established on 17 April 1989. It was later reorganized into the Nuclear Society of Russia which positions itself as a "creative, independent self-governing non-profit organization, a voluntary association of scientists, experts in production, operation and management, university faculty members and students in Russia and other countries specializing in the area of nuclear power application, nuclear research and related disciplines, and their popularization, as well as non-government stakeholders"[39]. Until the mid-1990s, when collective membership was practiced, this organization's membership consisted of about 100 companies or almost 4,000 people. At present, according to the organization's data, its membership is about 2,000 individual members. It has an extended structure embracing 9 regional and interregional branches, several topical divisions and sections (e.g. youth branch[40], or "Women and Nuclear Power" section[41]), as well as primary organizations. In various periods of its existence the Nuclear Society of Russia had partnership relations with over 20 foreign nuclear societies and organizations, including the WANO, WNA, IAEA, and so on.

[39] See the official webpage of the organization: http://nsrus.ru.

[40] "Young Generation and the Future of Nuclear Society", Obninsk, 30 November 2015, accessed December 6, 2016, http://nsrus.ru/meroprijatija/20-ja-ezhegodnaja-konferencija-mo-jaor/obschaya-informatsia/obschaya-informatsia.html.

[41] Panel "Women and Nuclear Energy" in the Russian Nuclear Society. Round table discussion "People. Society. Nature". Role of Women in the Formation of Positive Attitude towards Nuclear Technologies". Moscow, 24 October 2013, accessed December 6, 2016, http://wuor.ru/index.php?route=record/blog&blog_id=6_17.

3.4. Event 4: Anti-nuclear campaign against the import of the foreign spent nuclear fuel into Russia, 2000-2003

On 10 July 2001, President Putin signed the law that would allow the import of irradiated SNF into Russia for "technical storage" and "reprocessing." The events leading up to the passage of the law and its signature led to prolonged and active opposition and public demonstrations for several years.

Environmentalists called this law a "crime of Atomic Energy in collusion with foreign nuclear industry against the people of this country. This is an international nuclear mafia. The project would harm national security," they argued (Katys 2001). The atomic lobby contended that radioactive waste is not dangerous and that advanced processing technologies would generate significant profits. And they both saw in each other's intentions greed in receiving money from abroad. Supporters of the import of waste were charged of the pursuit of super-profits for "turning the country into a nuclear dump or nuclear graveyard". Their opponents claimed they were "receiving funding from foreign environmental funds" in a latent attempt to weaken the power of the country by discrediting, in this case, the nuclear industry. Both sides conducted an information war denouncing the arguments and actions of the other side. [42]

A characteristic feature of the debate of import of SNF was the fact that the power of the state did not act as a united pro-nuclear power as it generally had before. The governor of the Kemerovo region, Aman Tuleyev, called the adoption of the law on SNF a national disgrace, and his Nizhny Novgorod colleague, Mikhail Prusak, called it an ammoral act. About 20 regional legislative assemblies sent the State Duma votes expressing their disappoval of the law. For example, Sverdlovsk City Council announced its intention to appeal to the Constitutional Court with a request to recognize these laws unconstitutional. The “Yabloko" and Union of Right Forces political parties in the Duma also opposed the legislation.[43] The leader of the "Yabloko" Party Grigory Yavlinsky,

[42] See, for example: *Iadernaia energetika Rossii: neizvestoe ob izvestnom* (Nuclear Energetics of Russia: The Unknown About the Well-known), Moscow: Sovet Grinpis, 2003, accessed December 6, 2016, http://greendiplom.ru/Yadernaya-ehnergetika-Rossii-neizvestnoe-ob.html. The response of the opposing party: G. Kaurov, “Ocherednaia 'Pravda' Grinipis” (Another 'Truth' of Greenpeace), accessed December 6, 2016, http://greenpeace.narod.ru/kaurov01.htm.

[43] On the positions and activities of “Yabloko” on the question of import of SNF, see: http://www.yabloko.ru/Themes/Nuclear.

considering the import of waste an "ecological catastrophe, delayed by 5-10 years," tried to organize an all-Russian environmental referendum in the country. There were several such attempts and they were all unsuccessful (Vorob'ev 2004).

A significant portion of the Russian population was in opposition to this idea. Various public opinion polls conducted in 2000-2002 showed that the percentage opposing importation was from 81 to 93% of respondents (Denisovskii et al. 2003: 53; Münchmeyer 2003: 122-128; Sliviak, Diehl 2005: 2). Members of environmental organizations entered the streets of Nizhny Novgorod, Saratov, Tomsk, Volgograd, Chelyabinsk, Samara, Moscow, Yekaterinburg , Irkutsk and other cities. People came out with banners “Shame on the Duma which cannot think, "I do not want mutant children ", Russia is not a nuclear dump ", "No nuclear burial ground in Russia", and "Be active so as not to be radioactive!”

Protests in various forms took place throughout 2001. For example, on May 29, 2001, in St. Petersburg, at the Museum of Soil Science scores of activists gathered in an extraordinary conference of youth organizations in St. Petersburg and Leningrad Region to protest the proposed importation. The conference, organized by Greenpeace Russia, the Youth League of St. Petersburg, "Children of the Baltic” and others was attended by 30 civil society organizations, representing more than 23,000 young people in St. Petersburg and Leningrad region. Also in May 2001, the environmental movement "Rainbow Keepers" held a theatrical performance entitled "Homeland for Sale" at the building of the State Duma to protest the decision of deputies effectively to transform “Russia into the global nuclear dump.” All of the performance showed Russia for sale to foreign powers, depicted as “slave owners" in gas masks. Police arrived to harass the demonstrators in spite of the calm demeanor of the Rainbow Keepers. Not all protests were effective. For example, a rally in Irkutsk was able to collect only 69 signatures, an anti-nuclear picket in Kostroma was attended by about 100 people.

A protest rally at the State Duma of the Russian Federation in Moscow on 19 February 2002 was held by the Socio-Ecological Union, “Ecodefence!" and "Yabloko". The rally was attended by about 200 participants, including representatives of various political parties and ecological movements from 10 regions of Russia. After the protest the "greens" and representatives of "Yabloko” held a press conference to explain why the Russian people and several politicians oppose the "nuclear" amendments.

A spectacular protest action entitled "Nuclear waste is crawling to the Kremlin" was held on April 25, 2002, on the eve of the 16th anniversary of the Chernobyl accident. The organizers were Ecodefence!, the International Socio-ecological Union, and Youth Human Rights Action. More than thirty people (from Voronezh, Kaliningrad, Yekaterinburg, Orel, Ryazan, Vladimir and Ozersk) in white jumpsuits with signs of radiation danger lay on the cobblestones of Red Square and crawled to the Spassky Gate (Novozhilova 2002; Podosenova 2002). They symbolized the nuclear waste, indicating that even behind the Kremlin walls you cannot save yourself from radioactivity. The protest was not authorized, however, and the protesters were arrested by the police although in the evening of the same day all the detainees were released.

In November 2003, in 25 cities across the country theater protests against the deputies who voted to permit the import of nuclear waste were carried out. (The protests were timed for the next elections to the Russian parliament.) In St. Petersburg, “Death” walked through the streets in braids and black robes to explain to voters what the import of SNF meant, and how it was potentially dangerous. In Voronezh, in the headquarters of the "United Russia" party environmental activists handed out medals "for the most nuclear party in the State Duma.” Environmentalists published the names of deputies who secured passage of laws on the import of nuclear waste from abroad and urged Russians to boycott the pro-nuclear parties and individual deputies in the next elections (Katys 2003).

“Ecodefence!" pushed the November 25 demonstrations as an appeal to civil society to mobilize against the Duma’s approval to import 20,000 tons of SNF. Thirty non-governmental environmental and human rights organizations, including Greenpeace Russia, "Keepers of the Rainbow", Militia of Nature Protection of Tatarstan, "In the Name of Life", and others urged the deputies to repeal the law. Pickets gathered with signs and collected petitions to remove those deputies from office in more than 20 cities - Moscow, Kazan, Vladimir, Voronezh, Kaliningrad, Yekaterinburg, Novgorod, Nizhny Novgorod, Ryazan, Izhevsk, Rostov-on-Don, Stavropol, Vladivostok, Apatity, Orel, Saratov, Syktyvkar, St. Petersburg, Kamensk-Uralsk, Chelyabinsk, Ozersk and Krasnoyarsk.

In March 2006, the Russian Democratic Party "Yabloko" under party leader G. A. Yavlinsky repeated its categorical opposition to importation of radioactive waste, on the eve of the arrival of the next train from Gronau, Germany, with hundreds of tons of uranium tailings. Yabloko noted that “it is clear that Western companies pay [Russia]…not so much for the ‘pre-enrichment’, as for the opportunity to get rid of their own radioactive waste.” Yabloko critized the safety of the containers, the risk of terrorism, and their transit through populated areas amongst other risks.

However import continues, and the state has neutralized protest. Russia commercially imports, temporarily stores, reprocesses, and repatriates SNF only, but the exact quantities have been difficult to determine. Russia has contacted Switzerland, Germany, Spain, South Korea, Taiwan, and Japan about these imports. The US controls about 80% of the SNF in the world, so it will have some say about whether to permit the imports. Spent fuel from Soviet-era reactors, including from Ukraine, has been imported. Many people worry about the status of Russian facilities, their safety, and their capacity to import SNF.[44]

In the Russian Federation radioactive waste management is the responsibility of a specialized company - the Federal State Unitary Enterprise "Radioactive Waste Management Operator RosRAO", as well as the Northern Radioactive Waste Management Operator (SevRAO) and the Far East Radioactive Waste Management Operator (DalRAO). All these entities are part of the nuclear and radiation safety system of SC "Rosatom".

Radioactive waste management is regulated by the following documents: Federal Laws "On Radioactive Waste Management" and "On Ratification of The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management", sanitary rules and

[44] Among the sources consulted for this section were: https://www.newkaliningrad.ru/news/community/199-.html; http://www.seu.ru/svodka/189.htm; https://newsru.com/russia/11jul2001/protiv.html; http://www.partinform.ru/lenta/230301.htm; http://www.iephb.nw.ru/econews/2001/206.htm; http://www.qsl.net/ua9agr/197.htm; http://www.new-garbage.com/?id=4829&page=28&part=2#.V4qGXTkrKu4; http://bellona.ru/2001/12/13/vvoz-otrabotavshego-yadernogo-topliva/; http://www.yabloko.ru/Themes/Nuclear/; http://www.yabloko.ru/Publ/Atom/atom00101.html; https://www.newkaliningrad.ru/news/community/199-.html; and http://saint-petersburg.ru/m/spb/old/65386.

regulations ("Radiation Safety Standards-99/2009", "Basic Sanitary Rules for Radiation Safety-99/2010", and "Sanitary Rules for Radiation Waste Management-2002")[45].

3.5. Event 5: Creation of Rosatom: new forms of communication and public engagement, late 2000s-2010s

In 2007 under a Decree of the President of the Russian Federation the State Atomic Energy Corporation "Rosatom" under CEO Sergei Kirienko was created. The state is clearly oriented towards the development of the nuclear power generation industry. This is one of its priorities in the twenty-first century. The state is trying to restore the capabilities of the industry, lost during the reorganization of the national economy, in both the domestic and the export markets. The industry is positioned as part of national wealth as a company that employs cutting-edge and research-intensive technologies.

Industry officials and advocates of nuclear power engineering see its competitive advantages in the use of cutting-edge technology, the availability of a significant raw material base, qualified labor, relatively low operational costs, and stable economic growth of the industry. Moreover, its advocates believe that nuclear power engineering demonstrates environmental attractiveness (given the high level of safety standards) (Asmolov 2006).

Rosatom's public relations strategy was aimed at "maintaining adequate level of confidence in the actions of Rosatom and supporting high prestige of its companies" (Iakovlev 2004). Information of the population about Rosatom’s activities and the formation of the positive image of the Russian nuclear industry in society is the responsibility of the Communications Department of Rosatom. Rosatom's Public Council was set up in order to involve civic organizations in the policy making process. Seventeen multi-functional Rosatom Nuclear Energy Information Centers operate in the regions with either existing nuclear industry facilities or new construction projects[46]. The target audience for these centers are high school and undergraduate students; guided tours and popular

[45] Nuclear Safety Institute of the Russian Academy of Sciences website, http://www.russianatom.ru/enterprises/waste_management.

[46] Informatsionnyi tsentr atomnoi otrasli (Nuclear energy Information Center), “Ob organizatsii” (About the organization), accessed December 6, 2016, http://www.myatom.ru/about_company_ano.

education programs have been developed primarily with this audience in mind (e.g. "The World of Nuclear Power Engineering", "Safe Nuclear Waste Management in Russia", "The Nuclear Icebreaker Fleet"), as well as interactive games and quizzes. The visitors to the centers, including adult audiences, are invited to participate in various educational, popular science and social projects: round table discussions and conferences, public lectures by researchers, meetings with nuclear industry representatives, and experimental laboratories. In 2010 this project received the PIME (Public Information Materials Exchange) Award[47] for Communications Excellence from the European Nuclear Society as the best communication project in the nuclear industry. The first overseas information centers on nuclear energy were opened in December of 2012 in Hanoi (the Socialist Republic of Vietnam) and Mersin (Turkey). In 2013 another overseas information center was opened in Dhaka (Bangladesh), in 2014 – in Istanbul (Turkey), and in 2015 – in Minsk (Belarus).

The anti-nuclear movements in Russia today are also changing their tactics. Radicalism, provocation and populism are gradually disappearing from the environmental agenda (Kuksin 2015: 251). For instance, the Bellona Foundation defines its current position on the Russian-language website as follows: "We prefer to address the painful environmental issues by means of discussing them with the political leaders and representatives of the business community - this cooperation is a lot more efficient in achieving constructive results than the spectacular actions".[48] The reason for the change in tactics may have much to do with new laws that restrict NGOs and protests and set new standards for webpages.

Major environmental NGOs with significant financial resources and expert potential (e.g. WWF, Greenpeace, Bellona), environmental associations (the International Social and Ecological Union[49], the Green League[50], and so on), individual small environmental organizations (up to 300 non-profit organizations), and situational environmental groups continue their activities. Over the past five years there has been an apparent trend towards cooperation with regard to nuclear power

[47] The organizers of the award are International Atomic Energy Agency, European Nuclear Society and European nuclear forum FORATOM; the award is granted for the most creative communications strategy and the use of innovative tools of communication.

[48] "Znakomstvo s 'Bellonoi'" (Introducing Bellona), accessed December 6, 2016, http://bellona.ru/intro_to_bellona.

[49] See the official webpage of the organization: http://www.seu.ru.

[50] See the official webpage of the organization: http://green-union.org.

engineering on the part of the government authorities, the representatives of the industry (mainly the Rosatom), and the non-government environmental organizations. The position of the authorities and the nuclear industry was formulated by Sergei Kirienko at the VI International Forum-Dialog "Nuclear Energy, Society, Security" (St. Petersburg, April 19-20, 2011): "Either we learn to communicate and work together with the public, or nuclear power engineering has no future." In their turn many of the radically minded environmental and anti-nuclear organizations and movements in Russia have made a choice in favor of dialog with the nuclear industry and the authorities. For instance, the well known opponent to nuclear power, A. V. Yablokov, addressing the IX International Forum-Dialog "Nuclear Energy, Society, Security" (Moscow, April 10-11, 2014) called for "armed cooperation with Rosatom" (Yablokov 2014: 5). The public activist wanted to say that the NGOs were "armed" with the widely established in society understanding of hazards associated with the nuclear technologies as well as independent specialists' expert opinions. "Nuclear technologies will not disappear and would even develop in this or that direction," agreed the Chairman of the Board of Bellona Alexander Nikitin. "Therefore it was necessary to continue looking for opportunities of cooperation between nuclear industry and society, and spare no efforts for the development of strategies promoting such cooperation" (Nikitin 2015: 8).

However, in practice the process of "building such a cooperation" proved to be rather difficult. Involvement of the general public is hampered by low priority level of these issues, false information, insufficient coverage and lack of interest among broader groups of society and the political barriers[51]. It may be said that today in Russian society there is an active minority that consists of advocates and opponents of nuclear power engineering. Both groups are taking certain actions to promote their movements and win over a wider following via all kinds of actions, demonstrations, conferences, mass media and the Internet[52].

[51] In 2014–15 a number of environmental NGOs (Green World, Ecodefense!, Planet of Hopes, For nature!, and others) were listed in the "foreign agent" organizations register.

[52] As an example of anti-nuclear information website see, e.g. www.antiatom.ru and the pro-nuclear – www.atomic-energy.ru, http://www.proatom.ru or http://www.nuclear.ru.

4. Facts and figures

4.1. Data summary

Nuclear power engineering development is one of the priorities of the economic policy of Russia. The country is currently building 8 NPP power units. The atomic energy sector's investment plans and the program have been adjusted downward. The main task for the near future is the replacement of retiring nuclear power plants with new ones. In accordance with the latest version of the energy strategy of the Russian Federation, the projection for the period up to 2035 is that electricity consumption in Russia should remain almost at the level reached, and that nuclear power should provide about 18%of that electricity. Russia expands its participation in the construction of nuclear power facilities in other countries. Today it is building 36 NPP power units in other countries, which is more than any other nation.

4.2. Key dates and abbreviations

Table 4.2.1. Key dates

№	Date	Events
1	28 September 1942	Stalin signed a resolution "On setting up uranium-related activities" which gave rise to the Soviet atomic project.
2	11 February 1943	The start of the military application of nuclear power project. Specialized research center - Laboratory No. 2 was set up in Moscow. I. V.Kurchatov was appointed Head of Laboratory No. 2 of the USSR Academy of Sciences (now Russian Research Center - Kurchatov Institute).
3	16 May 1950	The USSR CM issued a resolution on "Research, Design and Experimental Works Involving the Use of Nuclear Power for Peaceful Purposes"
4	14 May 1951	Project specification for the construction of the first nuclear power plant (Obninsk).
5	20 November 1953	The USSR CM issued a resolution on commissioning MSM and a number of other departments to start design works and construction of the first 17,000 tonnage nuclear-powered icebreaker "Lenin".
6	April 1954	At Plant No.12 (Machine-Building Plant, Elektrostal) a set of fuel assemblies (tvels) was made for the first charging of the first in the world nuclear power plant in Obninsk. This gave start to the new

		business line of the plant - manufacturing of fuel rod arrays (FRA) for nuclear power engineering.
7	26 June 1954, 05:45 pm	The first in the world nuclear power plant in Obninsk was placed into operation with a generator capacity of 1,500 kW - for the first time in history commercial electricity was received from a nuclear reactor. The first in the world NPP was a 5 MW capacity power plant based on graphite thermal water-cooled reactor.
8	08 August 1955	The USSR CM issued a resolution on rolling out preparatory works for the construction of large capacity nuclear power plants with VVER, KS, AMB and AG reactors.
9	14 February 1956	An experimental 100 kW capacity mercury-cooled and fueled with plutonium metal fast-neutron reactor BR-2 was started. The BR-2 confirmed the increased core breeding ratio hypothesis and contributed to making a final choice in favor of the more efficient coolant - sodium.
10	24 September 1958	Commissioning of the first dual-purpose uranium-graphite reactor EI-2 at Plant No. 816 (SChW, Seversk). After replication of EI-2 and building of several additional power units the total capacity of Siberian NPP reached 600 MW.
11	21 July 1959	Completed construction of the BR-5 fast neutron reactor with 5,000 kW capacity. The reactor was plutonium dioxide fueled. The coolant was liquid-crystal sodium. Experience of BR-5 operation made possible the construction of the first large NPP with shell type fast-neutron reactors in Shevchenko (Kazakhstan).
12	26 April 1964	First commercial electricity produced by the first stage of the Beloyarskaya NPP in the Sverdlovsk region. Capacity of the first power unit AMB-100 with boiling water-cooled graphite moderated channel-type slow reactor was 100 MW. In addition to electricity and heat generation the power unit also served as testing ground for channel-type reactors. Power unit No.1 stayed in operation for 17 years.
13	01 October 1964	The first power unit of the Novo-Voronezh NPP was commissioned. It used a shell-type 760 MWt reactor; electrical capacity of three turbo-generators was 210 MW. The reactor unit was placed within a steel cylindrical body with 100 mm wide walls, diameter - 3.8 m, and height - 11.2 m.
14	December 1967	Second power unit of the Beloyarskaya NPP with AMB-200 reactor and electric capacity 200,000 kW was commissioned.
15	December 1969	Second power unit of the Novo-Voronezh NPP with 365 MW capacity was commissioned.
16	27 December,1971	Third power unit commissioned at the Novo-Voronezh NPP (capacity

		- 440 MW, reactor type - VVER-440).
17	In December 1972	The 4th 440 MW power unit of the Novo-Voronezh NPP was commissioned.
18	29 June 1973	Commissioning of the first power unit of the Kola NPP in the polar region, reactor electric capacity - 440MW. The reactor design and NPP cycle were similar to the Novo-Voronezh NPP.
19	16 July 1973	Multipurpose NPP with shell type fast-neutron reactor BN-350 was commissioned in Shevchenko (Aktau, Kazakhstan) at the Mangyshlak plant on the Caspian Sea coast. Electric capacity was equivalent to 350 MW, heat generation capacity - 1,000 MW, fuel - highly enriched uranium dioxide pellets in stainless steel shell. Alongside with the generation of approximately 150 MW the NPP also produced steam for seawater desalination unit with daily capacity of 120,000 m^3 of fresh water.
20	11 January 1974	Power unit No.1 of the Bilibinskaya NPP in Chukotka commissioned, The NPP was the first of its kind to be built in a permafrost zone. Power unit generation capacity - 12 MW.
21	01 November 1974	First power unit of the Leningrad NPP reached design capacity of 1 million kW. Reactor - RBMK-1000 uranium-graphite channel-type boiling water-cooled reactor. Fuel - uranium dioxide enriched to 1.8%.
22	09 December 1974	Power unit No. 2 of the Kola NPP commissioned.
23	05 May, 1975	First criticality achieved at the second power unit reactor of the Leningrad NPP. On 8 January 1976 the second power unit reached rated capacity.
24	June 1975	Nuclear icebreaker "Arktika" started on its first navigation.
25	23 February 1976	Icebreaker "Siberia" launched.
26	19 December 1976	The first power unit of the Kursk NPP with RBMK-1000 reactor was commissioned.
27	December 1976	The first power unit of the Armenian NPP commissioned. Power unit with VVER-440 reactor (type V-270) was an upgraded version of power unit No.3 of the Novo-Voronezh NPP. At the time this was the main reactor type used for new NPP construction both in the USSR and abroad. Taking into account the seismically active zone all primary coolant equipment and pipelines were fixed on hydraulic snubbers and rested on ball heads.
28	September 1977	The first power unit of the Chernobyl NPP commissioned. The first stage of the Chernobyl NPP was similar in composition to the first stages of the Leningrad and the Kursk NPPs. Construction of the first power unit started in June 1972, and of power unit No.2 - in February

		1973.
29	29 January, 1979	Power unit No.2 of the Kursk NPP commissioned.
30	30 December 1979	The third power unit of the Leningrad NPP commissioned. On 26 June 1980 the power unit reached its design capacity of 1 million KW.
31	08 April, 1980	First start of BN-600 fast neutron sodium cooled reactor, the reactor became the third power unit of the Beloyarskaya NPP.
32	22 December,1980	The first power unit of the Rovno NPP commissioned.
33	20 February,1981	The first reactor unit VVER-1000 (version 187) at the fifth power unit of the Novo-Voronezh NPP reached its design capacity.
34	24 March 1981	The third power unit of the Kola NPP commissioned. During the construction of the second stage of the Kola NPP VVER-440 ("V-230" type) reactors were replaced with VVER-440 version "V-213" generally recognized as one of the most reliable shell-type reactors worldwide.
35	29 August 1981	The fourth power unit of the Leningrad NPP reached design capacity of 1 million kW. This marked the beginning of operation of the largest in the world nuclear power plant of 4 million kW capacity with uranium-graphite channel-type reactors.
36	December 1981	The third power unit of the Chernobyl NPP was commissioned.
37	09 December 1982	Power unit No. 1 (reactor RBMK-1000) was commissioned at Smolensk NPP.
38	17 October 1983	Commissioning of the third power unit (reactor RBMK-1000) at Kursk NPP.
39	31 December 1983	First start of power unit No.1 of the Ignalina NPP with RBMK-1500 reactor.
40	09 May 1984	First start of the Kalinin NPP, power unit No.1, reactor - VVER-1000.
41	21 December,1984	The first power unit of the Zaporozhye NPP commissioned.
42	31 May 1985	Power unit No. 2 (reactor RBMK-1000) was commissioned at the Smolensk NPP.
43	02 December 1985	Power unit No. 4 (reactor RBMK-1000) was commissioned at the Kursk NPP.
44	21 December,1985	Nuclear icebreaker "Rossia" - the third nuclear-powered ship of the "Arktika" series with the 75,000 h.p. main nuclear propulsion unit.
45	28 December 1985	Power unit No. 1 of the Balakovskaya NPP with upgraded third generation reactor VVER-1000 commissioned.
46	26 April, 1986	Chernobyl accident.
47	03 December 1986	Power unit No. 2 (reactor VVER-1000) was commissioned at the

		Kalinin NPP.
48	08 October 1987	Power unit No. 2 (reactor VVER-1000) was commissioned at the Balakovskaya NPP.
49	24 December, 1988	Power unit No. 3 (reactor VVER-1000) was commissioned at the Balakovskaya NPP.
50	17 January, 1990	Power unit No. 3 (reactor RBMK-1000) was commissioned at the Smolensk NPP.
51	11 April, 1993	Power unit No. 4 (reactor VVER-1000) was commissioned at the Balakovskaya NPP.
52	30 March, 2001	Connection of turbo-generator of power unit No.1 (reactor VVER-1000) at the Rostov NPP to the Unified Energy System of Russia.
53	16 December, 2004	Power unit No.3 (reactor VVER-1000) of the Kalinin NPP commissioned.
54	16 March, 2010	Power unit No. 2 (reactor VVER-1000) was commissioned at the Rostov NPP.
55	24 November, 2011	Power unit No. 4 (reactor VVER-1000) was commissioned at the Kalinin NPP.
56	27 December, 2014	Power unit No. 3 (reactor VVER-1000) was commissioned at the Rostov NPP.
57	10 December, 2015	Power unit No. 4 (reactor BN-800) was commissioned at the Beloyarskaya NPP.

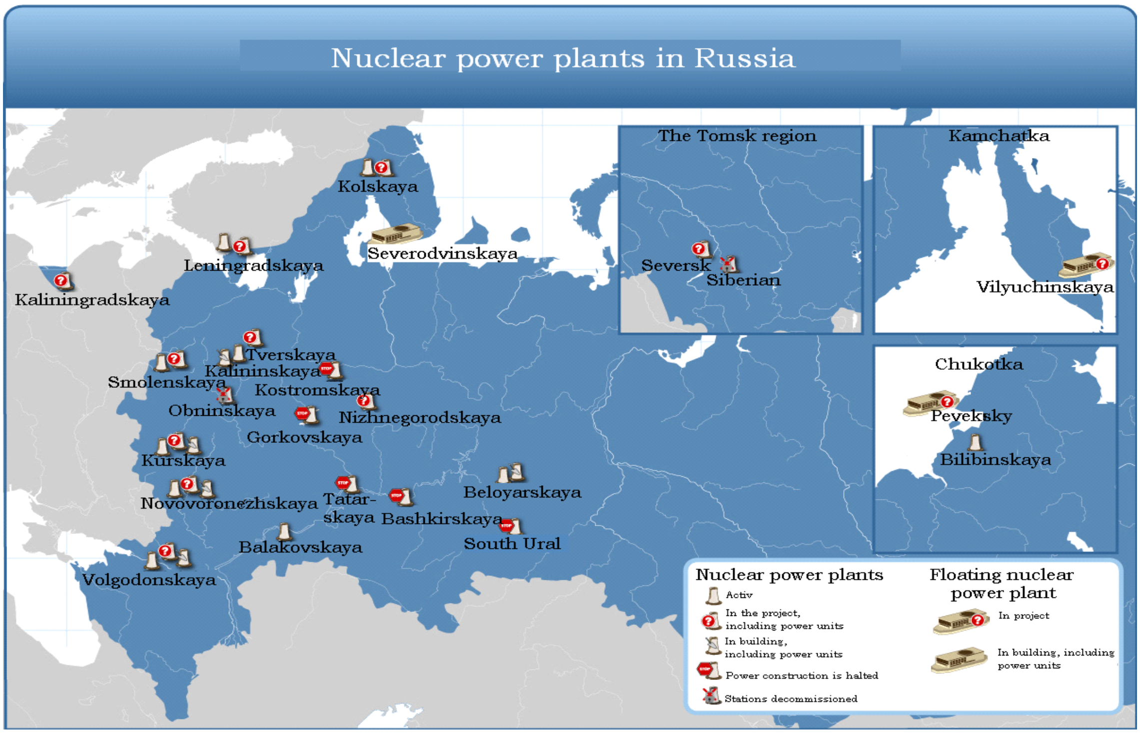
Table 4.2.2. Abbreviations:

Abbreviation	Interpretation
AMB	Atom Peaceful Large
AO	Joint-Stock Company
BN	Sodium-cooled fast breeder reactor
BR	Fast reactor
CIRCON	Center of intellectual resources and cooperation in the social sciences
CM	Council of Ministers
CNII	Central Research Institute
CPSU	Communist Party of the Soviet Union
EGP	A scaled down version of the RBMK reactor design
FGUP	Federal State Unitary Enterprise
GF NTD POM	Group funds scientific and technical documentation of the Production

	Association "Mayak"
GKO	State Defense Committee
GU, Glavk	Headquarters
IAEA	International Atomic Energy Agency
MMMB (MSM)	Ministry of Medium Machine-Building Industry
MGU (MSU)	Moscow State University
NII	Research Institute
NGO	Non-Governmental Organization
NPP	Nuclear power plant
NTS	Scientific and Technical Council
OAO	Open Joint Stock Company
OKB GMZ	Special Design Bureau of the Gorky Machine Building Plant
OKB Gydropress	Special Design Bureau specializing on pressurized water reactors design at Podolsk Machine Building Works
PAO	Public company
PO	Production Association
PGU	First Chief Directorate
RAN (RAS)	the Russian Academy of Sciences
RBMK	High Power Channel-type Reactor
RSFSR	Russian Soviet Federative Socialist Republic
SMI	Mass media
TVEL	Fuel element
USSR	Union of Soviet Socialist Republics
VNIIHT	**Russian Institute of Chemistry Technology**
VO	All-Union association
VPO	All-Union Production Association
VURS	East Ural Radioactive Trace
VVER	Water-Water Energetic Reactor (Russian equivalent of Pressurized Water Reactor)
WANO	World Association of Nuclear Operators
WNA	World Nuclear Association
WWF	World Wildlife Fund

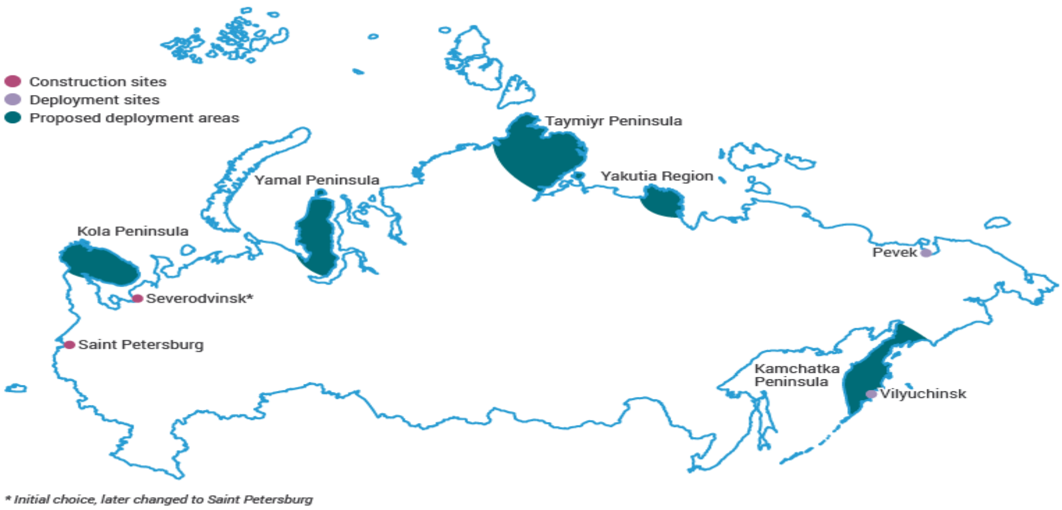
4.3. Maps of nuclear power plants

Figure 4.3.1 – Nuclear power plants in Russia (operating, under construction and planned).



Source: "Russian nuclear power plants: operating, under construction and planned."

Figure 4.3.2 – Map of floating nuclear power plants in Russia.



Source: "Rosatom 2015 in WNA 2016", http://www.world-nuclear.org/information-library/country-profiles/countries-o-s/russia-nuclear-power.aspx

4.4. List of reactors and technical, chronological details

Tables below shows the list of reactors, suppliers, operators as well as date details.

Table 4.4.1. Operational and projected nuclear power reactors.

No	Name	Operator	Supplier	Type	Mwe net	Construction began	Grid power	Status
1	**Academic Lomonosov -1**		Rosatom	KLT-40	35	2007		Under construction
2	**Academic Lomonosov -2**		Rosatom	KLT-40	35	2007		Under construction
3	**Balakovo-1**	Rosenergoatom	MSM	VVER-1000	1000	1980	28.12.1985	In operation
4	**Balakovo-2**	Rosenergoatom	MSM	VVER-1000	1000	1981	8.10.1987	In operation
5	**Balakovo-3**	Rosenergoatom	MSM	VVER-1000	1000	1982	25.12.1988	In operation
6	**Balakovo-4**	Rosenergoatom	Minatom	VVER-1000	1000	1984	4.11.1993	In operation
7	**Baltic-1**		Rosatom	VVER-1200	1200	2010		Under construction/suspended as Baltic countries refused to buy energy from it.
8	**Baltic-2**		Rosatom	VVER-1200	1200			Under construction
9	**Beloyarsk-3**	Rosenergoatom	MSM	BN-600	600	1969	8.4.1980	In operation
10	**Beloyarsk-4**	Rosenergoatom	Rosatom	BN-800	880	2006	10.12.2015	In operation
11	**Bilibino-1**	Rosenergoatom	MSM	EGP-6	12	1970	12.1.1974	In operation
12	**Bilibino-2**	Rosenergoatom	MSM	EGP-6	12	1970	30.10.1974	In operation
13	**Bilibino-3**	Rosenergoatom	MSM	EGP-6	12	1970	22.12.1975	In operation
14	**Bilibino-4**	Rosenergoatom	MSM	EGP-6	12	1970	27.12.1976	In operation

15	**Kalinin-1**	Rosenergoatom	MSM	VVER-1000	1000	1977	9.5.1984	In operation
16	**Kalinin-2**	Rosenergoatom	MSM	VVER-1000	1000	1982	3.12.1986	In operation
17	**Kalinin-3**	Rosenergoatom	Minatom	VVER-1000	1000	1985	16.12.2004	In operation
18	**Kalinin-4**	Rosenergoatom	Rosatom	VVER-1000	1000	1986	24.11.2011	In operation
19	**Kola-1**	Rosenergoatom	MSM	VVER-440	440	1970	29.6.1973	In operation
20	**Kola-2**	Rosenergoatom	MSM	VVER-440	440	1970	8.12.1974	In operation
21	**Kola-3**	Rosenergoatom	MSM	VVER-440	440	1977	24.3.1981	In operation
22	**Kola-4**	Rosenergoatom	MSM	VVER-440	440	1976	11.10.1984	In operation
23	**Kursk-1**	Rosenergoatom	MSM	RBMK-1000	1000	1972	19.12.1976	In operation
24	**Kursk-2**	Rosenergoatom	MSM	RBMK-1000	1000	1973	28.1.1979	In operation
25	**Kursk-3**	Rosenergoatom	MSM	RBMK-1000	1000	1978	17.10.1983	In operation
26	**Kursk-4**	Rosenergoatom	MSM	RBMK-1000	1000	1981	2.12.1985	In operation
27	**Kursk-5**	Rosenergoatom	Rosatom	RBMK-1000	1000	1985		Conserved
28	**Leningrad 2-1**		Rosatom	VVER-1200	1200	2008		Under construction
29	**Leningrad 2-2**		Rosatom	VVER-1200	1200	2010		Under construction
30	**Leningrad-1**	Rosenergoatom	MSM	RBMK-1000	1000	1970	21.12.1973	In operation
31	**Leningrad-2**	Rosenergoatom	MSM	RBMK-1000	1000	1970	11.7.1975	In operation
32	**Leningrad-3**	Rosenergoatom	MSM	RBMK-1000	1000	1973	7.12.1979	In operation
33	**Leningrad-4**	Rosenergoatom	MSM	RBMK-1000	1000	1975	9.2.1981	In operation
34	**Novovoronezh 2-1**		Rosatom	VVER-1200	1200	2008		Under construction
35	**Novovoronezh 2-2**		Rosatom	VVER-1200	1200	2009		Under construction
36	**Novovoronezh-4**	Rosenergoatom	MSM	VVER-440	440	1967	28.12.1972	In operation
37	**Novovoronezh-5**	Rosenergoatom	MSM	VVER-1000	1000	1974	31.5.1980	In operation
38	**Novovoronezh-6**	Rosenergoatom	Rosatom	VVER-1200	1200	2008	5.8.2016	In operation

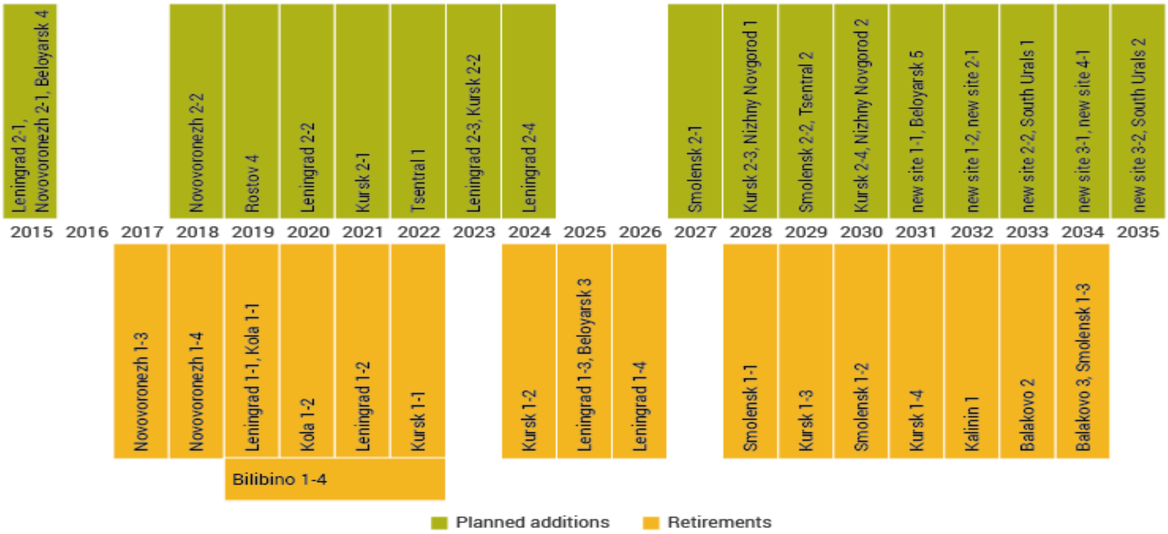
39	**Rostov-1**	Rosenergoatom	Minatom	VVER-1000	1000	1981	30.3.2001	In operation
40	**Rostov-2**	Rosenergoatom	Rosatom	VVER-1000	1000	1983	18.3.2010	In operation
41	**Rostov-3**		Rosatom	VVER-1000	1000	2009		Under construction
42	**Rostov-4**		Rosatom	VVER-1000	1000	2010		Under construction
43	**Smolensk-1**	Rosenergoatom	MSM	RBMK-1000	1000	1975	9.12.1982	In operation
44	**Smolensk-2**	Rosenergoatom	MSM	RBMK-1000	1000	1976	31.5.1985	In operation
45	**Smolensk-3**	Rosenergoatom	MSM	RBMK-1000	1000	1984	17.1.1990	In operation

Source: "Nuclear power plants of Russia", http://www.rosenergoatom.ru/stations_projects/russian_nuclear/; "Russian NPPs in operation and under construction (summary chart)", http://archive.rosatom.ru/aboutcorporation/activity/energy_complex/electricitygeneration/

Table4.4. 2. Reactors out of operation in Russia

No.	Name	Supplier	Type	Mwe net	Construction began	Grid power	Shut down
1	**Beloyarsk-1**	MSM	AMB-100	100	1958	26.4.1964	1983
2	**Novovoronezh-1**	MSM	VVER-210	210	1957	30.9.1964	1983
3	**Beloyarsk-2**	MSM	AMB-200	200	1962	29.12.1967	1990
4	**Novovoronezh-2**	MSM	VVER-365	365	1964	27.12.1969	1990
5	**Obninsk**	MSM	AM	5	1951	26.6.1954	2002
6	**Novovoronezh-3**	MSM	VVER-440	440	1967	27.12.1971	2016

Figure 4.41. Nuclear reactors planned additions and retirements to 2035.



Source: "Rosatom 2015 in WNA 2016",

http://www.world-nuclear.org/information-library/country-profiles/countries-o-s/russia-nuclear-power.aspx

Table 4.4.3. List of nuclear power plants and power units with VVER reactors that were built in Europe and the former Soviet Republics (as of 1.1.2002)

No.	Country buildings	NPP	Power unit	Reactor installation Index	Installed Capacity, MW	Date of the network
1	**GDR**	Reinsberg	1	B-2	70	6.5.1966
2	**GDR**	North	1*	B-230	440	13.12.1973
3	**Bulgaria**	Kozloduy	1	B-230	440	17.6.1974
4	**GDR**	North	2*	B-230	440	23.12.1974
5	**Bulgaria**	Kozloduy	2	B-230	440	26.8.1975
6	**USSR (Armenia)**	Armenian	1*	B-270	407	28.12.1976
7	**Finland**	Loviisa	1	B-213	440	8.2.1977
8	**GDR**	North	3*	B-230	440	3.11.1977
9	**Czechoslovakia**	Bohunice	1	B-230	440	17.12.1978
10	**GDR**	North	4*	B-230	440	2.8.1979
11	**USSR (Armenia)**	Armenian	2**	B-270	440	6.1.1980
12	**Czechoslovakia**	Bohunice	2	B-230	440	30.3.1980
13	**Finland**	Loviisa	2	B-213	440	4.11.1980

14	**Bulgaria**	Kozloduy	3	B-230	440	16.12.1980
15	**USSR (Ukraine)**	Rivne	1	B-213	402	22.12.1980
16	**USSR (Ukraine)**	Rivne	2	B-213	416	22.12.1981
17	**Bulgaria**	Kozloduy	4	B-230	440	18.5.1982
18	**USSR (Ukraine)**	South-Ukrainian	1	B-302	1000	22.12.1982
19	**Hungary**	Paks	1	B-213	440	28.12.1982
20	**Czechoslovakia**	Bohunice	3	B-213	440	28.8.1984
21	**Hungary**	Paks	2	B-213	440	6.9.1984
22	**USSR (Ukraine)**	Zaporizhia	1	B-320	1000	10.12.1984
23	**USSR (Ukraine)**	South-Ukrainian	2	B-338	1000	6.1.1985
24	**Czechoslovakia**	Dukovany	1	B-213	440	24.2.1985
25	**USSR (Ukraine)**	Zaporizhia	2	B-320	1000	2.7.1985
26	**Czechoslovakia**	Bohunice	4	B-213	440	9.8.1985
27	**Czechoslovakia**	Dukovany	2	B-213	1000	29.1.1986
28	**Hungary**	Paks	3	B-213	440	28.9.1986
29	**Czechoslovakia**	Dukovany	3	B-213	440	14.11.1986
30	**USSR (Ukraine)**	Zaporizhia	3	B-320	1000	10.12.1986
31	**USSR (Ukraine)**	Rivne	3	B-320	1000	24.12.1986
32	**Czechoslovakia**	Dukovany	4	B-213	440	11.6.1987
33	**Hungary**	Paks	4	B-213	440	16.8.1987
34	**Bulgaria**	Kozloduy	5	B-320	1000	29.11.1987
35	**USSR (Ukraine)**	Zaporizhia	4	B-320	1000	18.12.1987.
36	**USSR (Ukraine)**	Khmelnytsky	1	B-320	1000	25.12.1987
37	**GDR**	North*	5	B-213	440	24.4.1989
38	**USSR (Ukraine)**	Zaporizhia	5	B-320	1000	15.8.1989
39	**USSR (Ukraine)**	South-Ukrainian	3	B-320	1000	19.9.1989
40	**Bulgaria**	Kozloduy	6	B-320	1000	30.8.1991
41	**USSR (Ukraine)**	Zaporizhia	6	B-320	1000	19.10.1995
42	**Slovakia**	Mochovce	1	B-213	440	1.7.1998
43	**Slovakia**	Mochovce	2	B-213	440	21.12.1999
44	**Czech Republic**	Temelin	1	B-320	1000	21.12.2000

* The Power unit removed from service prematurely.

**The Power unit, decommissioning and re-started up ahead of 05.11.1991.

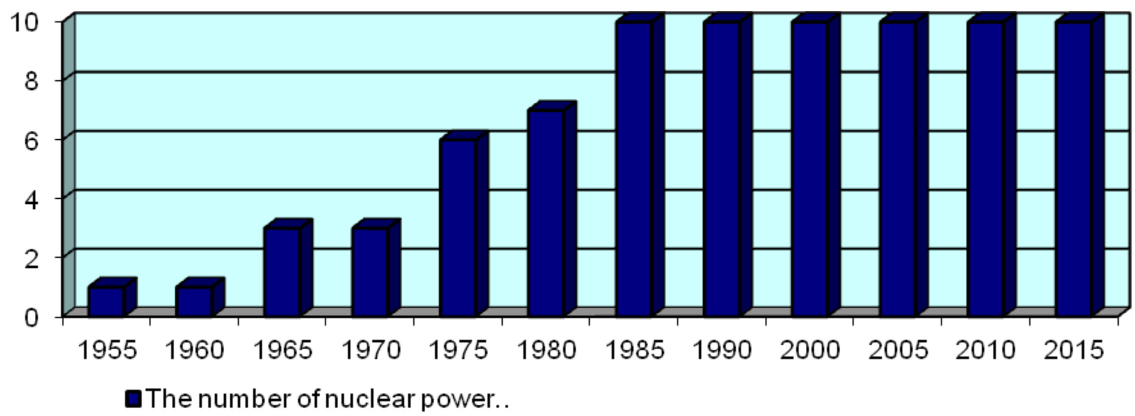
Source: V.A. Sidorenko, ed. "The history of nuclear power of the Soviet Union and Russia."

4.5. Periodization of nuclear developments

1) Preparatory stage (1945–1955)
2) Nuclear industry evolution stage (1955–1970)
3) Accelerated capacity build-up stage (1970–1986)
4) Crisis of the existing development model (1986–1991)
5) Under the conditions of radical political and economic transformations (1991–2000)
6) Present period (beginning from 2000).

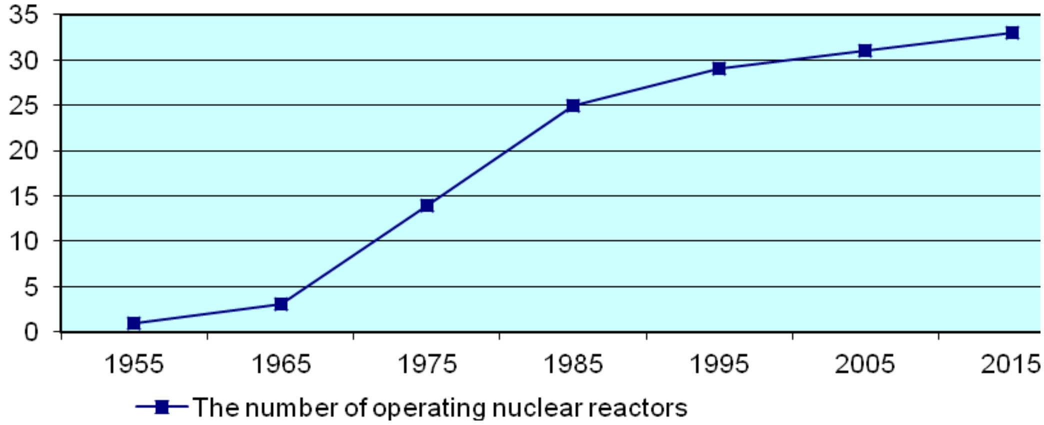
4.6. Electricity Data

Figure 4.6 1. Number of nuclear power plants operating in the territory of Russia in 1954-2015.



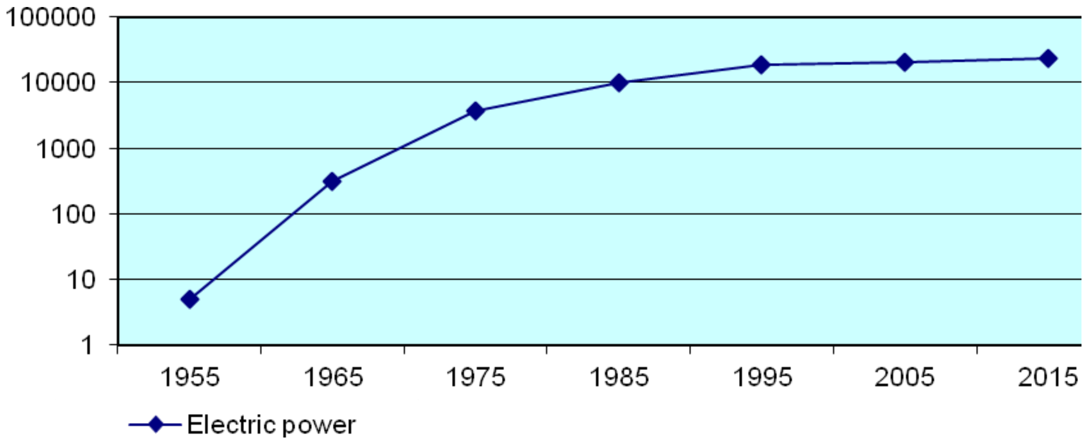
Source: "Russian nuclear power plants: a summary table."

Figure 4.6.2. The number of operating nuclear reactors in Russia in 1955-2015.



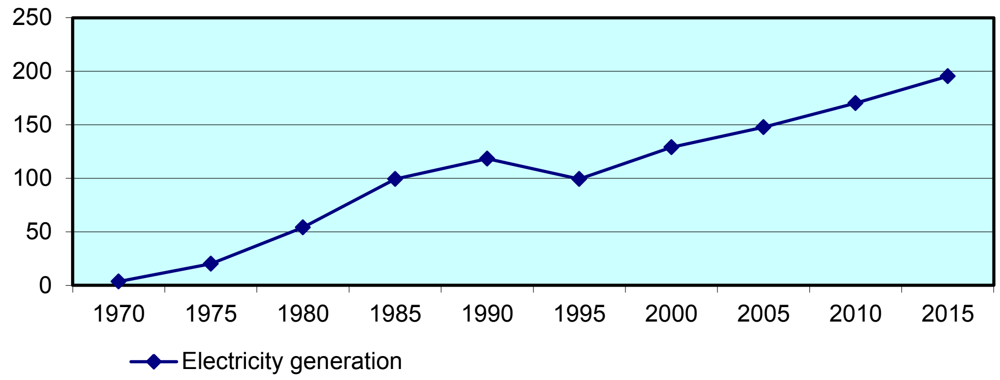
Source: "Russian nuclear power plants: a summary table."

Figure 4.6 3. Nominal installed electric power in Russia (MW).



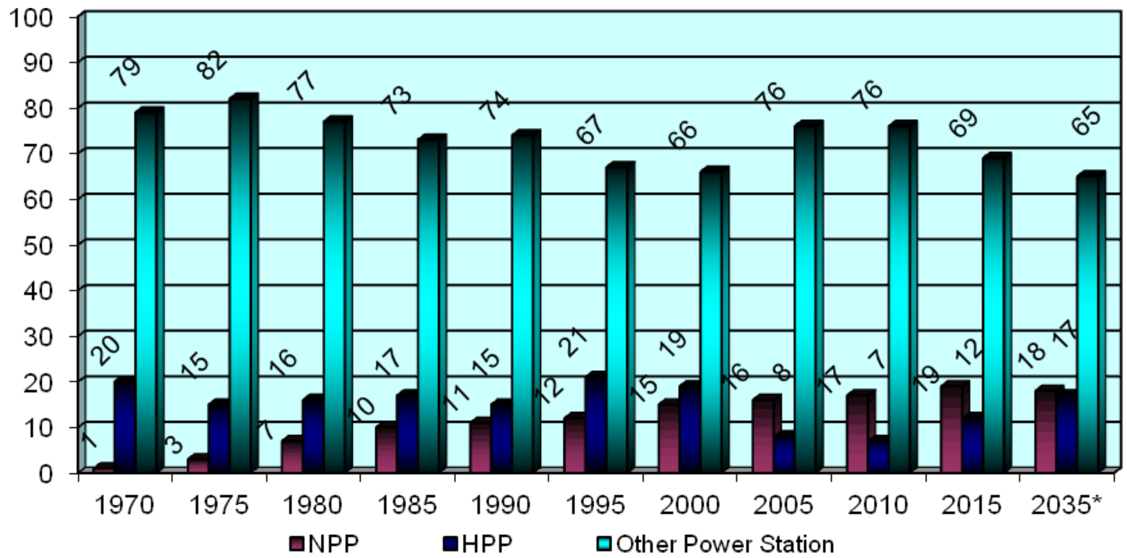
Source: "Russian nuclear power plants: a summary table."

Figure 4.6.4. Electricity generation in Russian NPPs in 1970 - 2014 (billion kilowatt-hour).



Source: "National Economy of the RSFSR for 70 years. Statistical Yearbook," 116; "National Economy of the RSFSR in 1990. Statistical Yearbook," 316; "Annual Report of OJSC Rosenergoatom Concern in 2008," 39; "Annual Report of OJSC Rosenergoatom Concern in 2010," 45; "Annual Report of OJSC Rosenergoatom Concern in 2015," 4.

Figure 4.6.5. The specific weight of nuclear in electricity production in the Russian Federation in 1985-2015 (%%).



*

Predicted data

Source: "National Economy of the RSFSR for 70 years. Statistical Yearbook," 116; "National economy of the USSR in 1977 Statistical Yearbook," 50; A.A. Troitsky, "Energy of the country and people of power," 83; "National Economy of the RSFSR in 1990. Statistical Yearbook," 316; Y.D. Sibkin, M.Y. Sibkin, V.A. Yashkov, "Power supply of industrial enterprises and installations," 14; "Russian Energy: A View to the Future," 342; "Annual Report of OJSC Rosenergoatom Concern in 2008," 38; "Annual report "RusHydro" in 2007," 32; "Annual Report of OJSC Rosenergoatom Concern in 2010," 45; "Annual report "RusHydro" in 2010," 14; "Annual Report of OJSC Rosenergoatom Concern in 2015," 4; "Annual report "RusHydro" in 2015," 9; "Russia's Energy Strategy for the period until 2035," 77.

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In drafting the report the authors relied on published sources on the history of the Russian nuclear power engineering, nuclear industry, and the sociological public opinion research. The section on the Kyshtym accident is based on open sources from the regional and local archives. The text links and references listed below are extensively referenced to the web resources. This should provide equal access to the referenced materials for all members of the research teams.

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WP2
Spain
Short Country Report

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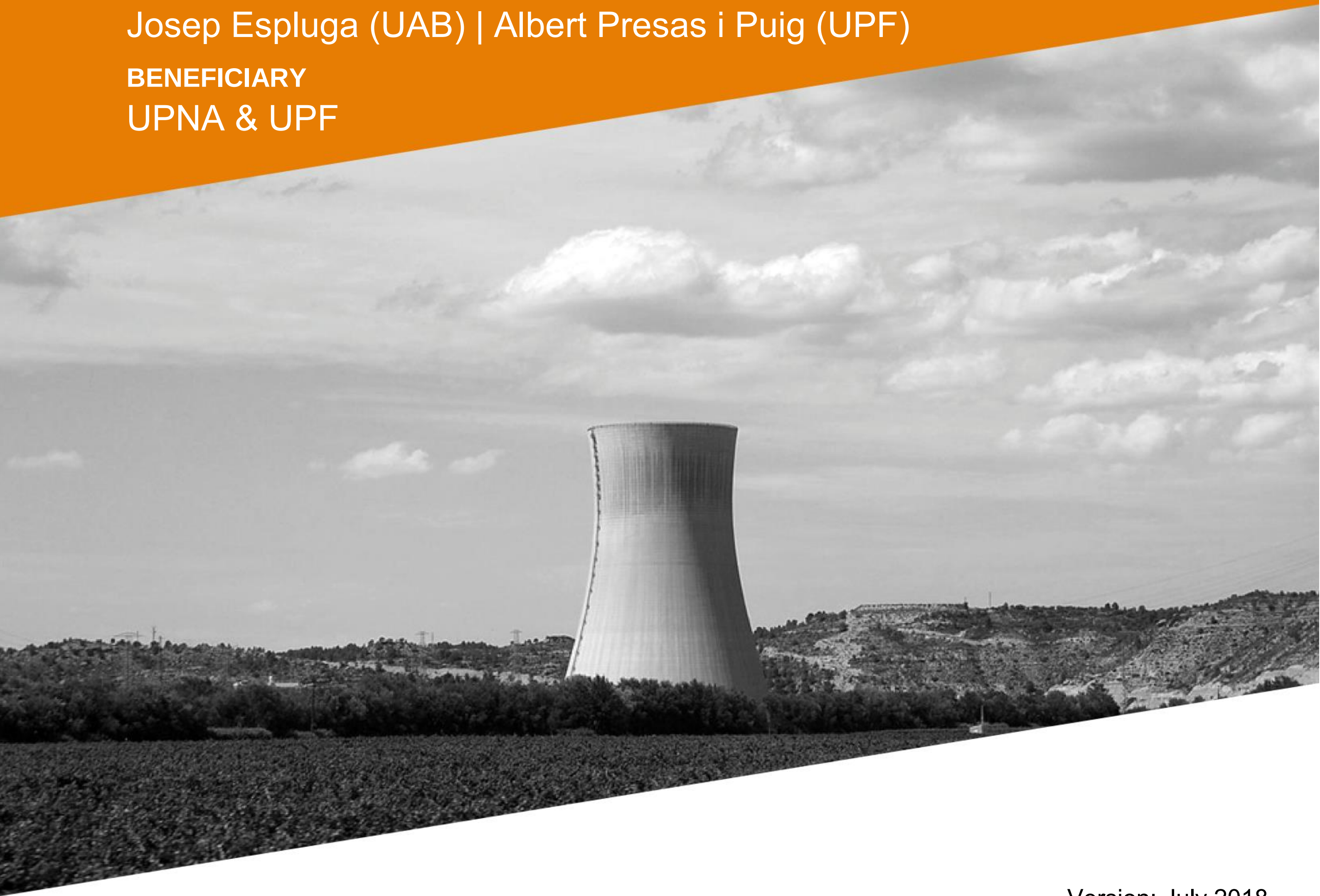

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HoNESt History of Nuclear Energy and Society

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EXECUTIVE SUMMARY

This report belongs to a collection of 20 short country reports on the History of Nuclear Energy and Society (HoNESt, project Ref.662268). The reports tackle the complex sociotechnical system around nuclear energy. Nuclear developments, notably nuclear energy, are closely intertwined with social, economic, environmental, political and cultural spheres. Nuclear energy is also a globalized system involving transnational transfers of knowledge, materials, technologies, people and products including electrical power, medical elements, spent fuel and other environmental hazards, materials, capacities and knowledge that must be carefully safeguarded. Nuclear energy is a complex social and technological phenomenon that influences societies but is also shaped by societies.

The short country reports are designed to assemble information and research results on the history of the relations between nuclear energy and society about all the different country cases in an accessible manner, and to document the findings with references. The purpose of the country reports is threefold, addressing three different audiences: (1) to provide basic elements of narrative and analysis for further historical research by HoNESt researchers, (2) to provide information, context and background for further analysis for HoNESt's social science researchers, (3) to provide accessible information on nuclear-societal relations in the various countries for the purposes of outreach and communication with stakeholders (civil society, industry, associations, policy makers, journalists).

This report focuses on the history of the relations between nuclear energy and society in Spain. Despite being a relatively poor country under the authoritarian Franco regime, Spain belonged to the group of pioneering nuclear countries by the mid-1950s, connecting its first nuclear reactor to the grid by 1968. This could only happen thanks to the full support of the government, the commitment of the private utilities which controlled the electricity market, and the transfer of technology and funds, mostly from the United States but also from France and Germany. During the 1950s and 1960s, while nuclear promoters portrayed nuclear power as the *only* plausible option to meet electricity demand ("nuclear or candles") the public had little, if any, knowledge of the technology. Thus the early nuclear projects barely faced opposition. By the mid 1970s Spain became the country where nuclear power grew fastest in the Western world. Yet competing uses of territory and resources (tourism along the coast and water needs for agriculture in the interior) brought the earlier critical

voices and administrative complaints by the late 1960s. The complaints were not directed against nuclear technology *per se*, but more against the alteration of the traditional use of land – i.e. other industries would have faced the same opposition. The regime forbade civil activism, but informal and unstructured social antinuclear groups arose around the projects from the mid-1970s, led by a handful of people. Beyond the social critical voices at the local and regional level, nationally and internationally the economic and political cycle played a crucial role in slowing down and eventually paralyzing the expansion of the Spanish nuclear program. The two oil crises (1974 and 1979) contracted the economy and the expected electricity demand, increasing the financial burden of nuclear projects and making them unbearable for the private utilities.

The economic crisis was paired with the uncertainties of the transition to democracy in Spain (1975-1982). The first elected Parliament in 40 years reduced the nuclear program in 1979. Terrorism and the military threatened the early steps towards democracy, with the former targeting nuclear power projects in the Basque Country. By the late 1980s, 10 nuclear reactors were producing electricity. The rest of the planned nuclear projects had been either abandoned or subject to the nuclear moratorium adopted by the government in 1984, for which the private utilities obtained compensation. Democratic Spain emerged as one of the societies most opposed to nuclear power in Europe, with a latent public opposition acknowledged by all actors. After the nuclear moratorium, a process started to reshape the institutional structures in accordance with the new political reality (mostly the CSN and ENRESA). Issues like transparency, trust, and reliable information -including new forms of engagement- became essential elements for the new institutions in their communication strategies and missions for interacting with society. The Spanish nuclear industry had grown to become an international player in engineering services and components, thanks to the technical expertise and human capital accumulated. However, the nuclear industry opted to keep a low public profile after the moratorium.

This report includes an outline of 5 events illustrating the history of some of the specifics of the relationship between nuclear energy and society in Spain, without being exhaustive. This preliminary analysis indicates that the available evidence on public opinion towards nuclear energy in Spain is quite limited, fragmented and dispersed. The review of the events reveals that historically all actors favoured, above all, public communication processes – i.e. non interactive between the parties - over active engagement procedures.

1. Historical context (narrative)

1.1. Introduction to the historical context

In Spain, nuclear research officially started in 1948 when the Francoist regime secretly decreed the foundation of the Junta de Investigaciones Atómicas (JIA- Board for Atomic Research), disguised within another body called Estudios y Patentes de Aleaciones Especiales (EPALE – The Study of Patent of Special Alloys). In 1951 it was renamed Junta de Energía Nuclear (Nuclear Energy Board - JEN), which was a government agency initially placed under the direct control of the military's Presidency Office but moved in 1957 to the Ministry of Industry. From a modest start, and with the full support of the regime, private utilities, and foreign aid, Spain emerged as an early adopter, and leading importer of commercial nuclear technologies. In fact, by the mid-1970s, Spain became the largest customer of the US – the world's largest provider of nuclear technology.[1] At its maximum the utilities formally applied to install reactors with a combined capacity of nearly 35,000 MWe. The government pre-authorised the installation of over 15,000 MWe. Yet, a combination of economic, political and social factors led to the curtailment of the Spanish nuclear program to just 10 reactors connected to the grid by 1988, just over 7,500 MWe. The 7 reactors in operation in 2016 provided about 20 per cent of Spanish electricity.[2]

Several types of periodization can be considered for the Spanish nuclear energy program: (1) one based on the characteristics of the technology of the imported reactors, (2) based on Spain's political and economic developments, and (3) based on the evolution of social interactions with nuclear power (see Table 1.1). The technological periodization focuses on dating the reactors of experimental nature, following the 1st, 2nd, and 3rd generations of NPPs. In the case of Spain, such periods cover pre-1964 for the experimental phase, 1964-1972 for the first generation, 1972-1982 for the second, and after 1977-1987 for the third.[3] For the objectives of HoNESt the other two periodizations are more useful, yet this does not make the history of the science and technology employed unimportant. The evolution of the institutional/political/economic setting includes the introduction of measures for

[1] Rubio-Varas and De la Torre (2016).
[2] REE (2016). An eighth reactor, Garoña, remains active but disconnected from the grid over a dispute about extending its licence beyond 40 years of operation.
[3] Alonso (2007).

the creation of the nuclear sector (1948-1962), the construction of the Spanish nuclear network – the government, experts, and industry- (1962-1976), and the response of Spain's first democratic governments to the nuclear legacy left by the dictatorship, during the nuclear power boom triggered by the oil crisis (1977-1985).[4] To these we should add the more recent period (1985-present), marked by the absence of additional nuclear power projects but also with the internationalization of the Spanish nuclear industry. On the social front, the early stages had no social impact. From the end of the 1960s some early, isolated, critical voices began to emerge in Spain. But only after 1974 can we identify the emergence of unstructured local groups, which in a few regions would grow to form regional forces. After the moratorium of 1984, the nature of the social movements around nuclear power changed towards a more organized, structured and wider range of action groups stabilising a nationwide latent public opposition to nuclear power.

Table 1.1 - Complementary periodizations of the Spanish nuclear program: technological, economic/political and social

Technological periodization	Economic/political periodization	Social periodization
1945-1964 Experimental reactors	**1948–62** institutional creation of the nuclear sector	**1948-1966** passive acceptance
1965-1972 1st generation NPP	**1962–76** construction of the Spanish nuclear network– government, experts, industry – and nuclear (and economic) boom	**1967-1973** early critical voices
1972–1982 2nd generation NPP	**1977–85** economic and institutional crisis. Rationalisation of nuclear plans; nuclear moratorium (1984)	**1974-1984** emergence of local unstructured social groups (regional in the case of the Basque Country and Catalonia).
1977-1987 3rd generation NPP	**1985- today** stabilisation of the sector –no additional power plants but discrete internationalisation of the Spanish nuclear industry. Spent-fuel storage as an issue.	**1985- present** National & international social movements' professionalization. Latent public opposition. Institutional renovation.

Source: Technological periodization from Alonso (2007); economic-political from De la Torre, J. and Rubio-Varas (2015); sociological periodization own elaboration from Costa-Morata (2009, 2011) and this report.

The next sections contextualize these periodizations and introduce some of the key actors in order to begin the analysis of the interactions between the nuclear sector and society in Spain.

[4] De la Torre and Rubio-Varas (2016).

1.2. Contextual narrative

Institutional framework and decisions

One of the main differences between Spain and the rest of Western Europe developing civil nuclear programs is that the former was a conservative-authoritarian dictatorship (1939-1975 Franco's Regime) and the latter democracies.[5] As a working hypothesis we propose that this difference defined how decisions were made: in the Spanish case without checks or balances which facilitated the concentration of power on a small elite with a great capacity for influence.

In fact, Spain was the only dictatorship among the early civil nuclear adopters in Western Europe. The economic policy of the regime made the situation more difficult: autarkical policies prevented access to external technology and funds, imposing strong controls which disrupted markets. In addition, the ideology of the regime worsened the human capital of the country. However, at the same time one of the explanations for why nuclear development outpaced economic growth in Spain is the institutional setting: a political regime combined with a lobbying private electricity sector that influenced the decisions made by officials in the government. As a dictatorship, the regime offered stability and time to mature the long term planning required for a nuclear program. However, as Spain could not develop a nuclear program on its own, the collaboration of the technological leaders, especially the US, was crucial. Despite this, and like most countries, Spain attempted to develop its own reactor technology until the 1960s.

The role of this handful of officials within the government was essential in facilitating the transfer of nuclear knowledge from the leading countries, funding the required investment, and managing the risks involved in domestic and global security (curbing the temptation to manufacture nuclear weapons).[6] Political-military and economic objectives motivated Spain's prompt response to the nuclear challenge (visible for the first time after Hiroshima and Nagasaki), although very few within government bet on the military option. Considering it a delicate matter, the government entrusted it to the army engineers. There was little alternative since purged universities had neither the adequate academic background nor the necessary flexibility, and no other scientific body existed that could take over the task. Spain's first move was to approach the Italian and German scientific

[5] Francoist Spain has also been classified as a totalitarian dictatorship.
[6] Caro (1995); Sánchez Sánchez, (2003, 2010); Viñas (2003).

establishments.[7] A combination of external and internal factors would alter the scenario. Internationally, the Cold War played its role; nationally, in the late 1950s it the need to restore economic progress altered priorities. The financial and military agreements of September 1953 between Spain and the US, which granted four military bases crucial to the US's geostrategic plans, turned Spain from "US outcast to US partner".[8] From the US perspective, active collaboration was strategic: because of its geographic position, Spain was considered the last bastion in Europe against Communism in case of a war in which Soviet forces expanded their control over the remainder of the continent. In December of 1953, President Eisenhower presented the "Atoms for Peace" Program to the United Nations. (See USA SCR) This context raised Spain to a privileged position among the beneficiaries of the US nuclear program, signing the first atomic agreement in 1955.[9] Spain participated from the start as an associate or full member in the main international agencies and forums, seeking the cooperation of the world's leading atomic powers.[10]

The public sector also took care of the fuel cycle (without enrichment) and nuclear waste management. The country lacked at that time the basic scientific and technical know-how to meet the atomic challenge. Before the 1960s, it could only be addressed by the public sector, albeit with high opportunity costs. The government was split between those who wanted nuclear power to remain under exclusive public domain and those who thought it would be better to involve major private companies in the business opportunities provided by this new power source. In the end, it would be the private sector (to whom the economic benefits had been guaranteed) that was in charge of building and operating nuclear power plants from the mid-1960s onwards.[11]

At that time electricity generation in Spain was controlled by more than 20 private companies that divided the country geographically and had configured the industry lobby, UNESA, since 1944.[12] The peculiar institutional structure explains how the first National Energy Plan of 1969 (PEN in Spanish)

[7] Ordóñez and Sánchez-Ron (1996); Presas i Puig (2005).
[8] Calvo-Gonzalez (2007).
[9] De la Torre and Rubio-Varas (2015).
[10] A Spanish delegation was present at the first Geneva conference (1955). Spain entered nuclear cooperation agreements with the US AEC (1955), France CEA (1956), Canada (1964). Regarding international nuclear bodies, Spain joined IAEA (1956), ENEA (1959), Eurochemic (1959), Foratom (1960) and Eurodif (1973).
[11] De la Torre and Rubio-Varas (2015).
[12] UNESA was created on the initiative of the private electrical utilities in 1944, under the name of Unidad Eléctrica, SA. Until 1979, it was also responsible for the operation of the national electricity grid system. UNESA controlled over 97% of the Spanish installed capacity throughout. See Serrano & Muñoz (1977:153). There existed several public owned companies of smaller scale at the time ENDESA, ENHER, Auxini Electricidad etc.

came to be designed under the dual auspices of UNESA and the Ministry of Industry: UNESA made a planning proposal, then the ministry's technical services units carried out the market research and network optimization studies. Furthermore, the electricity lobby performed a biennial review of the plan.[13]

Nuclear plants, uranium and industry

The inner working of the Spanish market for nuclear reactors was well known to the US stakeholders. Spanish electrical utilities, mostly privately owned and organised as lobby, had working relations with the US multinationals since the 1920s and managed to manoeuvre within the government in order to play a dominant role in the ordering of nuclear power plants. Utilities decided on the location of the plant (usually on a river dam which they owned), conducted the bidding process and selected the specific reactor supplier and engineering firms. The utilities also needed to seek the appropriate domestic permissions.

The first Nuclear Energy Law was approved by the Spanish Parliament in April 21st, 1964. In essence, the law assigned to the government the energy planning and coordination and reaffirmed to the Nuclear Energy Board (JEN) the scientific and technical development, external relations and safety and radiation protection. Eight years later, in 1972, a new decree on Nuclear and Radioactive Regulations was promulgated. For nuclear power plants the decree introduced a three step process: siting, construction and operation, to be granted by the Ministry of Industry and Energy after a safety evaluation performed by JEN. Thus the first permission became known as pre-authorization. The utilities applied formally for 27 reactors, from 1959 to 1975, the date of the last application, with a combined capacity of almost 35,000 MWe.[14] For the first generation of nuclear plants the government pre-authorized four projects over a period of four years (1964-1968). From October 1971 to August 1976, the government pre-authorized 15 reactors. However the utilities launched calls for suppliers in parallel to obtaining the governmental permissions. Thus, more contracts were formalised with suppliers and financiers than plants actually pre-authorized by the government. The utilities awarded contracts for 17 reactors from US manufacturers (12 Westinghouse [WH], 5 General Electric [GE]), 3 to Germany (KWU-Kraftwerk Union, a Siemens/AEG joint effort), and one with France (Electricité

[13] Rubio-Mondejar and Garrues-Irurzun (2016).
[14] Revista Energía Nuclear, nº 103, (1976), pp.390-391.

de France)). Only 10 of those reactors achieved connection to the grid: 8 by US companies (6 WH, 2 GE), and one by each of the French and German manufacturers. Except for Vandellós 1, of French technology and financed by the French government, all bids for nuclear reactors came with an offer of Import-Export Bank (Eximbank) financial support. Spanish utilities accepted all of them, except for three reactor contracts eventually awarded to German manufacturers (of which only the Trillo NPP was built).[15] US authorities attributed the loss of the two reactors of Trillo and the one of Regodola to German manufacturers to the superior financing terms offered by Germany, which the US Eximbank was unable to match.[16] The enormous financial needs of this program meant welcoming international public and private banks as well as American and European multinationals –WH, GE, and Bechtel Corporation [BC] – that would transmit the operative atomic *know-how* to Spanish engineers and industrialists.[17] The State would update legislation in accordance to what was defined by the International Atomic Energy Agency [IAEA], which led to the nuclear law of 1964, after the request for authorization of the first Spanish nuclear plant. Policymakers, interest groups, and technical experts and scientists were strengthened by this triangular relationship.

In principle, domestic reserves of natural **uranium** would make nuclear reactors relatively less dependent on foreign imports of uranium[18]. The government inaugurated a factory to process natural uranium in 1959.[19] But except for Vandellós I –a graphite-gas natural uranium French reactor design- the rest of the reactors needed enriched uranium. The US monopolised the process for the non-Communist world until 1974, even if the uranium came from Spanish mines in the early years. The government transferred all uranium-mining activities to a public company (ENUSA) in 1972. Created as a state-owned company (60% held by the government 40% by the utilities, which later sold their share to the JEN), and remaining so to the present, ENUSA has been Spain's nuclear fuel supplier

[15] Sánchez-Sánchez and Sanz Lafuente (2016).
[16] NARA. Exchanges of telegrams between Embassy in Madrid and Secretary of State in Washington. 9 September 1975: Telegram from the US Embassy in Madrid to the Secretary of State, Washington; NARA Ref: MADRID 06260 091426Z.
[17] The training opportunities and the permanent contacts with the nuclear leading companies appear clear in the interviews with the Spanish nuclear industry representatives. See references.
[18] De la Torre and Rubio-Varas (2015: Chapter 5). The government restricted the access to the country's uranium and radioactive mineral resources from 1948, forbidding exporting it. Decree of December 29, 1948 published in Boletín Oficial del Estado [BOE] nº 19 (Madrid 1949).
[19] The Factory General Hernandez Vidal, operated in Andújar (Jaén) from 1959 to 1981.

since 1979.[20] In Spain there is no facility for the enrichment of natural uranium and the necessary fuel elements must be imported. In 1985 the ENUSA factory of Juzbado (Salamanca) was commissioned to manufacture combustible elements for Spanish nuclear reactors, departing from imported uranium - some 1600 tons per year. Since then the factory has been producing high-density, accurately shaped ceramic UO_2 pellets, and loading them into cladding rods (made mainly from a zirconium alloy, imported from Westinghouse), sealing them and then assembling them into the final fuel structure (also imported, except for a few parts produced at ENSA premises in Santander).[21] ENUSA has established collaboration agreements with both WH and GE. These partnerships have resulted in trade agreements or specific agreements to operate in the European market; in 2018 more than half of ENUSA's production is intended for export to France, Belgium, Finland, Sweden, and Germany as principal customers.[22]

From an industrial perspective, the evolution of the Spanish nuclear sector has been relatively successful. As in other countries, the early projects tended to be turnkey, where the reactor manufacturer and its associated country or contractors would provide most of the engineering. Progressively Spanish industry achieved higher levels of participation, fostered by the construction authorization issued by the Ministry of Industry and Energy which included requirements about the degree of national participation. To verify compliance, the Ministry engaged the JEN to follow and appraise the participation of domestic industry in the projects. The first projects barely reached 40% of domestic participation, however, by the 1970s, around 60% of the projects were executed by local companies; even though most of their effort was concentrated on civil works and low-medium technological equipment. In the later projects, up to 80% was achieved. However, the nuclear sector continued to grow in order to serve the nuclear plants projected. When five of the nuclear projects under construction were paralysed by the nuclear moratorium of 1984, and several others projects were abandoned by the utilities along the way, Spain had developed an industrial sector around the fabrication of service components (e.g. ENSA) and engineering for nuclear power plants (e.g. Empresarios Agrupados, Tecnatom, ENUSA), which in the absence of a domestic market, managed

[20] Except for Trillo NPP supplied from Germany. In our visit to ENUSA we learned that the peculiarity of Trillo goes back to the first contract where the terms agreed between the operator and ENUSA could not be met. In parallel, ENUSA, Our history; http://www.enusa.es/en/conocenos/historia/.
[21] Visits to ENUSA and ENSA in the spring 2016 brought about this information.
[22] ENUSA, Annual Report 2015; http://www.enusa.es/wp-content/uploads/2016/05/ANNUAL-REPORT-2015.pdf.

to rise above the moratorium and compete internationally. The moratorium, which at the time was perceived as the *coup de grace* to the Spanish nuclear sector, eventually became its growth opportunity.[23]

Learning by doing was key for the Spanish Nuclear Programme. Many things remained unresolved (technological, legal, logistic, and economic) before the first three nuclear power plants were built. We have argued elsewhere that Spain became the world's nuclear laboratory.[24] Turnkey projects, offered at a price just equivalent to coal-fired plants, lost money for the reactor manufacturers for a while. But it can also be considered a private demonstration program that allowed manufacturers to create enough market activity for later generations of reactors.[25] Turnkey projects were a game changer: WH and GE sold 17 reactors abroad in the second half of the 1960s alone. Some of the elements of the first Spanish nuclear plant, Zorita, stood as a learning experience for all parties involved, including many aspects that would have continuation.[26] Contact with nuclear leaders in Europe and America and generous financing from American public and private banking had continuity. The learning process for technicians and specialists intensified.[27] In fact, Tecnatom, the Spanish engineering company initially established to manage Zorita, developed its own technology for training purposes, using the first nuclear plant as a training school for Spaniards and foreigners.[28] Zorita's experience helped with the creation of protocols for the logistics of transport and timing the supply of different components to the plant site, both within Spain and worldwide. While no legislation allowed the AEC to sell enriched uranium to foreign countries in long-term contracts and no protocols existed to manage spent fuel generated abroad, the process had to be created from scratch in order to supply the Spanish reactors.[29] All of this added to the upgrade of the low-tech equipment and civil work provided by Spaniards to the level appropriate for matching US manufacturing standards.[30] The

[23] Our interviews at Tecnatom, and to a lesser extent at ENSA, pointed at this paradox. Projects abandoned or cancelled by the utilities include Sayago, Punta Endata, Escatron and Santillan, all of which had industrial assignments and contracts in place. In some cases, the presence of Spanish companies in the international market has been done through construction under license.
[24] De la Torre & Rubio-Varas (2018, forthcoming*).*
[25] Burness et al. (1980).
[26] The first Spanish nuclear plant also happened to be the first U.S. export of a "turnkey" nuclear project that was eventually completed; De la Torre, J. & Rubio-Varas (2018).
[27] De la Torre & Rubio-Varas (2018, forthcoming).
[28] Álvaro (2014:702-704).
[29] All Spanish plants use enriched uranium with the exception of Vandellós I of French technology, which used natural uranium
[30] Our interviews with nuclear industry experts (Segarra, San Antonio and Alvarez-Miranda) confirmed and emphasized this point.

learning curve and technical improvements allowed for better performance of American firms abroad, with corresponding discounts to capital cost for the utilities.[31] Although the industry's learning process held better in small plants such as Zorita and Garoña NPP than in large stations.[32]

Economic and Financial costs of the nuclear project

There are no official figures about the cost of the Spanish nuclear program. Some economists argue that more than safety or waste issues, cost is nuclear energy's Achilles' heel.[33] According to Plumer (2016), in the 1960s new reactors in the US were considered as one of the cheapest energy sources around, but two decades later, after a series of missteps, costs had increased six-fold.[34] And the ever-rising costs seemed to be replicated across the globe in all nuclear countries, except perhaps, South Korea.[35] Ever since, experts have been debating whether nuclear cost problems are an intrinsic flaw of this technology or whether lessons can be learned from the hundreds of reactors built to date.[36]

The high capital cost of nuclear plants means that their overall economics, and the feasibility of their financing, depend greatly on the cost of that capital (which always excludes insurance and waste management costs). It was 'simply impossible during the, 1960s and 1970s, for the private utilities in countries such as South Korea, the Philippines, Spain, and Yugoslavia to raise, in the private market, the $500 million or more required for a single nuclear plant.[37] With only a few exceptions, national export financing institutions of the principal supplier nations undertook external financing of nuclear power projects.[38] In the case of Spain, with all but three reactors bought in the US, the Import-Export Bank (Eximbank) provided the crucial financial aid. This support took the form of direct credits, refinancing, interest-rate support (where the government supports a fixed interest-rate for the life of the credit), aid financing (credits and grants), export credit insurance and guarantees.[39]

[31] Joskow & Rozanski (1979:168).
[32] Cowan (1990:550).
[33] Cohen (1983; 1990).
[34] Plumer (2016).
[35] Sungyeol Choi et al. (2009).
[36] Plumer (2016).
[37] Eximbank Archives Box H128, Folder 705.
[38] Eximbank Programs in Support of Nuclear Power Projects (Washington, D.C., 1970), 3. Box J11, Folder 2347.
[39] Ibíd.

Pumping public money into the export of nuclear facilities to the world explains a great deal of the US leadership in the global nuclear market before the 1980s and the US quasi-monopoly of the Spanish nuclear market.[40] In fact, by the mid-1970s, financing by the supplier's government became more important to customers than the overall cost evaluation of the project.[41] For the whole period 1955-1985, the Eximbank financed more than half of the free world sales of nuclear reactors. By the late 1970s all but one –sold to Switzerland- of the US' reactor exports came with an Eximbank financial package.[42]

The financial facilities provided by the US helps to understand how Spain, one poor developing country of the Western World in the 1950s, managed to become an early adopter and leading importer of commercial nuclear power materials in less than two decades. Spain became, by the mid-1970s, the largest nuclear client of the US by, at the same time, becoming the largest nuclear borrower of the Eximbank.[43] These financial facilities were in the past (and continue to be) crucial for business decision makers in deciding to go ahead with or cancel their nuclear projects. The availability of such facilities depends to a large extent on the macro-economic background, and they became more scarce from the mid-1980s onwards. In fact, Eximbank loans become more exceptional in the early 1980s until their total obliteration by 1985. [44]

The private utilities contracted the engineering, signed credits and owned the nuclear power plants. The Spanish government however, guaranteed many of the international credits, particularly the early ones.[45] The bulk of the credits were paid back by the utilities. Yet those pertaining to the moratorium, as in the Italian moratorium,[46] were securitized in bonds guaranteed by the Spanish Government, and the cost was paid in the electricity tariff on consumers, in their monthly bill, until 2015. As a consequence of the restructuring of the electricity sector, large shares of previously NPP private property ended up in the hands of ENDESA, the public electricity company in the early 1990s, before it was privatized in 1998.[47]

[40] Rubio-Varas and De la Torre (2016)
[41] US Comptroller General's Report to the Congress (1980:10).
[42] Eximbank Programs in Support of Nuclear Power Projects (Washington, D.C., 1970**)**, 3. Box J11, Folder 2347.
[43] Rubio-Varas and De la Torre (2016).
[44] Becker and McClenahan (2003) Appendix B.
[45] De la Torre and Rubio-Varas (2015).
[46] Frabrozzi (1998:270); see Italy Short Country Report.
[47] Gallego Málaga, 'Mas cambios en el sector eléctrico' *El País* 18/10/2000; Majo, J. '¿Fue un error privatizar Argentaria y Endesa?', *El País* 17/3/2010.

1.3. Social responses to nuclear power

The political regime shaped the social reaction to nuclear projects

Under Francoism, civil society could not manifest itself openly with police controls and press censorship in place. Even in the later period, all the civil rights common to other Western democracies did not exist. However, administrative channels offered the opportunity to show dissatisfaction. In late 1966 the private electricity utility Hidroelectrica Española [Hidrola] obtained the authorization of the Directorate General of Energy to install a nuclear power plant of 500MW at the mouth of the Torrent of Irta, between the emerging tourist villages on the Mediterranean coast.[48] The municipality of Peñíscola, some housing developments, and individuals legally appealed the authorization of the plant. The conflict of interest was clear: tourism entrepreneurs, owners of holiday homes and the town council understood that the location chosen was placed in a territory qualified in 1960 as a developable area, excluded from any commercial or industrial use, with the sole exception of hostelry. The administrative litigation lawsuit lasted for 9 years. Finally, in March 1973, the Supreme Court quashed the site. By then, Hidrola had already abandoned the idea.

What happened in Irta was crucial in the process of subsequent nuclear projects. Electricity utilities began to clash with local interests in virtually all locations chosen for their central second and third-generation NPPs. And municipalities played a decisive role in their fate. A pioneer in the Spanish anti-nuclear activist explained to us that he became interested in the case of Irta when he learned Iberduero planned to install a nuclear plant near his village –Tudela– in 1973.[49] He visited Peñíscola and understood that there was a way to halt nuclear projects: by utilising the administrative route that the Franco regime allowed.[50] The actions of the electricity companies, which in some cases ignored the law in their dealings, also helped.[51] Administrative and legal litigation by local authorities against chosen nuclear locations became the initial strategy in most cases.[52] But even before Francoism's

[48] BOE-A-1966-21148.
[49] Interview with Mario Gaviria.
[50] After the opposition of the municipality of Irla against the construction of the NPP, the regime modified the legislation, including that in the case of the NPPs, the municipality had to accept the decision of the corresponding Ministry and facilitate the construction permits to the utility. Nuclear Law Bulletin Nª12 (1974), 15.
[51] The abusive attitude of the electric utilities has been mentioned in all interviews with antinuclear actors and was a constant repetition in the books and pamphlets of the antinuclear movements. See below the cases of Valdecaballeros and Ascó.
[52] Interview with Costa Morata.

end, there were unstructured informal social groups, with strong leadership from a small group charismatic people, which pushed for formal complaints by local authorities in almost all of the 20 locations where there were plans for a nuclear project (see section 4 “Facts & Figures” for dates and locations). Other civil strategies, meetings, pamphlets, demonstrations, parades, voluntary confinement, etc., would arise after Franco’s death in 1975.[53] Many of these movements are difficult to distinguish from anti-dictatorship movements and in many occasions arose directly within them.[54] Throughout the 1970s antinuclear protests remained rooted in strong regional identities –particularly so in the case of the Basque and Catalan regions.[55] Yet opposition to nuclear power also came from people within Franco’s regime (mayors, provincial governments, religious associations, agricultural unions, etc.) who expressed their dissatisfaction with and opposition to decisions to locate nuclear power plants in their territory.

Meanwhile the promoters of nuclear projects grouped in 1962 to form the Spanish Atomic Forum to defend their entrepreneurial interests, disseminate information and knowledge to the public and connect with international networks. Foreign partners participated often in academic and business nuclear meetings in Spain.[56]

The democratic transition in Spain coincided with the aftermath of the two oil crises of the mid-1970s. This made a unique background to the strategic decisions that had to be made. In energy policy terms, the transition to a democratic regime meant institutional change and new tools for public intervention. Democracy led to public debate and the government’s Energy Plan was reviewed, discussed, and approved in a multi-party parliamentary setting. The public voice could also be heard, especially in regions where building nuclear power plants had already commenced, and local press coverage brought lobbying by stakeholder groups into the public’s eye. However, nationally and internationally the economic and political cycle played a crucial role in slowing down and eventually paralyzing the Spanish nuclear program. The economic crises slowed down the expected growth in electricity demand, but also led to the devaluation of the Spanish currency –the peseta– and a period

[53] Interviews with Allende and Serna.
[54] From our interviews with antinuclear activist, the link between antinuclear and anti-Francoism emerges (Gaviria, Costa Morata, Serna, Naredo and specially Allende). So it transpires in some of the contemporary literature Costa Morata (1976), Fisas (1978), Gaviria et al. (1978).
[55] Rüding (1990:216).
[56] Presas i Puig (2000).

of high inflation, thus contributing to make the financial burden of the nuclear projects unbearable for the private utilities. The first elected Parliament in 40 years rescaled the nuclear project down in 1979. Between 1979 and 1983, the political spectrum on the nuclear issue ranged from soft support for a nuclear program along the original basic lines, to appeals for a nuclear moratorium and reassessment of the situation. The Parliament approved in 1980 a law creating the Consejo de Seguridad Nuclear (CSN - Nuclear Safety Board) for nuclear safety and radiation protection as an independent public body. Since its creation, CSN mains objectives included timely informing both the parliament and the public. In the early stages of the CSN, the obligation to inform the public payed special attention to the functioning of the organization itself, as a new body it had to be introduced to society.[57] Until the early 1980s the Spanish environmental movements had a marked local or regional nature. Professional environmental organizations sprung from the 1980s.[58]

The Socialist government elected at the end of 1982 faced plenty of challenges. The moratorium contrasted with the energy decision making of the previous decades. The General Secretary for Energy within the Ministry of Industry took the leading role (see Event 4, section 3.4 below). After a period of consultation and negotiation with the electric companies, it became clear that the sector required restructuring, since the sheer size of the project plus the increasing financial cost had become unaffordable.[59] In the autumn of 1983, the Socialist government announced a nuclear moratorium, which temporarily halted 5 of the 7 NPP under construction. The plan included a possible revision of the decision before 1992, if electricity demand rose. The process included the remodelling of institutional structures in accordance with the new political regime and energy policy (from JEN to CIEMAT)[60]; and the creation of new ones (ENRESA as the public organization in charge of waste management and REE as the first company in the world exclusively dedicated to the transmission of

[57] Menard et al. (1999)

[58] Vasi (2011:78). Nationwide, the number of environmental organizations almost doubled from the late 1980s to the late 1990s. They increased their mobilizing capacity to levels above the European average by the early 2000s, and gained access to policy making (Jimenez, 2007:370-375). In fact, the Spanish government created the Ministry for the Environment in 1996.

[59] Interviews with M. Gallego (General Secretary for Energy, 1982-1986), C. Mestre (General Director for Energy (1982-1986) and a government employee involved in the financial calculations around the moratorium who wanted to remain anonymous. Much has been discussed about the influence of the terrorist attacks against the Lemóniz NPP, in the decision on the nuclear moratorium. In any case, it is accepted that the circumstances surrounding Lemóniz conditioned the nuclear policy of the newly elected socialist government. See Event 3 below. On terrorism and Lemóniz see also Jauréguiberry (1983).

[60] Romero de Pablo and Sánchez Ron (2001); interview with Gonzalo Madrid.

electricity and the operation of the electricity system[61]). Since its creation, ENRESA holds in its strategic plan a fundamental view on the importance of developing a communicative strategy as to meet social demands, to facilitate public knowledge about the Institution, and to smooth the tasks of the Institution[62].

The moratorium became definitive in 1994, and the five projects paralyzed a decade earlier, were finally cancelled. The procedure for paying compensation to the utilities took a long time. The utilities got rid of their debts and obtained compensation for the estimated losses incurred from stopping their nuclear projects. Although it became possible to build nuclear plants again from 1997 there have been no formal attempts to do so in Spain. The final instalment of the moratorium was finally paid in December 2015, charged on the public's electricity bill.

Local and Regional scale effects

The typical location of a nuclear power plant was a rural landscape with sufficient water to cool the reactor. Bringing thousands of jobs to rural areas was a major selling point for the nuclear industry. In many countries the nuclear sector became a pulling force for national industry as a whole. In fact, after the nuclear pioneering countries, some follower countries –France, Germany, Canada– started to build their own nuclear power plants and compete internationally in this market, while some of the most significant nuclear importers –Italy, South Korea, Spain– pushed hard for increasing local participation in nuclear projects.[63] Yet, in many rural areas nuclear installations were seldom accompanied by an offer to make local use of the electricity produced by the new power plant. While local authorities may accept the plants on the prospect of the economic bonus they promised, on many occasions the hinterland further away raised opposition due to the conflicting use of the territory and safety concerns. The opposing forces included a variety of groups and reasons: downstream landowners because of the use of water for agriculture; fishermen's fears of contamination of their fishing waters; the threat to vested tourism interests in early stages of development, etc. (see our events description in section 3).

[61] López (2010).
[62] Cebrián, A., Prades,A., and Solá, R (1998)
[63] US Comptroller General's Report to the Congress (1980:34).

The utilities opened public information centres in some nuclear sites from the end of the 1970s, in some cases ahead of the opening of the nuclear facilities.[64] Eventually municipalities in the area of NPPs organized into the Association of Municipalities in Areas of Nuclear Power Plants (AMAC) in 1990.[65] Assuming that nuclear power plants have a limited life, AMAC focuses much of its activity on promoting economic activity in core alternative areas to nuclear power: industry, agriculture, services and tourism. In fact, the limited lifetime of NPPs creates uncertainties about the future benefits of hosting a nuclear site. The local population, in general, has given its agreement to expand licences further, as in the case of Garoña NPP, while nationwide there exists a wide debate on its licence extension, both in favour and against.[66]

In more recent years, the attempt to create a Centralized Temporary Storage facility for nuclear waste (ATC in its Spanish acronym) has been the first attempt at a participative and transparent process to select a nuclear site in Spain. But the process so far has not managed to escape from the political tensions that historically shaped the nuclear program and the social reactions at national, regional and local levels which have affected other European cases (see Event 5, section 3.5).

1.4. Presentation of main actors

From the narrative above we can identify several key actors in the interaction of nuclear power and society in Spain, but that necessarily also includes international actors. The main national actors involved in the Spanish nuclear program are:

Junta de Energía Nuclear (JEN) (1951-1986), Nuclear Energy Board, the government agency in charge of the regulation, development, and implementation of civil atomic uses (medicine, agriculture, industry and power) through research programs in all of the auxiliary sciences (physics, chemistry, materials), including the training of personnel. From the 1972 decree regulating Nuclear and Radioactive Installations, the Board had the authority to analyse and produce mandatory (but not binding) reports on the safety of such installations and inspect them. The Board also had full

[64] Opening dates of public information centres at nuclear sites: Almaraz 1977, Cofrentes 1978, Trillo 1981, Ascó 1982, Garoña 1992, Ascó-Vandellós II 2011. (Fuente Arias, 2004:219). Zorita did not have an information centre during its years of operation, but maintains an information centre about its decommissioning.
[65] Association of Municipalities in Areas of Nuclear Power Plants (AMAC) http://www.amac.es/
[66] "Imagen de Energía Nuclear: Garoña, ¿2009 ó 2019?" ; Guzmán, C. El Gobierno revoca el cierre de Garoña: seguirá funcionando hasta 2019, El plural.com, 3/7/2012 [available at: http://www.elplural.com/2012/07/03/el-gobierno-revoca-el-cierre-de-garona-seguira-funcionando-hasta-el-2019].

responsibility for certifying the operators of such installations. JEN would require the acquiescence of other government departments, especially the Ministry of Industry, but also the Treasury and the Bank of Spain in order to obtain the necessary funds.

At the advent of Democracy, the Parliament approved in 1980 a law creating the **CSN (Nuclear Safety Council)** for nuclear safety and radiation protection as an independent public body –without any promotional function– and JEN entered a new phase that culminated with its transformation into an energy research public body called CIEMAT by 1986. The reshaping of the Spanish nuclear institutions after the moratorium also included the creation by the Parliament of **ENRESA** in 1984 as a public, non-profit organisation responsible for the management of radioactive waste.

The electricity utilities, organized as a lobby under UNESA (1944-present day). They created two specific companies for the development of nuclear projects NUCLENOR (1958) and CENUSA (1958). In most cases nuclear plants resulted from joint partnerships among the private electricity utilities. Only the largest private companies (Union Electrica, Iberduero, Hidroeléctrica Española, FECSA) dared to tackle such projects on their own.[67] Among the actors we must include their shareholders which included several private Spanish banks, who had representation in the utilities Boards and would also contribute to the financing of nuclear ventures.

The industrial nuclear sector that emerged around the construction and operation of atomic plants. These included some private companies such as Tecnatom (engineering services) –owned by the utilities– Empresarios Agrupados (Architect Engineer and Constructor), but also public companies such as ENSA (components), ENUSA (fuel) and ENRESA (waste management), plus hundreds of other engineering and equipment firms for which the nuclear market was not its core business, but a good client.

The companies involved in the nuclear sector –including the utilities– joined to form the lobby **Forum Atómico Español**(1962-present). The individuals working in the nuclear sector created **Sociedad Nuclear Española (SNE**-1974-present).

[67] The public ownership of nuclear power plants was restricted to the participation of public smaller public companies in Vandellós I (see Event 1, section 3.1). The largest public utility, Endesa, attempted but failed to have its own nuclear plants: Escatrón, El Paramo and Chalamera. The last two were proposed together with ENHER. The State had some minority shares in some of the private utilities (i.e. Sevillana, Unión Electrica).

Association of Municipalities in Areas of Nuclear Power Plants (AMAC, 1990- present). The municipalities located in Zone I of the Nuclear Emergency Plans identified gaps in safety programs and the consequent impact of nuclear facilities on the socio-economic development of the towns and geographical areas where they were located. It has become one of the supporters of nuclear power outside of the sector.

Among the international actors on the promoting side of the Spanish nuclear program we must include **the US, French and German government agencies and companies**. Some examples of the US companies are Westinghouse, General Electric, Babcock & Wilcox, Bechtel, Harmon, Chase Manhattan Bank, Manufactured Hanover, City Bank, etc. US agencies directly involved include the AEC and Eximbank, French companies EDF, German companies KWU and Siemens/AEG.

As we move forward in time **dissenting voices** began to emerge and another set of actors appear. Initially, individual one-person initiatives, which led municipalities or other pre-existing local formal organizations to question nuclear projects (see Section 3). Some of these concerns were adopted and introduced into the founding aims of the early environmental groups such as *Asociación Española para la Ordenación del Medio Ambiente* **(AEORMA, 1974)**. In most places, specific informal groups emerged, bringing together the people opposed to nuclear projects at the local level, many of whom occupied NIMBY rather than true anti-nuclear positions: **CDCVNN,** Antinuclear Committee of Ascó, etc**.** National and international NGOs adopting anti-nuclear positions, such as Ecologistas en Acción or Greenpeace became actors in Spain only after the 1980s, remaining so until the present. The tendency since the 1990s has been to create ‘platforms' of opposition that amalgamate groups of different natures: environmental NGOs, neighbourhood associations, cultural associations, trade unions, etc.

The **political actors** need to be included. The **Congressional Commission on Industry** within the national government is the most relevant recipient of the CSN yearly Report to the Congress and the Senate. It controls and judges the activities of the CSN and, when estimated necessary, emits requirements for the CSN to comply. The positions of **municipalities, regional authorities and national authorities** tended to clash, blocking decisions even before the democratic period. In Spain, territorial and regional identities played a crucial role in accepting or rejecting nuclear projects. In some instances, when the national authority took the siting decision, the opposition to nuclear power became a fight of regional identity versus the central government and the imposition of economic power on the territory (see our event descriptions in Section 3). This becomes clear in the interviews with antinuclear leaders, all of whom started their activity when a nuclear energy project was announced on their territory (village, hinterland, birthplace, etc.).[68] In this respect a peculiar actor must be included as a force against nuclear power in the Basque Country: ETA, the Basque separatist terrorist group (see Event 3, section 3.3).

Finally, **public opinion** has been an actor, but one which is difficult to pinpoint. The media, promoters and opponents often targeted public opinion with their messages (see section 3.6 for an overview of public opinion towards nuclear energy in Spain).

[68] Interviews with Gaviria initially reacting to Vergara-Tudela NPP, Costa Morata to Águilas NPP, Allende to Iberduero plans for six new reactors in the Basque Country.

2. Showcase: Valdecaballeros nuclear power plant

Figure 2.1 Valdecaballeros location from Google Maps

Valdecaballeros, one of the Spanish nuclear projects halted by the moratorium in 1984 when Unit 1 of the plant was almost complete, includes in its origins and development most of the characteristics that have dominated nuclear societal relations in Spain. The various actors repeatedly sent unidirectional messages, past each other to the crowd; implausible statements remained unchallenged and implicit value judgements were unacknowledged. The denouement includes the intrinsic tensions between regional and national political powers which appeared elsewhere, but without the dramatic turn of the Basque Country, making Valdecaballeros a more suitable case for international comparisons for the purposes of HoNESt. It also offers an interesting national contrast, since the region also hosts another nuclear power plant, Almaraz, which by comparison had little social opposition.

Proposed in 1972 and known as the "Energy Marshall Plan for Extremadura, the Siberia of Spain", Valdecaballeros NPP illustrates the typical site of a request for authorization of the early 1970s: depopulated and abandoned areas with low expectations.[69] Thus, in a village of 400 inhabitants, some 5,000 construction workers arrived. The site stood some 60 Km from uranium mines, which also had apparently been used as waste disposal area (La Haba) since 1970.[70] The two proposing utilities planned to sell the electricity to Madrid and Seville, important urban centres some 200 Km distant from the plant. Both utilities had faced local opposition in a number of earlier attempts to place a nuclear power plant elsewhere in the country. However, available reports suggest that the NPP at Valdecaballeros was welcomed and supported by much of the local population and authorities.

[69] Baigorri (1999).
[70] RTVE (2011). ENRESA has collaborated in the dismantling and environmental restoration of La Haba, in Badajoz, now in the monitoring phase.

The government gave its preliminary authorization to the project in September 1975. During the previous months, from March to July of the same year, the utilities had secured the contract for the reactor with General Electric, the funding from the Eximbank, and agreement to enrich the necessary uranium for the plant.[71] The companies had also hired personnel and began building on site in June 1975 despite the lack of preliminary reports from the water authorities, the environmental evaluation by the national and regional governments, the proper expropriation of the affected lands, and the required construction permits.[72] Some of these issues were legalized by government decree in 1979, when the government –now democratically elected – gave the definitive authorization for the construction of the plant, which was already well advanced. In 1984, the Socialist government decreed a nuclear moratorium (see Event 4, section 3.4) which paralyzed the construction work of five reactors in Spain, two of which belonged to the Valdecaballeros NPP. The first reactor was 70% complete, and the second 60%. In fact, only a month before the moratorium became official, Valdecaballeros I was granted the authorization to perform the so called pre-nuclear testing**,** as defined in article 18 of the 2869/1972 Decree on Nuclear and Radioactive Installations.[73] Despite the moratorium, the construction continued until at least 1988, taking the plant to almost 90% completion.[74]

From a social perspective, Valdecaballeros shows the role of political decisions and regional identity in the development of nuclear energy in Spain. While local authorities accepted the plan, opposition arose from the early stages in the hinterland a little further away, due to the conflicting use of water by landowners downstream for irrigation. But it became more than a defense of the local use of water in an agricultural region. At a time when both the regional government and the state were from the same party, it became a fight for regional identity against the central government and imposed economic power (represented by the utilities). *'Saying no to the NPP, besides environmental motives, was showing people from Extremadura that the regional political power could slam both – the economic power and central government'.*[75] The regional president of Extremadura also recognized,

[71] NARA archives telegram references 1975STATE166552; 1975STATE229036, among others.
[72] Gaviria, Naredo and Serna (1978).
[73] Contreras Velazquez (2007).
(partially available at: http://centralnucleardevaldecaballeros.blogspot.com.es/2009/04/httpsites.html).
[74] During the implementation of the program halt much of the project engineering was completed and more than 100,000 m^3 of concrete was put in place, corresponding to the necessary civil works to leave the buildings and structures in good conditions. Contreras Velazquez (2007).
[75] Rodriguez Ibarra (2008:120-126).

some years later, "*once we won the battle of Valdecaballeros, people began to think we [the regional government] had a heavy responsibility and great power*."[76] "*The only way to generate a regional power in Extremadura was facing [up] to those who had the power historically in the region. Namely: the savings banks, electricity utilities and landowners*."[77] Thus, what began as a grassroots movement ended up as the flagship of regional politics: closing Valdecaballeros.

Valdecaballeros Actors

Table 2.1 Valdecaballeros actors

Promoters	• The electricity utilities; Unión Eléctrica, Hidroeléctrica Española and Sevillana de Electricidad (the same companies involved in Almaraz, the other NPP in Extremadura) *
Regulators	• JEN (until 1980) • CSN (from 1980)
Receptors	• National government • Regional government (Autonomous Community) • Local governments
	• Valdecaballeros inhabitants • Hinterland inhabitants (Villanueva de la Serena, Don Benito, etc) • Other concerned populations: o Landowners downstream o Community of irrigators o Commission in Defence of the Guadiana River o Early environmental/ecological organizations in Extremadura
Others	• Scientific experts

Note: *Union Eléctrica abandoned the project in the very early stages to concentrate in another nuclear project (Trillo)

[76] Iglesias (2003:247).
[77] Rodriguez Ibarra (2008:120-126).

Phase 1: 1975 – 1983

During the first period, the **promoters** of Valdecaballeros linked technological and economic progress to the nuclear power plant, both at the local and at the national level. The economic arguments justified the location chosen: a disadvantaged region which would develop thanks to nuclear energy. During the construction phase, the plant was a source of wealth. As Marino Sierra (subsequent mayor of the town), pointed out: *"All flats were rented, lots of workers came (…) and more benefits were expected, not only during the construction phase but also due to the operating profits. NPP villages received substantial amounts of money from the government, for job creation and other activities".*[78] Even the environmental impact of the NPP was suggested as an unquestionable advantage, as "heat emitted by the NPP – around 30 degrees in winter – will bring a tropical climate to the touristic destination of the Guadiana reservoirs`. This change in the climate will be to the advantage of the farmers." (Diario Ya - 25-10-1974). A report from the Ministry of Agriculture to substantiate this argument was commissioned.[79]

The disagreement between pro and anti-nuclear power groups began during the construction phase (from 1975). One highlighted economic arguments and the wealth produced for the village and the nation, whereas the latter focused on safety and health related issues: *"People didn't want the NPP, whatever they say today. Just a few of them really wanted it: those who had lands and the construction workers. Regarding health issues, our children's health issues are not a game…*"[80] But the real opposition to the nuclear plant arose and organized some 80 km downstream, in the city of Villanueva de la Serena, which agglutinated the landowners of the irrigated lands. Irrigators knew of a precedent with an attempt to build a cellulose factory upstream, and they feared contamination and competition for water, *"here the future was irrigation, it was agriculture".*[81] With frequent droughts, they argued, the Guadiana River would be insufficient to meet the needs of both the nuclear power plant and the irrigated lands. The concerned leaders of the irrigators sought information and support

[78] http://www.canalextremadura.es/alacarta/radio/audios/central-nuclear-de-valdecaballeros-100315.
[79] Ministerio de Industria y Energía (1979). "La Central de Valdecaballeros, influencia sobre el entorno agrícola" and "La central de Valdecaballeros. Informe público."
[80] http://www.publico.es/actualidad/vuelto.html.
[81] Gaviria et al (1978:561-565). Quotation from our interview with Serna.

from other anti-nuclear movements within the country, which at the time were also connected with international anti-nuclear figures.[82]

Social and environmental movements denounced the unequal distribution of risk over the territory, and the fact that Valdecaballeros was chosen because it was an impoverished village and few cared if they hosted what they considered the "worst industry."[83] Finally, the rhetoric of the anti-nuclear movements included aspects identifying nuclear power with technological colonialism and imperialism given the crucial role played by the US on its expansion in Spain, but also by the Spanish electricity companies and the Administration that imposed their will on the locals.[84] The mayors of Valdecaballeros and Castillblanco (a neighbouring village) expressed their feelings of powerlessness during the decision process because the siting of the nuclear power plant was only political (not technical) and it *"came from above".*[85]

As delays accumulated –partly due to the regional Administration's hesitation to provide permits for continuing the construction -, the promoters insisted in their arguments:

> "*1) nuclear power is the only solution to meet the growing electricity demand in Spain at least until the end of the century, 2) nuclear power has been adopted by all civilized countries, whichever their political regime, 3) nuclear energy is more economical than that obtained by other systems, therefore constituting a key factor for the competitiveness of our industry, 4) delays in the building of the 7 reactors currently under construction is causing very serious damage to the economy of the country, imposing an unnecessary external indebtedness by the import of petroleum, 5) in addition to the mentioned economic harm, the delays […] threaten to produce electrical energy restrictions in precisely the years in which a recovery of the national economy can be expected, coinciding with the entry of Spain into the Common Market"*[86]

[82] Interview with Serna. He contacted Gaviria and Costa Morata. Allende had been student of Walter Izard in the US, one of the earliest sceptics of nuclear power, and fed information from the US to the Spanish antinuclear figures.
[83] Costa Morata (2011).
[84] Gaviria et al (1978); Serrano & Muñoz (1977); Fisas (1978), and different articles in *Andalan* or *Alfafa* journals.
[85] Costa Morata (2011:115).
[86] CEO's speech before Sevillana de Electricidad General Shareholder meeting, 13 April 1978 (Archivo SEPI, Presidencia, Caja 552).

<u>Phase 2: 1983 – the moratorium</u>

The re-structuring of the Spanish state in 'Autonomous Communities' (regional political structures) affected nuclear policy, as the new regional government needed to demonstrate their sensitivity to the social demands in their region. In 1982 the Socialist Party (PSOE) came to power both in the nation and the regional government of Extremadura. The regional government cashed in on public opposition by appointing the leader of the anti-nuclear regional movement, Serna, as its Environment Counsellor. In the light of this outright opposition by the Extremadura government, the Spanish government decided in 1984 to suspend the building of the Valdecaballeros' reactor, sticking to the nuclear moratorium it had promised during the electoral campaign.

During this period (1980s and 1990s) concerns were mainly expressed by those who lived in the nearby areas, but not inside the municipality. Thus, it was said that thanks to the prosperity and the employment that the NPP would bring "*opposition is not to be expected*" [87] – as the district was far from the natural area of Guadiana.[88] On the other hand, local environmental movements had a negative perception of the economic wealth that the NPP apparently provided, which they saw as conflicting with the traditional uses of the territory.

The promoters insisted on the economic value of the plant for the locals, its significance for the national electricity supply –in terms of price, independence from oil and baseload- and the importance for the nuclear sector industry as a whole, given the national participation in its construction. The thousands of workers involved directly and indirectly in the construction of the plant faced a grim future. Promoters also insisted on the safety of the installation. The local government and the utilities tried to continue with the building of the NPP against the decision of the regional government. According to the Mayor of the town: "*Workers mobilized with strikes, people were very worried, some assemblies in the town hall, meeting with the government of Extremadura, we occupied the church…*

[87] A policeman, for example, remembers that "*at the NPP a private security guard earned 60,000 pesetas, three times more than I did*" (the daily El Mundo, 2015). Or as a retired construction worker affirms: "*When I retired in 1999, I bought the house that the company provided in Los Encinares, one of the villages built for the workers. The first reactor was finished by 80%. There was little left to do. What a pity*", affirms José looking at the ruins of the nuclear plant, which had turned into a monumental metaphor of uselessness. "*And it is expensive on top of that*." (Público, 2008).
[88] Costa Morata (2011).

we did a lot of things but they weren't useful at all (Marino Sierra, 1987-1995 Mayor of Valdecaballeros).[89]

Phase 3: from the moratorium onwards

When the halting of the NPP became a reality, the local government was disappointed with the decision. Thus, over the years several mayors of the municipality demanded redress for the economic damage they had incurred because the nuclear plant had not been built, and for the lack of alternative projects.

A former mayor, the Socialist Miguel Ángel García, sent a plenary agreement to the Socialist President of Regional Government Juan Carlos Rodriguez Ibarra in a virtually desperate tone. "*Valdecaballeros was sacrificed to the common good*", said the text, detailing a miscellaneous catalogue of possible projects which never got off the ground: an industrial estate, renewable energies, a swimming pool, a water-treatment plant, a sewage plant, an old people's home (Público, 2008). The national Government rejected the range of alternatives suggested by the town council for re-using the NPP site. The proposals were, for example, the construction of a combined cycle-power plant or a hydroelectric pumping storage plant using the infrastructure of the dam. The final proposal, which has remained since 2007, is the installation of two thermo-solar (of 49 megawatts) and two photovoltaic plants (of 10 megawatts) in the land belonging to the nuclear power plant.

"*The NPP even paid the neighbours' water*", remembers the current mayor (2015), Gregorio Rodríguez. He was one of the neighbours who left his work in Madrid to return to his village working at the NPP. "*Everything is abandoned, and it will remain that way, because it is very expensive to dismantle it. For many years, we have suggested reusing the land and installing renewable photovoltaic and thermal-solar energies*" (El Mundo, 2015).

According to David Baños, another former mayor of Valdecaballeros, the installation of renewable energy plants would entail an investment of between 500 and 700 million euros, plus the creation of more than 500 jobs during the construction phase, and 2 million euros for the city council in administrative authorisations and taxes. In this sense, in 2011 Baños stated: "*The town council has on the table four important renewable energy projects for the land*, *four projects that would imply an*

[89] http://www.canalextremadura.es.

important income for the municipality and would create hundreds of jobs in the heart of one of the territories of (the shire of) the Siberia of Extremadura, most affected by unemployment".[90] However, the National Government has rejected the proposal for the last 4 years. Baños suggested that the Minister does not want to hand over the fields in case they could be used in the future, if Spain bet on nuclear energy again[91]."*Before, there was a lot of business. But now it is dead. I migrated when the nuclear power plant closed, as all of my generation did. Everything has dropped by 90%*", explains Julio Sánchez who runs the bar in the municipal pool.[92]

The Regional Government, commissioned several surveys at the local and regional level (Extremadura Barometer 1985-1992) to assess public opinion towards nuclear energy and the Valdecaballeros NPP. After its initial standstill (1984), and even more after the definitive closure ten years later, the opinion polls in fact reflected a positive opinion towards the economic impact of building a nuclear power plant in Valdecaballeros and towards nuclear power in Extremadura (which hosts another nuclear power plant, Almaraz).

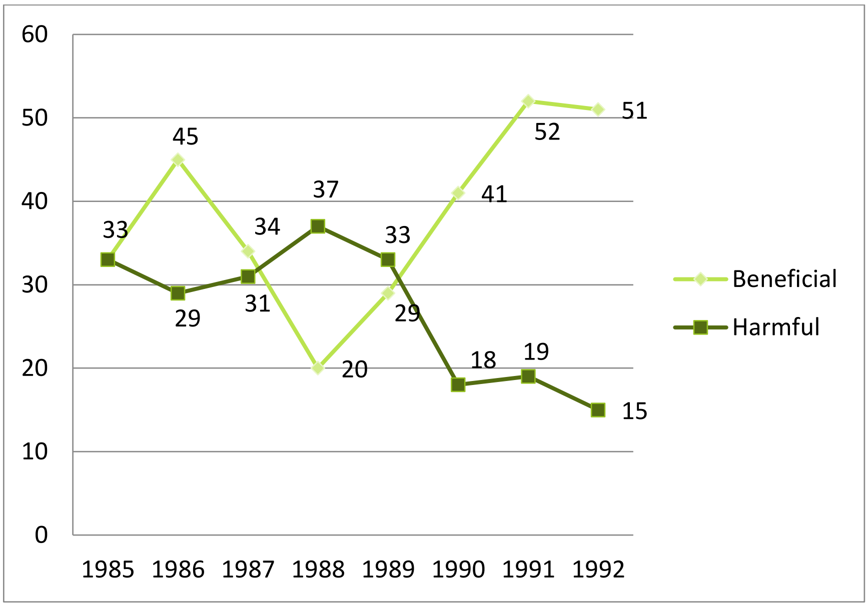

Figure 2.2 – Perception on the effect of the building works in Valdecaballeros NPP Regional population (%)

[90] www.elperiodicodeextremadura.com
[91] http://www.elperiodicoextremadura.com/noticias/temadeldia/gobierno-niega-desprenderse-terreno-nuclear-valdecaballeros_558766.html.
[92] http://www.publico.es/actualidad/valdecaballeros-duda-valio-pena-antinuclear.html.

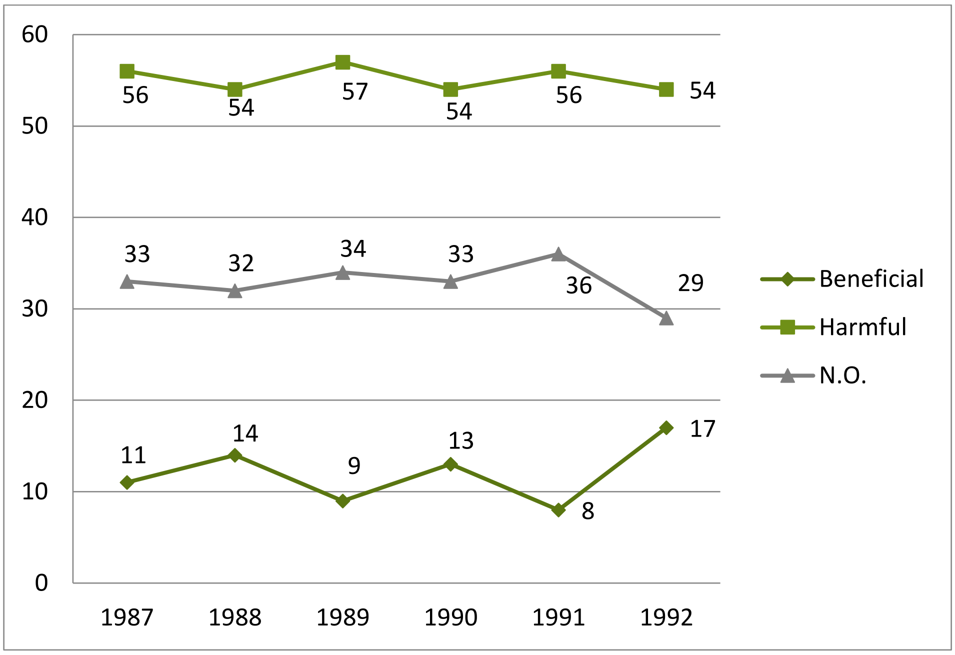

Figure 2.3 – Evolution on the attitudes towards nuclear Energy in Extremadura (%)

With more than half of the sample considering the building works of the NPP as beneficial for the region, Extremadura remained as an outlier at the national level, where the average for the Spanish population by that time was much more against nuclear power (see section 3.6 below for the public opinion polls).

Despite the initial legal requirement for the owners to keep the plant in a suspended status –in case it would be eventually allowed to operate– the facility has been progressively abandoned.[93]

2.1. Valdecaballeros' communication and engagement activities

<u>Phase 1: 1975 – 1983</u>

Official information, both from JEN during its existence, and the Nuclear Safety Council thereafter, as well as the correspondent Ministry of Industry, appeared in the Official State Gazette (BOE). This information had to be considered as a reliable source and, in some instances, it was the only source available. The Ministry of Industry, on the initiative of Joaquín Ortega Costa, as Subdirector of Energy Planning, included in the required authorizations for the construction of nuclear power stations an

[93] Contreras Velazquez (2007).

Information Committee, which he himself presided over. The Information Committees included mayors and social representatives of the affected municipality and neighbouring municipalities, as well as representatives of the JEN.[94] These Committees, later included in the Regulation on Nuclear and Radioactive Facilities, were a reliable and direct source of information for the representatives of the population. Promoters and regulators also communicated, via both specialized and national media, their plans and positions about Valdecaballeros.[95]

The promoters, however, never attended the debates organized in the region by opposing forces.[96] The antinuclear movement engaged in a wide range of public communication activities in rising order of magnitude: a) early small informative meetings of local affected population (1976-1977), b) big demonstrations until the “green march” of 1977 (unprecedented demonstration in the history of the region) involving the participation of environmental social movements and neighbours from throughout the county.[97] And c) the constitution of an assembly of town councils, asking the Spanish government to stop the permission to build the NPP in 1979.[98] They denounced all the irregularities in the process of authorizing the plant and asked for the cancellation of the project through local, regional and national press.[99] These can be understood as active ways of engaging the public and trying to influence the decision making on the NPP.

<u>Phase 2: 1983 – the moratorium</u>

The communication activities during this period took place through information broadcasts (advertisements via newspapers or magazines, TV, newsletters, radio, etc.). The exchange of messages between the regional and national governments and between those and the promoters, often happened through the pages of national newspapers. The strong opposition of the regional government of the Socialist party to the nuclear plant had to fight to make it national policy in Madrid

[94] We thank Agustin Alonso for providing this information.
[95] *Energía Nuclear* was the journal of the energy sector in Spain, published by the JEN from 1958 to 1982.
[96] Interviews with Serna, Costa and Gaviria. The promoter absence is also referred to in the proposal before parliament asking to stop Valdecaballeros presented in 1979. *Interpelación sobre la autorización de la construcción de la Central Nuclear de Valdecaballeros* (BOCG, núm. 142-1, de 21-09-1979, Ia Legislatura, Serie Di: interpelaciones, mociones y proposiciones no de ley).
[97] They also join forces to write and distribute a book of over 600 pages explaining their position. Gaviria et al (1978).
[98] Costa Morata (2011:199).
[99] *Interpelación sobre la autorización de la construcción de la Central Nuclear de Valdecaballeros* (BOCG, núm. 142-1, de 21-09-1979, Ia Legislatura, Serie Di: interpelaciones, mociones y proposiciones no de ley).

from the same party. The tensions within the Socialist party (in power both at the national and the local level) were resolved behind closed doors.

<u>Phase 3: from the moratorium onwards</u>

Few efforts in communication activities seem to have taken place. As the Valdecaballeros mayor said: "*We were cheated vilely, they started the nuclear power plant without asking our opinion, and they took it away in the same way, without considering the people living in the territory*[100]".

When the moratorium become definitive in the 1990s, there were attempts to revive the option to reopen Valdecaballeros.[101] Most of the communication for and against such a possibility happened though the national media. The promoters insisted on the need to open Valdecaballeros to meet electricity demand in the country and to avoid the cost incurred by stopping it. The regional government maintained its opposition to the plant, including public threats of unilateral resignation by the regional president if the plant went ahead.[102] The regional socialist president, Rodriguez Ibarra, had it his way and remained as one of the strongmen within the Spanish socialist party. For him *"Valdecaballeros represents a turning point for Extremadura's autonomy. It was from that collective triumph that we began to seriously assess the expectations that opened in our land with autonomy."*[103]

3. Events

The aim of this section is to provide a preliminary – but meaningful – overview of the interaction between nuclear energy and the Spanish society. The section identifies the more significant temporal periods and their singularities and includes an outline of the available evidence in two key main areas: the evolution of public opinion towards nuclear energy in Spain; and the analysis of five specific events illustrating the singularities of the Spanish case in a diverse range of historical and

[100] https://www.youtube.com/watch?v=M-WRj9gFP9Q.
[101] An issue also discussed in Parliament. Comisiones Mixtas, Sesion Nº24 (extraordinária) Diario de Sesiones de las Cortes Generales, p.1409.
[102] Iglesias (2003:235-236).
[103] "Extremadura en el concierto auton. mico español" // Conferencia del Excmo. Sr. d. Juan Carlos Rodríguez Ibarra, Presidente de la Junta de Extremadura, organizada por la Real Academia de la Historia // Madrid, martes, 17 de abril de 2001.

socio-political contexts.[104] These choices aim to show the peculiarities of the ways and types of the relationships in Spain. The choice of events attempts to cover the maximum range of time to capture the different mechanisms of engagement under changing circumstances (economic, political, sociological, technological, etc.). The five events cover the period 1960s to 2016. We included distinctive events, without which it would be impossible to understand the Spanish nuclear history – the moratorium and the Basque Case. Besides the conflict about nuclear plant sitting, we include issues of tackling accidents, decommission and spent-fuel management in order to provide a variety of issues over which nuclear engaged with society. Finally, as it could not be otherwise, the choice was also influenced by the availability of documents and the memory of the interviewees. The selected events for the Spanish case are the following ones:

1. **Vandellós I nuclear power plant:** its construction without opposition at the end of the 1960s, its accident in 1989 and its decommission thereafter.
2. **Ascó nuclear power plant:** the social opposition throughout the 1970s, 1980s, 1990s without managing to stop the plant, still in operation today.
3. **Basque antinuclear movement (1973-1984):** a massive social movement from 1974, which transformed into something different after the irruption of terrorist attacks after 1978, stopped all nuclear plans for the Basque country and contributed somehow to the Spanish moratorium.
4. **The 1984 nuclear moratorium:** a widely discussed decision where financial issues and political tactics played the leading role over social pressure.
5. **Radioactive Waste Management in Spain (1950s-2016)** proves the evolution from the absence of societal interaction during the early decades to the first attempt of a transparent process to install a temporary centralized storage facility since 2004.

In line with the Guidance Framework, **actors** have been classified in four main types (according to their structural role), as follows:

1) “**Promoters**” or those whose main interest is in promoting nuclear energy.

2) “**Receptors**” or persons / entities able to respond to an external stimulus (as nuclear installations) and transmit a signal to the system (in form of acceptance, rejections, demonstrations, etc.), and that

[104] The analysis of these events at this stage is only a first approach to realities which require more research and analysis (as we will do in the second phase of the project).

can be affected directly or indirectly, formally organized to a higher or lower degree, from the population in general to social movements, etc.

3) "**Regulators**" meaning those agencies and public organisms in charge of regulating nuclear energy, but also those promulgating legal restrictions which may indirectly affect the nuclear sector usually public bodies on different hierarchical and territorial levels.

4) In addition to that we have considered the option of "**others**" which includes mainly scientists or academic institutions, or media, which provide knowledge and support to any of the aforementioned actors. Notably, the roles of the different actors can change from one event to another, so actor A can be a promoter in the event X and a receptor in the event Y. Roles can vary in time and context.

3.1. Event 1: Vandellós I nuclear power plant

The only Spanish nuclear power plant with French technology (carbon dioxide gas cooled reactor), using natural uranium with a graphite moderator, was a technology advocated by French Prime Minister De Gaulle and the French Commissariat Energie Atomique (CEA), for reasons of national independence, but rejected by EDF and private builders for reasons of economic profitability (see France Short Country Report).[105] The reasoning behind its construction has been attributed to the hypothetical use of the resulting plutonium for military uses.[106] Its construction began in 1968 and it became operational in record time, by 1972. While the plant was being built and during the first years of its operation, promoters, authorities and the local population showed signs of satisfaction and pride. The only consistent rejection and organized opposition came from the fishermen of L'Ametlla de Mar.

In 1989 a fire broke out in the zone of the turbo-generators; it was classified as a level 3 incident on the International Nuclear Event Scale. The high costs required by the Spanish regulatory agency (CSN) to mend the irregularities which were discovered induced the operating company to shut it down for good and to decommission it. The National Company for Radioactive Waste (ENRESA) noted that closing down and ultimately decommissioning the nuclear power plant Vandellós I – in

[105] Sánchez (2000; 2016).
[106] Velarde (2016).

latency period since 2003 – was a clear illustration of the maturity and capacity of the Spanish industry and intend to make it an international reference case.

Vandellós I Actors

Table 3.1.1 Vandellós I Actors

Promoters	• A public-private consortium of electric utilities: Hifrensa (Hispano-Francesa de energía nuclear S.A) • ENRESA (in the decommissioning phase) • Spanish and French governments
Regulators	• JEN (UNTIL 1980) • CSN: Council for Nuclear Safety (FROM 1980) • Civil courts (the Fire accident was prosecuted and judged in the Third Room sentencing hearing from Tarragona)
Receptors	• National, regional and local governments (the mayors of Vandellós) • Vandellós inhabitants • Other concerned municipalities: L'Ametlla de Mar, Pratdip, Montroig and Tivissa • Environmental movements: Ecologistas en acción, Terra - Ecología Práctica
Others	• Scientific: -Fishery Research Institute

Phase 1: Construction (1968-1972) and Operation (1972 – 1988)

During the construction and operation, promoters, regulators and other public bodies (municipalities at that time) were highly techno-optimistic. The local authority considered the NPP a very high income and growth for the region being like the tourism industry,[107] which was very representative at that time. Thus, the director of Vandellós I plant asserted in an interview that *"people killed in road accidents caused by tourism deserve more attention than nuclear accidents listed"* (El Correo Español, 21 September 1974).

Before the Vandellós municipality was finally selected as the location of the NPP, other locations, and more precisely L'Ametlla de Mar, were considered. L'Ametlla was not selected due to a strong social opposition coming both from the local authorities and the local community. Concerns were

[107] Costa Morata (1976).

also raised at this stage by fishermen from the coastal region, worried about the potential pollution of marine resources and their way of life (Le Monde, 03 April 1975). Their negative perception was exacerbated since opponents felt that promoters and regulators did not provide trustworthy information about the management of the nuclear plant. To compensate this lack of information they decided to ask an expert institution for advice (they commissioned a study by the Institute for Fishery Research).

Phase 2: The fire and the judgement (1989 -1998)

This second period started with a fire in Vandellós I, the incident led into an accusation and judgment of the promoters. Although the reasons of the fire seemed to be unclear, what is known is that the fire occurred on Thursday, 19 October 1989, when one turbine stopped suddenly. The coupling of one of the two steam turbines with the corresponding electricity generator suddenly broke and damaged the generator's hydrogen cooling system releasing hydrogen and causing an explosion which ignited the lubricant oil of the broken coupling. The fire was maintained until all the oil in the reservoir was injected into the broken coupling. The reactor was safely shut-down and decay energy removed. After an initial classification as category 1 incident, it was finally classified as level 3 ("major incident") on the INES scale. The INES scale includes three levels of incidents and four levels of accidents

Phase 3: Decommissioning and dismantling (1991 to 2027)

This third period, still in force, relates to the decommissioning and dismantling process, during which the promoters' messages concentrate on technical control. The communication policy of the decommissioning company (ENRESA) was quite different of that of the company operating the plant (HIFRENSA). A commission created for Vandellós-I, made up of representatives of ENRESA, the Town Council, institutions and local organisations, with the following basic objectives: tracking of project dismantling evolution, verification of compliance by the project of the licensing conditions, analysis of the physical and radiological safety of the workers and keeping relevant groups informed through their representatives. Level 2 of the Vandellós-I project having been completed, this Commission has proven to be a particularly valid instrument.[108] Local governments related to the fact

[108] OECD, 2003.

that the population is "familiar" with the risks. This is especially so in the case of Vandellós, where in the 1980s a second reactor was installed. In an interview to the newspaper El Mundo (2003), the director of decommissioning the NPP highlighted the knowledge and technical experience gained at the decommissioning of Vandellós I, guaranteeing the high reliability and safety levels, generating international benchmarks for decommissioning nuclear power plants. Apart from familiarity, the access to information about the risk management provided by ENRESA is highly valued. In 2014, and apart from safety "which must prevail over everything else", the mayor valued the impact on the area of the NPPs as being positive not only as far as employment was concerned but also as generating wealth which in various forms benefits the citizens of his municipality (El Diario, 2014).

The little public debate raised concerning the dismantling process was about the siting of the radioactive waste dismantled (Ecologistas en Accion, website, La Vanguardia 2009).

3.2. Event 2: Ascó nuclear power plant

Ascó I is a 2nd generation Spanish NPP, authorized in 1968[109]. At a press conference in February 1970, FECSA (Fuerzas Eléctricas de Cataluña SA – Electric Power of Catalonia Ltd.) published their project beginning, construction in 1971. It was built some 37 km from NPP Vandellós, 74 km from the city of Tarragona and 184 km from Barcelona. Connected to the grid in 1984 (Ascó I, Westinghouse PWR of 1032.5 MWe, initially 930 Mwe) and in 1986 (Ascó II, Westinghouse, 1027.2 MWe). It lies on the right bank of the river Ebro, in the village of Ascó in the province of Tarragona, where there is a high concentration of risk-related, mainly petrochemical industries, and the nuclear power plant Vandellós. The triangle Ascó-Vandellós-L'Ametlla de Mar is the area with the highest density of nuclear reactors in Spain.[110] From a social point of view, Ascó may serve as an example for the formation and development of an antinuclear movement in Catalonia.

[109] BOE, 5 August 1970.
[110] Garcia, Reixac & Vilanova (1980:62).

Table 3.2.1 Ascó Actors

Promoters	• The utilities: • Ascó I - Originally FECSA (100%) • Ascó II –Originally: • FECSA (40%), • ENHER (40%) • Hidroeléctrica de Cataluña (10%) • Fuerzas Hidroeléctricas del Segre (10%) • Asociación Nuclear Ascó-Vandellós (ANAV) from 1998 (Endesa 85% - Iberdrola 15%)
Regulators	• JEN: Nuclear Energy Board • Ministry of Industry • CNS (Nuclear Safety Council)
Public bodies	• National, regional and local governments • Autonomic government • Inhabitants of Ascó • Farmers Unions • Other villages concerned • Environmental movements • Fishermen's association of L'Ametlla de Mar • Antinuclear Committee of Ascó, • Agricultural Cooperative of L'Ametlla de Mar, • Housewives Association of L'Ametlla de Mar • Commission of the Representatives of Ribera del Ebro (CARE) • Citizens Association of L'Ametlla de Mar (COVEMAR)

Phase 1: 1970 - 1977

The village of Ascó lies in a predominately rural area based on agriculture. In contrast to other villages in the surroundings, Ascó had no touristic potential. The power plant was built when the area underwent a structural crisis in agriculture and the rural population increasingly migrated to the cities. The movement against the building of nuclear power plants started to rally in areas which were affected by the construction work. In this way, L'Ametlla de Mar[111] and Ascó turned into the centres where the hard core of resistance against these installations took shape.

As in another cases the property developers' decided to hide the real reason for acquiring land in the municipality initially pretending they intended to build a "chocolate factory" until it was leaked that they really intended to build a nuclear power plant; although it must be admitted that this did not

[111] L'Ametlla was a potential location for a NPP.

mean much to the residents of the local countryside The press announced, on 27 February 1970, that "*the new factory of Ascó would provide 300 jobs and while it was being built even 2,000 workers would be needed"* (daily newspaper La Vanguardia, 27 February 1970). The reaction of the Francoist town hall was one of euphoria.[112] The villagers did not react to this announcement until some of them came across an article by Mario Gaviria "*La amenaza de la energía nuclear*" ("The menace of nuclear energy" Triunfo, 2nd February 1974) on the potential danger of these installations. Some started worrying and founded a group that took a critical stance on the project during the ensuing pronuclear discussions. Their point of view differed considerably from that of the rest of the villagers who saw their chance of making a living by working at the nuclear power plant.[113]

From the very beginning, local groups rallied in popular protest against the NPPs. During the first years, they were busy collecting data, reports, statements and articles garnered from the international press which provided information and arguments. But the first voices of opposition arose among Christian groups under the shelter of the parish, the safest place to gather while during Francoism all other gatherings were illegal. The role played by quite a few priests must be underlined. Clerics considered it their duty as Christians to show solidarity with those who were threatened in their opinion, to be dispossessed and robbed of their land. For this social commitment, the priests were severely reprimanded by the ecclesiastical authorities. The associations went well beyond the environs of the parish and turned into the core of the movement against the nuclear plant.[114]

In response to the electrical companies' report "The Nuclear Power Plants as a Source of Electrical Energy" published in 1974, the villages concerned submitted two reports. The first report had been compiled in 1975 by the Economic Department of the University of Barcelona. It analysed the impact of the plant of Vandellós on the area of L'Ametlla de Mar and its coast.[115] Later the *Comitè Antinuclear d'Ascó* and the Commission of the Representatives of Ribera del Ebro (CARE) drew up a new document in which they expounded their opposition to use water from the Ebro river to cool the NPP reactors. It called attention to the negative consequences for the environment and the agricultural economy of the area.

[112] Newspaper Antorcha. núm. 385 (24/1/1970).
[113] Ferrús i Batiste (2004).
[114] Font i Tió (2006).
[115] Hortalà (1975).

By interacting with city dwellers, who already were aware of environmental questions and who acted as allies from without, new elements entered the local discourse against the installation of nuclear power plants.[116] In this way, Ascó activists looked for support among scientists and lawyers, they established links with the academic world of Barcelona and together with it links to well-organised political movements who fought against the Franco regime. At the beginning of 1975, various professional associations joined and issued the manifesto "The impact of the nuclear power plants in Catalonia". The earliest criticisms of the NPPs came from scientists, engineers and some mass media right after the first Vandellós reactor started to work.[117] In 1977, the Antinuclear Committee of Catalonia (Comitè Antinuclear de Catalunya, CANC) was set up bringing together the small antinuclear groups which had been formed since the end of the sixties and especially during the seventies.[118]

Phase 2: 1977 - 1987

After Franco's death the opening of the political system and the very experience and maturity of society in general, concerning activism and political demands, gave new dimensions to the antinuclear protest.[119] Between 1977 and 1979 Catalonia recovered its autonomous government, the first democratic municipal polls elected new mayors and mixed commissions had to be formed to address territorial questions. One of the most prominent campaigners became the first democratically elected mayor of the village of Ascó on an anti NPP list.[120] As the opposing groups in the town hall could not possibly roll back the situation or stop the on-going construction, they demanded compliance with municipal laws and regulations and reliable information about the plant.[121] As at the regional level new political parties looked favourably on nuclear power, the local antinuclear movement had few options to make their demands. The projects of the NPP of Ascó was confirmed by the new authorities under the autonomous government, which at that time was a fully-fledged democratic one. In March 1978, the opponents organised the first antinuclear demonstration in

[116] López Romo & Lanero Táboas (2011).
[117] In June 1974, the newspaper *La Vanguardia* published an article where it warned of the contamination of the coast close to the nuclear plant of Vandellós I which made sea life sterile. In May 1976, another newspaper *El Correo Catalán* condemned placing radioactive isotopes in waters close to the reactor.
[118] Font i Tió (2006).
[119] La Vanguardia, 8 August 1982.
[120] La Vanguardia, 7 April 1979.
[121] La Vanguardia, 10 May 1979.

Barcelona, in which more than 50,000 people took part, demanding a nuclear moratorium and a halt to Spain's National Energy Programme. In June 1978, on the occasion of the *International Day against Nuclear Energy*, more than 100,000 people demonstrated in Barcelona against nuclearizing the country.

Meanwhile when the construction works of the plants made fast progress and the first problems with the installation of the reactors surfaced due to soft ground, some positions against the plant grew more radical and undertook a strategy of violence.[122] These actions caused a considerable delay in building and launching the nuclear plant, which almost a decade later would add to other factors in aggravating the financial crisis for the owner, FECSA which resulted in its virtual loss of ownership of the nuclear plant in favour of Endesa, the State owned company.[123]

To counteract this development, the strategy of the promoters was to make sure that there was a patron relationship. This had been reorganized as an entrepreneurial and municipal paternalism to exert social and political control on the workforce. This was supposed to counteract the antinuclear opposition, who by now sat in the town hall and who by denying the required municipal permissions, intended to put the construction of the nuclear plant and its functioning into question. The new town hall asked the University of Bremen, Germany, for a new report in 1982 that in conclusion disapproved of the presence of the nuclear plant taking into account the radiation and health risks (*El Periódico,* 12 August 1982).[124] This strategy finally failed in the second democratic municipal elections (1983) when FECSA compelled all its employees to take up residence in Ascó so that they could vote in local elections and in this way contribute to decisions which favoured the nuclear plant.[125]

The owners of Ascó opened an information centre about the plant in 1982. The permanent exhibition included the fundamentals of nuclear fission, nuclear safety, concepts of radiation protection and

[122] With the support of an extreme left wing break-away circles a series of violent actions (about 30 actions from 1980 until 1992) were perpetrated by the terrorists' movement "Terra Lliure" (Free Land) against companies that owned the plant.
[123] La Vanguardia, 19 juny 1983; La Vanguardia, 20 octubre 1985.
[124] La Vanguardia, 5 August 1982; La Vanguardia, 1 october 1982.
[125] El País, 15 may 1983. On the position of the company, see the information note in La Vanguardia, 29 August 1982.

emergency plans. Visits came from secondary education courses, vocational training, universities, associations in the area, official bodies, politicians, and groups of companies, etc.

The movement against Ascó NPP never enjoyed the reliable support of any political party who participated in what was to be called the "Spanish transition" to democracy. The requests of the citizens of Ascó, who were critical of the nuclear plant, to be received by or to consult with the new democratic representatives, are proof of the already mentioned tension between the rural world of the countryside and the urban one of the towns. As Jordi Pujol, President of the new Autonomous Government of Catalonia, declared, "*We cannot return to the times of the windmills*" (newspaper *El Noticiero Universal* (29/5/1982). The basic idea was that "*this is progress and cannot be stopped*."[126] Eventually, the judicial disputes between the local authorities and the plant, resolved in favour of the latter.

Phase 3: from 1988 to the present

On the social front, the accidents of Harrisburg and Chernobyl created a situation of distrust among the people. To this were added increasing knowledge about antinuclear movements in West Germany and Denmark that denounced the health risks caused by radioactive waste and nuclear arms proliferation. This state of public opinion boosted international campaigns against nuclear energy, which in Catalonia were supported by organizations of secondary importance (platforms, federations and coordinators). This resulted in campaigns which were directed towards international institutions and autonomous communities with the Grup de Científics i Tècnics per un Futur No Nuclear (Group of Scientists and Technicians for a Non-nuclear Future, GCTPFNN) as unifying group. Some of the mottos of the campaigns include: "Let's not Nuclearize the Climate" (*"No nuclearitzem el clima", 2000),* "Sustainable Nuclear? By No Means, 2001 (*"Nuclear sostenible? de cap manera", 2001),* European Petition against the use of radioactive weapons) *"Petició Europea contra la utilització d'armes radioactives".*

On the institutional front, in 1998, as a result of a merger between the companies that independently managed the Ascó and Vandellós II nuclear power plants, an economic interest group known as Asociación Nuclear Ascó-Vandellós II (ANAV) was born. The rather similar technologies of both

[126] Ribes Serrano (2008:31).

plants, and their relatively close locations, led their owner utilities to integrate them into a common management company. At Ascó and Vandellós nuclear power plants several activities aimed at personnel were carried out with more than 160,000 man-hours of training since the beginning of the project (this meant an increase of 15% in the time dedicated to Training at Ascó), and the associated documentation, with the revision of more than 20 procedures and the creation of more than 30 new guides.[127]

In 2011 the information centre at the NPP was renovated. For the companies running the plant, this new equipment, designed as an interactive space for the dissemination of information on nuclear energy and the operation of a nuclear power plant "responds to the multiple objective of meeting the existing demand for visits to the plant and at the same time generating added value that complements the offer of attractions for visitors to the region of the Ribera d'Ebre".[128]

In recent years the Vandellós/Ascó area has turned a pole of attraction of investment for other companies of the nuclear realm. In 2003 Tecnatom inaugurated its new research and training facilities in the area.[129] In 2007 Enwesa, a maintenance and assembly company specialized in the nuclear energy sector, also inaugurated a new branch with an investment of more than one million Euros and 50 employees.[130]

3.3. Event 3: the Basque antinuclear movement (1973-1984)

In the middle of the nuclear euphoria, in September 1973, the leading power company of northern Spain, Iberduero, applied for authorization to install 4 reactors in two nuclear power plants to be located along the 176 kilometres of Basque coastline, plus one more reactor to be sited in Tudela-Vergara (1,000 MWe) in Navarra.[131] Adding the Garoña plant (460 MWe), already in operation and known originally as the Bilbao-Ebro NPP, the two reactors the company had started in Lemóniz (920 MWe each), and another reactor by Viesgo in Santillán (Cantabria), according to these plans over 25% of the nuclear power plants in Spain would be located in the Basque Country. The social rejection response, slow until then, grew rapidly in view of the new nuclear challenge. Originally

[127] ANAV (2008) in http://www.anav.es/es/
[128] http://www.rinconeducativo.org/es/visitas/centro-de-informacion-de-la-central-nuclear-de-asco.
[129] Tecnatom (2009:18).
[130] ENWESA web page http://www.enwesa.com/en/company/shareholders.
[131] Punta Endata (Deba) and Ea-Ispaster (Orguella).

Lemóniz had been pre-authorized in 1969 for a single reactor of 500 MWe later expanded in 1971 to two units of 900 MWe and works began in 1972 but these had aroused little opposition, except some dissenting voices. The alarm was activated when the promoter, Iberduero, announced in late 1973 its goal of building five new reactors at once in three different locations.

From a social perspective, this event toured two distinct stages: 1) the configuration of a social movement defending the country through peaceful activist resistance between 1973 and 1977; and 2) the eruption of several extreme left terrorist groups from 1977 (essentially ETA-M, but also ETA-PM and the Anti-capitalist Autonomous Commandos) which used the antinuclear struggle as an instrument of their political strategy for the independence of the Basque Country. From a political perspective, this process was marked by the transition to democracy, the consolidation of new democratic institutions, and the rise of political nationalism and terrorist violence.

Table 3.3.1: Basque Country actors

Promoters	• Iberduero: the largest company of the Spanish electric power sector, with headquarters in Bilbao (Basque Country), a symbol of the Basque capitalism's success. [132]
Regulators	• JEN: Nuclear Energy Board and Ministry of Industry
Public bodies	• National, regional and local governments (the Diputaciones Forales) • Basque Government (since 1978)
Receptors	• Big Bilbao area inhabitants (more than 1 million) • Other concerned populations: Deba, Ispaster, Lemóniz, Tudela • Environmental movements: • Defence Commission for a Non Nuclear Basque Coast [CDCVNN] • Commission Against Nuclear Risk (Deba) • Local antinuclear committees (cities, neighbourhoods and villages)
Others	• Scientific: Basque universities. Aranzadi Sciences Society

The Basque region had, during this period, a high level of industrial development, and a human capital higher than the Spanish average. It ranked first among the Spanish regions in terms of electricity consumption and income per capita. However, the two oil crises knocked its industrial

[132] Founded in 1944, Iberduero became the main producer of electricity in Spain, with nearly 20% of the total. Had a network of over one hundred hydroelectric plants and operated a dozen power plants, with a dominant market position in northern Spain. It pioneered the nuclear program to build, through Nuclenor, the second Spanish NPP: Garoña.

economy with business closures and job losses. The sum of these factors affected the behaviour of the actors and their perceptions of the Basque anti-nuclear movement.

The social perception of the Basque anti-nuclear movement has been marked by terrorist violence against the only NPP that began building in Basque Country: Lemóniz. For some analysts, Lemóniz is inextricably linked to the complexity of the transition from the Franco dictatorship to democracy in the Basque Country. Within HoNESt, we must emphasise the uniqueness of this event within the European nuclear social conflict perspective.

Phase 1: 1968-1972

The words of the Minister of Industry in the official sanctioning of the contracts with Westinghouse for Lemóniz, Almaraz and Ascó, summarize the main argument of the promoter: "The strengthening of the nuclear aspect in the production of electrical energy" and "the crucial influence these facilities will have on the development of Spanish industry" (ABC, 30.06.1972). Nothing at the time indicated any rejection to these projects.

Phase 2: 1973-1978

In September 1973, Iberduero sought approval for 5 reactors to be installed in the Basque Country and Navarra, triggering social reaction. The case of Punta Endata NPP summarizes the attitudes of the promoter and the affected population. Before receiving prior authorization, Iberduero began purchasing land by means of a figurehead and undertook the first works without a municipal license. The neighbours got organized and created the Commission against Nuclear Risk. They hired a prestigious lawyer and began traveling through Europe seeking information. The town council denied the building permission to Iberduero. Antinuclear activism included collecting signatures, conferences, pursuing support from other municipalities in the province, from cultural organizations and from celebrities.

The highest level provincial institution commissioned a report to international experts who give reason to antinuclear: risk multiplied in a densely populated area. Guipúzcoa Provincial Council rejected the installation of Punta Endata NPP. It is worth noticing that the Commission at Deba[133]

[133] The small town of Deba, was one of the initial choices of Iberduero for siting a nuclear plant. It also found social opposition from late 1973. An event historised in Urdangarin et al. (2016)

ceased its activity on 15 February 1978 for two reasons: "the new political situation, which advised for the political parties recently established to take the leadership" and "the remission of the dangers posed by the construction of the NPP" given that the possibilities of the project to go ahead decreased over time”.[134]

The process was more complicated for Lemóniz NPP, which eventually become the symbol of the Basque antinuclear struggle. Despite starting works at the venue and concluding bidding processes for the reactor in 1972, Iberduero, the promoter, did not apply for a definitive building permit until September 1976, and for the required reclassification of the land from rural and natural to industrial uses until March 1977. The company made no attempt to correct it until the social opposition had fully-grown. The Committee for the Defence of a No Nuclear Basque Coast (CDCVNN) formalized in May 1976. The organization amalgamated antinuclear neighbourhood associations, cultural groups and, professional associations of Gran Bilbao. The economist and specialist in Urban Planning, Jose Allende led CDCVNN. Their commitment to the defence of the territory stemmed from their concern over the potential impacts of a serious accident in Lemóniz. Such an event "would mean the disappearance of the Basque people, and the disappearance of Euskadi as a political project".[135]

They used a variety of protest actions: demonstrations of more than 50,000 people, (some of the largest in the Basque Country after the Civil War), signature collection (over 150,000), informative lectures, requests for public discussion with all actors and sabotage during the construction works.[136]

None of that affected the strategy of the promoter and works continued and investment multiplied. The lack of dialogue among the actors and the institutional resolutions favourable to the NPP, created frustration. Meanwhile, the newly legalized political parties were able to make their position known within the conflict. At a broad-brush level, organizations of the left and extreme left positioned against Lemóniz (with great prominence of the radical “abertzale” –Basque nationalists on the far left- which made anti-nuclear speech one of their hallmarks), while right-wing parties were pronuclear (including a Christian Democrat party as PNV –the Basque nationalists on the right).

[134] CDCVNN (1981).
[135] CDCVNN (1981).
[136] López Romo (2012).

Phase 3: 1978-1984

In this third stage the process underwent a radical change. The terrorist organization ETA came into action. In a first phase, it acted against the plant under construction and against all types of company facilities, causing unintended victims. The spiral of violence intensified between 1981 and 1982 when ETA kidnaped and killed the Chief Engineer of Lemóniz and shoot dead the Project Director few months later. There were 13 deaths between 1977-1983 (seven activists of ETA handling explosives, five workers of the plant - three blue collar and two white collar- plus an anti-nuclear activist killed by the Civil Guard at a protest march). To those victims, ETA added other kidnappings, and more than 300 bombs on the electricity network, sent to Iberduero's offices and those of other companies involved in the construction of the plant. Moreover, the clandestine sabotage of the works of the plant proliferated, casting serious doubt on whether the plant could ever be safely operated.

Democratic institutions and social movements were forced to take a stand by this dramatic turn. The central and regional governments interpreted it as a challenge to the State and concluded: "*we cannot give in to blackmail*". The newly created Basque Parliament established commissions of inquiry and before taking a position. The CDCVNN and antinuclear committees (which proliferated throughout the region since 1978[137]) faced a moral dilemma: accepting, rejecting or living with terrorist violence to achieve their goal of stopping Lemóniz. They did not promote violence but never criticized or condemned it either.[138] The Three Mile Island (TMI) accident (see US Short Country Report) reinforced the arguments and the strength of the anti-nuclear movement, under the close vigilance and repression of the Police and the Civil Guard.

By the end of 1981, the deputy director of Iberduero stated that "*the administration pushed us to build Lemóniz, thus the administration must be consistent and assume its responsibilities*". An argument that power companies repeated in those years was that "*Lemóniz is a state problem rather than Iberduero's*". The Association Pro-Defence of Nuclear Energy in the Basque Country (1980), insisted "*countries that believe in nuclear power plants will live in progress; the others will sink into poverty*". So did the electoral programs on the right side of the political spectrum, "*nuclear power is required*

[137] Independent local units instigated from CDCVNN, due to the fear that if the regime acted against the group directing the movement it may disappear, thus the need to spread it out. Interview with Allende for HoNESt.

[138] López Romo (2012).

to achieve energy self-sufficiency in Basque for industrial recovery and to avoid the challenge of ETA against the state " (electoral programs of right –AP- and centre –UCD- parties in 1982). In May 1982, after the assassinations of the Chief Engineer and the Project Director, Iberduero unilaterally paralyzed the works. In September 1982 a Government Decree declared the Government intervention on Lemóniz- the Government was made responsible for the plant but the property remained with Iberduero- and created an Intervention Council responsible for properly maintaining the physical status of the plant, without any advance in construction. The promoter negotiated for a compensation. After two years halted, the 1984 moratorium included Lemóniz among the projects being stopped. The Basque terrorists reclaimed the closure of Lemóniz as their victory over the Spanish State.

3.4. Event 4: the 1984 nuclear moratorium

The energy policy of the new Socialist administration, which came into power in December 1982, included a complete review of the National Energy Plan. With respect to the electricity sector, analysts insisted on the need for institutional reform and avoidance of the over-investment that had accompanied previous planning. After a period of consultation and negotiation with the power companies and the banks, in the autumn of 1983, the government announced a nuclear moratorium.[139] It responded to the double imbalance of excess of borrowing and of power plants.[140] It was a “temporary” halt; revisable by 1992, if the energy demand required it, the 5 reactors affected by the moratorium may restart building again.

[139] Ministry of Industry and Energy of October 14, 1983. The New Energy Plan passed in 1984, and so were the provisions establishing how the costs of the moratorium would translate on to electricity tariffs. It would take 4 more years to define the recognized costs of the moratorium; see BOE-A-1988-4778.
[140] This formed the essence of the strategy by the Ministry of Power and Industry see Cortes Generales: Congreso de los Diputados nº 12, ‘Acta de la Comisión de Industria, Obras Públicas y Servicios’ 22/02/1983, available at: http://www.congreso.es/portal/page/portal/Congreso/Congreso/Publicaciones/.

Table 3.4.1 Nuclear moratorium actors

Promoter	• General Secretary for Energy (Ministry of Industry) • Socialist Party • Parliament (legislator)
Regulators	• CSN (Nuclear Safety Board)
Receptors	**Electricity sector** • Companies of the electric power sector • Electricity power large shareholders (family capitalism) • UNESA (Electric lobby) **Nuclear Industry** • Companies directly participating in the construction of nuclear power plants • 40,000 workers in the Nuclear Industry (Unions) • Foro Atómico Español (Nuclear lobby) **Financial institutions** • National Banks (The Seven major: Bilbao, Santander, Vizcaya, Hispano Americano, Central, Banesto and Popular) • Spanish Private Banking Association • Foreign Banks (from US, UK, EU and Japan) **Civil population** • Population of the areas with halted NPP • Antinuclear movements • Electricity consumers: homes and industries (tariff increase over 30 years)
Others	• Central Bank (Banco de España: international Payment Systems)

In this case the receptors split between those formally against the moratorium (electricity companies, the nuclear industry and the Spanish banks –as shareholders of the industry), those that accepted the decision as long as their interests remained untouched (the international banks) and those that saw in the moratorium a way of partly satisfying their demands (the antinuclear movements, for which however, the moratorium was insufficient).

<u>Phase 1 –the period leading to the moratorium (1979-1983)</u>

Following the TMI (Harrisburg) incident, industrialized countries had toned down their nuclear programmes.[141] International reports were now warning that nuclear power ceased to be a cheap

[141] Most of this section has been borrowed from De la Torre and Rubio-Varas (2016).

source of energy once the costs of radioactive waste management and the dismantling of defunct power plants were included.[142] This was particularly true in Spain given that the institutional response to both these issues was still pending.[143]

Three years before becoming General Secretary for Energy, in 1978, Martin Gallego had written a series of articles in a national newspaper about the future of the electricity sector. In those, he classified the stakeholders of the electricity sector in Spain, pointing at the imbalance of power regarding the decision-making process in the Spanish electricity sector (see Table 3.4.2). His depiction helps to understand how the major electricity companies had driven themselves into heavy overinvestment resorting to international debt: a tiny group of people held the power over the decisions being made. In 1978, Gallego had pointed out the disadvantages of the lack of integration of Spanish private electric companies compared to the predominant public ownership in most European countries; and their reduced size and productivity much lower than that of US private power companies. He also pointed out that the focus of the utilities nuclear investments, essentially oriented towards their benefits, posed serious difficulties for the Government to amend actions that prevented the construction of public trust, which was inexistent but indispensable.[144]

Meanwhile, the economic crisis was deepening, and ETA contributed to the debate with its terror attacks. Some antinuclear movements asked for a moratorium and a popular plebiscite already in 1979.[145] The energy sector entrepreneurs' association continued its campaign in favour of nuclear energy, with warnings of the risk of a return to underdevelopment if the nuclear path was to be abandoned. In written press, TV debates and radio programs the pro-nuclear insisted that nuclear was *the only way* out of the economic crisis (caused indeed by the strong dependence on petroleum).[146]

[142] BOC Nº 129.
[143] Safety legislation, at least, had been strengthen. In March 1981, the Nuclear Safety Council (CSN) was set up to, among other things, pass on to Congress the six-monthly reports on the civil uses of the sector. Consejo de Seguridad Nuclear (CSN) *1982-1986. Informe al Congreso de los Diputados y al Senado*. (Madrid 1982) p. 9).
[144] Gallego Málaga et al. (2010).
[145] 'Muchos piden un plebiscito popular` El País, 27- 04-1979.
[146] In prime time, with only one TV channel, there was a debate in june 1979 about "nuclear danger" in which participated most actors, with the notable absence of the nuclear industry and the electricity companies. RTVE, 21 June 1979 [available at: http://www.rtve.es/alacarta/videos/la-clave/clave-peligro-nuclear/3605246/.

Table 3.4.2 - Stakeholders and interest in the Spanish electricity sector by 1978

Stakeholder	Type	Size of group	Influence on the electricity sector	Needs and wants from the sector
Consumers	Industrial	Small	Relative	Acceptable service, minimum price
	Domestic	Large (all of them)	Very scarce	Idem plus avoid subsidising industrial consumers
Environmentally affected population by the electricity installation	Expropriated landowners. Affected by actual or potential emission of sulphur, nuclear radiation, etc.	Large	Very scarce	Risk, sanitary decay and environmental effects. Seek appropriate compensation
Shareholders of electricity companies	Individual shareholder	Large	Very scarce	Return on investment. Liquidity. Good share price in capital markets
	Institutional shareholder	Small	Scarce	
	Oligarchy (electricity families, owners and banks)	Tiny	Large	Continue to keep the control of the sector, getting around rationalising the sector by increasing tariffs
Employees of electricity companies	White collar	Tiny	Relative	Maintaining high wages
	Blue collar	Medium	Scarce	Promotion, keep job and salary

Source: Translated from M. Gallego Málaga, El futuro del sector Eléctrico español (3), El País 27- 05-1978.

Phase 2- from "temporary" to "permanent" moratorium (1984-1994)

The government portrayed the moratorium as the necessary 'rationalization' of the electricity sector and the only viable option to restore their wrecked finances. A 'giant snowball' is the perception of a government employee who was directly involved in calculating the cash flows of the electricity companies: the companies were in negative numbers, it did not matter how the figures were calculated.[147] The companies had more debts to pay than income entering their accounts. The gap was expected to get worse given the nuclear commitments building at that time. A financial rescue

[147] In our interviews Martin Gallego, Mestre, and a government employee who was directly involved with the calculations who prefers to remain anonymous.

had to be done without harming the share price on the stock market of the companies involved and seeking the complicity of the international banks to continue financing them.

UNESA and the Spanish Atomic Forum had acknowledged the moratorium as inevitable. They accepted the compensation mechanisms but expressed concern regarding the impact on auxiliary industries.[148] And they also questioned the pure techno-economic reasoning and suspected political reasons behind the moratorium. For some years, the companies hoped the affected plants would be finished and pressed for it.[149] Then the Chernobyl nuclear accident happened (see Ukraine Short Country Report) and the option to restart the works seemed further away.

The procedure for the compensation to the utilities for the moratorium took a long time, reaching the first agreement by 1988. The companies argued that the moratorium 'addressed, in a realistic fashion, the financial adjustment of the sector, made necessary due to the major investment that had been demanded from the sector by the Administration in the past'.[150] In other words, the companies blamed the overinvestment on the coercion of previous administrations rather than their mismanagement, thus the administration must compensate them. It took until 1994 when the five projects, paralyzed a decade earlier, finally became officially cancelled.

There were many private meetings between the government delegates and the electric utilities and the banks (national and international).[151] None of that discussion was made public. The government disregarded any communication strategy for explaining the moratorium to the public. The media would inform without guidance from the government. Unlike the electricity firms, the nuclear industry was never involved in the discussions with the government about their fate regarding the moratorium and looked for eventual compensation through their contracts with project owners.[152] But the industry

[148] The Spanish Confederation of Business Organisations (CEOE) and the Confederation of the Metal sector also expressed their fears for the nuclear manufacturing network (*El País* 15 October 1983; November 6, 1983; December 6, 1983; December 17, 1983). An appraisal of the power company situation, in E. Ontiveros and F.J. Valero (1985:45-52. An overview of the sector in Foro Nuclear, *La industria nuclear española.* Madrid (2011).
[149] Interview with Serna for Valdecaballeros, but also the works continued for pieces due for other NPP at ENSA; interview with Alvarez-Miranda.
[150] The power companies' view was expressed at the Unión Eléctrica-Fenosa General Assembly, held in May 1984. From *Economía Industrial*, 1984, nº 237.
[151] interviews with Martin Gallego, Carmen Mestre, and a government employee who was directly involved with the calculations who prefers to remain anonymous.
[152] Interviews with Segarra, San Antonio and Alvarez-Miranda.

paid for full page adverts in the newspapers decrying the disastrous effects of the moratorium on employment and the industrial development of the country.[153]

Neither antinuclear movements nor local populations were consulted about the moratorium according to sources at both ends, our interviews and, the available evidence.

Phase 3- 1994- to the present

Three decades after the Spanish government's decision to pause and reshape the country's nuclear power program, the controversy lingers. Some from the old guard of the electrical companies judge it to have been a mistake with very little technical justification. Others, typically from the right-wing People's Party, see it as one of the greatest economic disasters to have befallen Spain since the transition to democracy. Still others view it as the government's response to the financial breakdown suffered by the major power companies that had embarked on a nuclear program that overstretched the country's capabilities.[154]

Between 1984 and 1994 the electricity companies and the nuclear industry privately attempted to have the government revise the moratorium. Declarations in newspapers, TV and radio reclaimed the need to restore the original nuclear plans. Accounts of the moratorium in industry pamphlets tended to portray it as a politically unjustified decision (if any). Since 1994 press articles regularly covered the topic, but no consistent campaign from either side has occurred.

3.5. Event 5: Radioactive Waste Management in Spain

Radioactive waste management shows the Spanish evolution from top-down, unidirectional, strategies applied in the earlier decades to a more comprehensive, bidirectional and participative approaches for interacting with society in the last thirty years. In that sense, the management of El Cabril from the 1990s exemplifies how continuous and direct contacts with the locals, incorporating participatory methods, generate trust building processes. By its part the process for siting the Centralized Temporary Storage (ATC), initiated in 2004 but yet unfinished, illustrates the challenges

[153] ABC, 7 october 1983.
[154] Centeno, (2009); Narbona and Ortega, (2012); Sánchez Vázquez, (2009).

that inclusive nuclear waste governance entails in a country with a complex and intertwined political decision-making process.

Table 3.5.1 Waste Management actors

Promoters	• JEN (until 1984) • ENRESA (from 1984)
Regulators	• Consejo de Seguridad Nuclear (Nuclear Safety Council) including the division of Earth Science from the same organisation. • - Supreme Court of Castilla-La Mancha and the Council on Public Transparency.
Receptors	• National government, Ministry of Justice, Inter-ministerial Commission • Autonomic governments: Parliament of Catalonia, provincial council of Cuenca, Castilla-La Mancha Council. • Local government all the town councils candidates.
	• Social and organisations and environmental movements: • Against: Plataforma contra el Cementerio Nuclear en Cuenca, Greenpeace and Ecologistas en Acción. • Pro: Agrupación de Empresas de Villar de Cañas, Plataforma SÍ queremos el ATC en Villar de Cañas.
Other (scientific)	• Instituto de Salud Carlos III. • Institute of Geologists. • Transparency International Spain. • URS (engineering company hired by CSN to provide technical support the project).

Phase 1: Dealing with the first (low and intermediate level) radioactive wastes (1950s-1985)

The management of low and intermediate level waste in Spain is closely linked to El Cabril, located in the northwest of the Province of Córdoba, in the municipal district of Hornachuelos, at around 130 km from the capital city, in a rural area of very low population density. The origins of El Cabril date back to 1935 when uranium ore was discovered in that area. It was intensively exploited from the 1940s until its closure in 1959.

The generation of radioactive waste in Spain began in the 1950s as a result early research into the use of radioactive isotopes in medicine, industry and agriculture, as well as in particular research centres.[155] From 1961 the Nuclear Energy Board (JEN) started to use the former uranium mine in El

[155] https://www.oecd-nea.org/rwm/profiles/Spain_profile_web.pdf.

Cabril for storing low level waste.[156] The storage of radioactive waste was first regulated by the Nuclear Energy Law of 1964, although before this date El Cabril already exercised, as has been said, as the storage of radioactive waste. [157] In October 1975 El Cabril was licensed as a deposit of radioactive waste, after more than 3000 drums had already been stored. This means that until that moment it did not receive the first official authorization. It is then, when the existence of the deposit became public, that the first social protests took place.

Until 1985, the nuclear power plants, still under the supervision of JEN, stored their own waste at the nuclear sites awaiting its final destination.[158] In 1986 the waste stored at El Cabril was moved from the mine into new buildings on the same site.[159] But the real changes in waste management started in parallel.

Phase 2: The creation of ENRESA and the management of low and medium radioactive waste (El Cabril)

In 1984 the National Company of Radioactive Waste (ENRESA) was established to provide services and special facilities for storage, transportation, disposal and handling of radioactive waste.[160] ENRESA was set up as a state-owned limited liability company, independent of waste producers, and is also responsible for the decommissioning of nuclear installations. The company is supervised by the Government. The installations at El Cabril underwent a thorough modernization becoming a near-surface disposal facility with engineering barriers, taking the French "Centre de L'Aube" as reference. Designed by INITEC Nuclear (Westinghouse Electric Spain) the preparatory work started in 1986, the construction in January 1990, and the authorization for start-up was granted in October 1992. ENRESA has operated El Cabril since 1992, when it began to receive low-and intermediate-level waste.[161] El Cabril is considered by the United States Nuclear Regulatory Commission (NRC)

[156] In this sense, JEN followed the recommendations of the American National Academy of Sciences; Caro (1995:128); National Research Council (US) Committee on Waste Disposal, (1957). The Disposal of Radioactive Waste on Land. Washington (DC): National Academies Press US.
[157] Ayllón (1999) p. 166.
[158] Caro (1995) p. 48.
[159] Interview with Gonzalo Madrid, last president of the JEN and first of CIEMAT.
[160] Royal Decrees 1552/1984, july 4th and 1899/1984, august 1th..
[161] http://www.westinghousenuclear.com/About/News/View/Westinghouse-Wins-Contract-to-Continue-Supporting-Spain-s-El-Cabril-Waste-Repository (visited on 19.02.2018.). Among other projects, ENRESA, has participated in the construction of the waste repository in Bulgaria at Kozloduy, whose reference facility is El Cabril, Biurrun et al(2013).

as one of world's best radioactive waste disposal facilities, being a model for similar centres in other countries.

In line with the IAEA guidelines and the requirements of the Aarhus convention[162], ENRESA recognizes that if public acceptance is to be achieved, "it is necessary to provide and impulse public participation in decision making"[163]. To this end, communication, consultation and engagement initiatives have been carried out in El Cabril (ENRESA, 2007)[164]. During the licensing period ENRESA focussed on getting to know the local communities and inform them about the characteristics of the facility. In the licensing process of El Cabril, the legislation in force at that time requested an environmental impact assessment to evaluate the suitability of the site for its purpose. That assessment was carried out in the context of the construction authorisation of an existing facility which was expanded. A number of local institutions were involved in this communication process although the Town Council played the main role. One of the first actions was the opening of an information bureau to explain not only the details of the disposal facility, but also the job-related opportunities and requirements for workers and contractors. ENRESA, in collaboration with the local authorities, provided training to the locals and gave priority to local companies in any service contract (Molina, 1996).

In terms of economic compensations, measures to provide financial allocations to the municipalities have been in force since 1988.[165] Such financial allocations were taken from the Fund to perform the activities of the General Radioactive Waste Plan, managed by ENRESA. According to the system established besides Hornachuelos (the village hosting El Cabril), the Spanish legislation provides financial allocations to villages located up to 8 km from the facility.[166] It is important to note that natural spaces, endogenous resources, and agriculture are key socio-economic components for the

[162] Act 27/2006 of July 18 that regulates the right to access information, public participation and access to justice in environmental matters
[163] Lang-Lenton, J (2001)
[164] ENRESA (2007:69)
[165] In 1988, a Ministerial Order was adopted to authorize ENRESA to allocate funds to town halls of municipalities where facilities are located specifically for the storage of radioactive waste, plus other municipalities defined as affected. One year after, a new Ministerial Order extended the scope to nuclear power plants that store the spent fuel generated by them in their own sites. The system of allocations to the municipalities was further refined by the jurisprudence and new Ministerial Orders in the following years, to the existing Ministerial Order in force of 2015. (Order EIT/458/2015, of 11 March, regulating allocations to municipalities in the vicinity of nuclear facilities from the Fund for the financing of activities included in the General Radioactive Waste Plan).
[166] BOE – Official State Gazette Ref A-2001 12320 pp22910

sustainable development of this rural area. Studies on the economic impact of El Cabril indicate a positive effect in its area of influence. This indicator is manifested in the index of job creation and the impact on the remuneration of the work of residents in the local municipalities, as well as the direct allocations linked to the operating company ENRESA.[167] Thus, from 1989 to 2006, the economic compensations provided by ENRESA included more than 30million euros in salaries; 30 million euros in compensations to the affected municipalities; and around 6.5 million euros from the ENRESA foundation.[168]

→ ***Public perception, communication and engagement activities in El Cabril***

The available evidence on public perception indicates that, at first, in a context of lack of information and, consequently, distrust towards ENRESA, the facility was perceived as being imposed on local residents. The media echoed this distrust, emphasizing the fear of the unknown. The Anti Cabril movement group, supported by environmentalists, politicians and unions, argued that the facility 'has hindered' the development of the region.[169] At the regional level, ENRESA actions were rejected by both the public and opinion leaders.[170] This opposition included anti-ENRESA demonstrations outside the main entrance of El Cabril.

From 1989 ENRESA commissioned several studies to track the public perceptions of the facility and its economic and social impacts in the area of influence (2009[171], 2010[172], 2014[173]). In addition, the Chair on Sustainability, created at the Cordoba University in 1996, has been very active in promoting deliberative workshops in the area of influence of El Cabril[174] (Local Encounters for Sustainable Development- ELDS in Spanish). Thus, stakeholders who believed they could contribute to the sustainable development of their villages were invited to present opinions and proposals and discuss them with local institutions, including ENRESA.

[167] Arjona et al. (2009: 6).
[168] Arjona et al. (2009)
[169] Alba, A., 2004. IU pedirá los planes de emergencia de El Cabril. Diario Córdoba, 12-08-2004 (was last Accessed 30 August 2016). goo.gl/KlWzOD.
[170] Lang-Lenton(1999)
[171] Domínguez Vílches, E. (2010)
[172] see also the results of the study Arjona et al (2009: 15-18).
[173] Gil-Cerezo and Dominguez-Vilches (2014)
[174] http://www.cma-enresa-uco.net/cma/

Interviews with key local stakeholders in the area indicate changes in the perception of risk, with risks perceived to be lower today than in the past. This perception of risk, as in some other cases, was not shared among the population of more remote municipalities and with less exposure.[175] Key findings from the local participatory workshops show that the original local rejection was mainly based on the perceived negative socio-economic impact in the nearby villages, as they felt they were not sufficiently compensated. Notably, dissatisfaction was not limited to El Cabril, there were other local matters also perceived to be restricting the sustainable development of the area (public policies on natural environment or rural development). The environmental mediation – leaded by the local university – allowed, for the very first time, the integration of ENRESA's representatives in the local debates as a 'local company' committed with the local sustainable development. This change in the institutional image of ENRESA, in turn, fostered the creation of the `Group for active social dialogue towards local sustainable development'. As a result of the whole mediation process not only tensions were reduced, but trust and smooth interactions were promoted between ENRESA and the local residents[176]. This evidence shows that, with the support of the administration, as hitherto, and by informing and involving the public and its opinion leaders, the social objectives of radioactive waste management can be achieved.[177] Finally, and following the suggestions by the ELDS mediators', any change in El Cabril activities' that may provoke social destabilization or damage the fruitful relationship (so hardly stablished) between ENRESA and the local communities would require special communication and engagement actions at the local level.

Phase 3: The management of high level radioactive waste (ATC)

The successive Plans for the Management of Radioactive Waste considered the Centralised Temporary Waste Store–in Spanish *Almacén Temporal Centralizado* or ATC- as a suitable transitional strategy for high level radioactive waste management (HLRW) and Spent Nuclear Fuel (SNF). It was argued that the ATC option was economically, strategically and technically better than the Individualized Temporary Stores at the NPPs, as it provides more time for adopting 'final solutions' and reduces the number of nuclear installations. By 2004 a resolution by the Congressional

[175] Domínguez Vílches, E. (2010)
[176] Gil-Cerezo et al. (2017).
[177] Lang-Lenton, (1999).

Commission on Industry, urged the conservative Government, in partnership with ENRESA, to develop criteria for establishing the ATC. The 6th General Plan for the Management of Radioactive Waste, drawn up by ENRESA and approved by the Spanish Council of Ministers on June 23rd 2006, gave priority to start the ATC. Notably, a major requirement was that the decision-making process should comply with the principles of voluntarism, transparency and openness. This is a substantial milestone in the nuclear history in Spain. For the very first time, there was a clear determination towards a more inclusive and dialogue-oriented nuclear governance.

A relevant antecedent in this direction was the creation of the Dialogue Board for the evolution of nuclear energy in Spain (in Spanish known as '*Mesa sobre energía nuclear*`) in 2005 (November the 29th)[178]. The Board was chaired by the General Secretary of Energy and included representatives from all political parties in Congress and Senate, public bodies in charge of nuclear, environmental and industrial matters, trade unions, municipalities, consumers and environmental groups[179]. The Board concluded that the ATC was a need for the country (with the only disagreement of the environmental groups).[180] It should be noted that the Spanish environmental groups are opposed to any type of waste policy, as long as nuclear power plants are in operation. Another milestone was the launching of the Community Waste Management (COWAM)[181] Spain initiative (2004-2006) with the involvement of AMAC (Association of Municipalities Affected by Nuclear Power Plants), the CSN and ENRESA. Based on the COWAM experiences at the EU (and its methodology to search suitable candidate sites[182]), AMAC announced its commitment to support the government in the ATC siting process, and organized a number of information meetings, seminars and debates in the nuclear areas.

The need for an ATC was fully debated in, and supported by, the Parliament, at least in three occasions between 2004 and 2006[183]. Thus, in April 2006, an Interministerial Commission (IC) for the ATC was set up by the government to look out for the transparency and openness of the decision-

[178] http://www.minetad.gob.es/energia/nuclear/mesa-dialogo/Paginas/mesa-dialogo.aspx
[179] Green Peace and Ecologistas en Accion
[180]http://www.minetad.gob.es/energia/nuclear/mesa-dialogo/Clausura/C.%20Conclusiones/Conclusiones_EeA_GP.pdf
[181] http://www.cowam.com/ Euratom Research and Training Programme on Nuclear Energy within 6FP (2002-2006)
[182] The European network on radioactive waste governance involves local actors, experts, implementers and regulators to enhance the quality of RWM decision-making processes.
[183] ENRESA (2010)

making process around the siting of the ATC (RD 775/2006). With the support of a Technical Advisory Committee, the IC defined the basic criteria for the ATC and facilitated all the necessary information to municipalities and entities potentially interested in hosting the ATC. In the words of the (at that time) President of ENRESA 'the launching of such a transparent and public procedure is a unique and inspiring experience, a real challenge for the involved public bodies, institutions, political parties and stakeholders. Moreover, it is an opportunity for democracy to show how reasonable solutions can be found on significant topics requiring broad consensuses'.[184]

→ ***The call for candidates to host the ATC:***

In December 2009 (BOE 23 December 2009) a public call was launched which gave any interested municipality a month to apply as candidate to host the ATC. The call clearly defined the basis and the procedure of the decision process, specifying that the Central Government would be the one designating the ATC site once the process ended. The Interministerial Commission deployed a series of informative and support actions to help potentially interested municipalities. All documents produced by the IC during the selection process were uploaded at the web. (www.emplazamientoatc.es).

In February 2010 the IC elaborated a report describing the selection process and presenting the final list of selected candidate sites.[185] It should be noted that most candidate municipalities were rural, isolated, underdeveloped areas. A month later, a Public Information and Participation (PIP) procedure was opened so any interested party could present arguments and request clarifications on the decision-making process (BOE March 6 2010). In addition, individual notifications on the PIP procedure were sent to municipalities, councils, Autonomous Communities, the Spanish Federation of Municipalities and Provinces, associations and organizations. Finally, and taking into account the considerations (if any) by the Autonomous Communities, in September 2010, the IC published a report with the proposed candidate sites. A total of 8 municipalities from 5 Autonomous Communities were finally accepted.[186] The accepted sites were then evaluated against the pre-defined quantitative

[184] ENRESA (2010)
[185] A total of thirteen candidacies were presented (CI, 2010)
[186] The towns were: Albalá (Cáceres), Ascó (Tarragona), Congosto de Valdavia (Palencia), Melgar de Arriba (Valladolid), Santervás de Campos (Valladolid), Villar de Cañas (Cuenca), Yebra (Guadalajara), Zarra (Valencia). CI (2010*) Informe de propuesta de emplazamientos candidatos para albergar el emplazamiento del almacén temporal centralizado (ATC y su Centro tecnológico asociado)*

and qualitative criteria that had been favorably valued by the CSN (for details on the criteria see: IC, 2010). The IC concluded that although all sites were technically viable, Zarra, Ascó, Yebra and Villar de Cañas (in this order) were the most suitable ones, with little technical differences among them.

→ ***The selection of Villar de Cañas and the political blockage***

On 30 December 2011, the Council of Ministers designated Villar de Cañas, a very small rural municipality in the province of Cuenca, as the site to host the ATC. ENRESA started the licensing process by sending the corresponding formal request to the Ministry of Industry, Energy and Tourism (Minetur).[187] The process took over 4 years. In July 2015[188] the CSN, in its plenary session, favorably informed and forwarded to Minetur the prescriptive and binding report to the site license and the favorabley report on the public radiological impact in normal operation, establishing the limits and the conditions in terms of nuclear safety and radiological protection.[189] By law all the information related to the nuclear related ATC licensing process was (and still is) available at the CSN website (www.csn.es/almacen-temporal-centralizado).

But, a crucial element in the licensing process was a combination of the complex Spanish political system and the changing position of the affected Regional Government (Castilla La Mancha). In February 2010 the Regional Parliament, ruled by the socialist party, declared that no ATC (or any other nuclear facility) should be installed in any of the provinces or municipalities under their control, as they supported a sustainable development model based on renewables.[190] In 2012, with the conservative Popular Party now ruling the region, the ATC was fully supported.[191] Yet, on July 2015 the Socialists took power in the region again, ousting the conservative Popular Party, which rules at the national level, and the ATC was (once again) fully rejected at the regional level. The collision of interest between the national and the regional government was set. The regional government strategy focussed on expanding a Specially Protected Bird Area (ZEPA in Spanish) known as '*Laguna del Hito'* (from 1.000 Ha to 25.000 Ha) to include ATC land. This decision by the Government of Castilla La Mancha was challenged by the (central) State's Attorney and the final statement by the

[187] In 2006 the CSN plenary session favorably assessed the conceptual basic design of the ATC without a specific siting location.
[188] https://www.csn.es/notas-de-prensa3/-/asset_publisher/tRe0sHX3tTTE/content/el-csn-establece-condiciones-en-el-informe-favorable-para-la-autorizacion-previa-del-atc
189 Instrucción del Consejo IS-29
[190] *http://www.castillalamancha.es/sites/default/files/documentos/20120511/memoria2010.pdf*, pág. 2
[191] *Boletín Oficial de las Cortes de Castilla-La Mancha,* núm. 28, de 8 de febrero de 2012, pág. 612.

Courts is still pending.[192] As of 2018, the ATC is awaiting final approval in the licensing process to obtain the construction permit from CSN, that is mandatory to start the construction activities.

→ ***Public perception, communication and engagement activities in the ATC***

Very limited social research on the public perception and/or acceptance of the ATC at the candidate sites is available, and most of it relates either to the Ascó candidacy (as part of the socio-environmental conflicts in Catalonia[193]) or to Yebra.[194] Considering the scope of this report, this section focusses on public perceptions of, and social responses to -including the related communication and engagement practices – the location of the ATC in the finally selected site (Villar de Cañas).[195] The nature of the available evidence must be kept in mind.[196]

The Plenary Session of Villar de Cañas City Council unanimously agreed to present its candidacy to host the ATC (BOE 313, January27th 2010). The first and main argument was the need to stop the major, and increasing, depopulation in the area. But as in other candidate sites, platforms and movements emerged at the local level to both support and reject the ATC candidacy. On the one hand we find, for instance, the 'Platform Yes we want the ATC in Villar de Cañas'[197] and the Association of Companies of Villar de Cañas[198]; on the other, the "Platform against the nuclear repository in Cuenca'.

The pro ATC collective claims that the ATC is the best solution for the huge depopulation problem in Villar de Cañas. They argue that ATC will transform the area in an internationally recognized research, development and innovation reference in the search of solutions for radioactive waste management. They declare they have no ideological principles or vested interests; they just want a future. The Yes Platform became very active all along the decision-making process, collecting signatures and presenting their arguments. The pro ATC platform intensely reacted against the (previously mentioned) extension of the ZEPA area proposed by the Autonomous Community.

192 Bello Paredes, S. (2015

193 Prades Tena et al (2015); Maestre Andrés, S. M. (2017)

194 Costa Morata, P., & Baños Páez, P. (2010)..

195 In our view this case sufficiently illustrates some of the key arguments underlying the siting process for the ATC in Spain.

196 Web pages and public documents from ENRESA, CSN, Interministerial Commission, AMC, CI, NGOs, affected municipalities, etc

197 http://plataformasiatc.blogspot.com.es

198 http://www.vocesdecuenca.com

Signatures were collected through the change.org platform[199], and buses with neighbors went to the capital (Cuenca) to demonstrate against the uncertainty created by such a 'stand-by' situation, and its implications for the local economy. More than 1,500 individual allegations were presented only at Villar de Cañas municipality.[200]

The "Platform against the nuclear repository in Cuenca" rejects the ATC, not only for Villar de Cañas but for any other municipality in Castilla La Mancha, and commits to mobilize the citizens to avoid it.[201] It is formed by 49 organizations, including public and private bodies. A key argument in their manifesto relates to the decision-making process. They claim that in a complex, long-term, and global issue (such as radioactive waste management), the final responsibility cannot be only assigned to local entities. They support a new energy model based on renewables, sustainable tourism, and high quality foodstuffs; a model that enhances local values and resources (historical, archeological, natural, etc.). They claim to represent the opinion of a majority of Cuenca's society. The anti-platform was also very active all along the process, organizing protest, demonstrations, and deliberative workshops at the local and the regional level.

Spanish environmental groups are opposed to any type of waste policy, as long as nuclear power plants are in operation (as previously said). The two main environmental NGOs in Spain (Green Peace Spain and *Ecologistas en Accion*) were also very active in engaging the ATC decision-making process. For instance, and among other actions, *Ecologistas en Accion* presented an allegation requesting a negative Environmental Impact Assessment (EIA) for the ATC at the Government Delegation in Cuenca.[202] Their request was mainly grounded on the need to preserve the Natura 2000 network, and on the lack of appropriate geological or accident risk assessments. In 2015 Green Peace required the government to recognize that the ATC is not a viable option, and to definitively cancel the project. They claim for a dialogue process to find a solution for radioactive waste, involving the whole society, which should start with an agenda to close the NPPs.[203] Greenpeace also

[199] Change.org, one the world's biggest request platforms
[200] http://plataformasiatc.blogspot.com.es/
[201] http://cuencadicenoalcementerionuclear.blogspot.com.es/
[202] Ecologistas en Acción (2017)
[203] Greenpeace (2015) http://archivo-es.greenpeace.org/espana/es/news/2015/Noviembre/Greenpeace-celebra-la-anulacion-del-Plan-de-Ordenacion-del-municipio-en-el-que-se-ubicaria-el-ATC/

published a document highlighting the ATC transport risks':[204] radioactive waste will pass through 216 municipalities in their way from the NPPs to the ATC. Lastly, and in line with the Anti Platform at Villar de Cañas, a relevant argument in the environmentalist narrative (Costa Morata and Baños, 2010) is that radioactive waste management is a global, transboundary, issue so it cannot be just 'confined to a limited piece of land'. In their view, and as for other techno-environmental problems, social legitimacy does not necessarily come together with the municipal-administrative one.

This short outline on the public perceptions and social responses to the ATC decision-making process and its results does not intend to be exhaustive or systematic; it just aims to illustrate the variety and complexity of the social arguments underlying the pros and cons towards the ATC in Spain. To conclude, despite the willingness to define and implement an inclusive decision-making process (based on public information and participation procedures, and open and transparent principles), the final result of the process – the selection of Villar de Cañas – did not obtain the expected support, and the ATC works remain politically blocked.

3.6. An overview of public opinion towards nuclear energy

Opinion polls can provide useful insights on public attitudes towards nuclear energy and its changes (if any) through time, both at the national and at the local level. Notably, although quite a number of public opinion polls towards nuclear energy have been found (at the national and the local level) there is little consistency in terms of the survey design, its specific objectives, and the sampling. Thus, the polls have addressed a quite wide range of diverse nuclear related issues in different historical moments, so there are strong limitations in terms of historical and comparable data or longitudinal analysis.[205] Even though, the available evidence does provide a useful overview of the Spaniards opinion' towards nuclear.

Figure 3.6.1 shows the **number of public opinion polls** on nuclear related issues identified in a first approach to the topic (i.e., there may be surveys on other topics including a couple of questions on nuclear attitudes). It is important to stress that the figure below does not reflect an exhaustive and systematic review, but an overview.

[204] Greenpeace (2015) .
[205] For an early review see Ferrando (1981); Aragones et al. (1993).

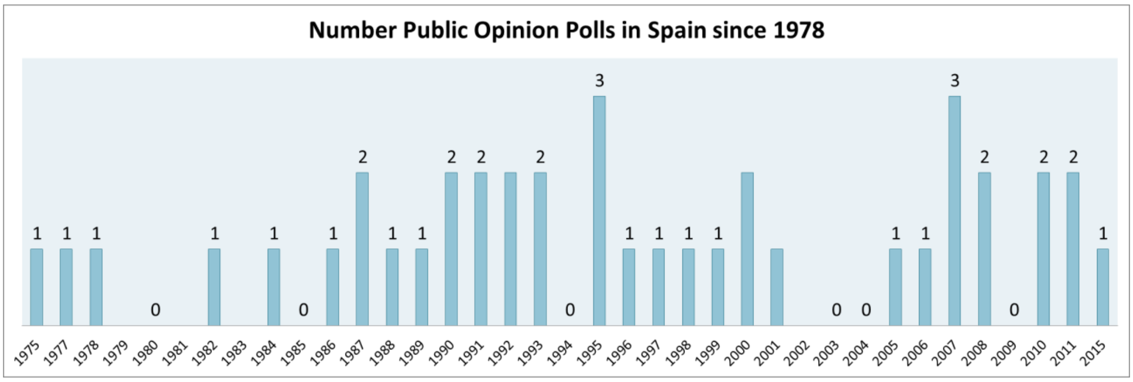

Figure 3.6.1 - Number of polls on nuclear in Spain at the national level (source: own preparation based on the opinion polls quoted in 'sources of evidence')

The **nature and the evolution of the topics of interest** for the institutions commissioning social research on nuclear energy in Spain can also provide insights in terms of the issues in the public arena. For instance, it is worth mentioning that during the first years most surveys dealt with the understanding and perception of radiation issues. NIMBY (Not in My Backyard) issues do not emerge as a topic until 1990; risk perception becomes crucial from 1993 (including the perception of both health and environmental risks); support to research in nuclear energy and the related investment is first addressed until 1997; environmental benefits arise as a topic also by 1997, etc.

During the Francos dictatorship period the unique reference comes **in 1975** when Spaniards were first asked about their attitudes on nuclear energy.[206] Back then a majority of Spaniards (45%) just felt indifferent about this source of energy at that time, with 35% in favour and only 20% against.

The next available evidence at the national level is dated in **1988**. Lack of knowledge about the nuclear energy is noteworthy, with more than 35% of the sample stating they do not know what its goal is. In this context, and as Figure 3.6.2 shows, just 17% considered nuclear energy risks as

[206] Results from the survey on nuclear energy by the Ministry of Industry 1975-1977; source: Spanish Information Bulletin number 56 (1978: 27).

acceptable in 1988; Chernobyl is identified as the worst nuclear catastrophe. Living close to a NPP and working in uranium mine are considered the most dangerous activities.

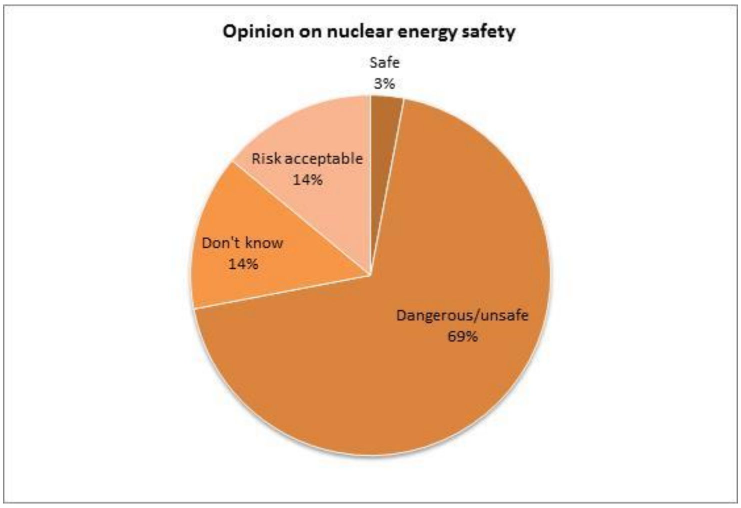

Figure 3.6.2– Opinion on nuclear energy safety in Spain by 1988 (source: EMOPUBLICA, 1988)

In the study by Alvarez Miranda in 1990 (Figure 3.6.2), the percentage of “don’t know” about NPP related risks again provides precise evidence on the very low levels of knowledge about nuclear issues and energy issues in general, especially if compared to the EU. In such a context, the key finding is that almost half of the Spaniards perceived nuclear related risks as unacceptable. Results from this survey also indicate that less than quarter of the Spanish population supported the construction of new nuclear power plants to meet the energy demand, whereas the rest would rather shut down NPP once its usefulness has come to an end, or even to shut them down before that date. Importantly, just 18% of the Spaniards believe nuclear energy is a valuable energy option, compared to 28% at the EU level.

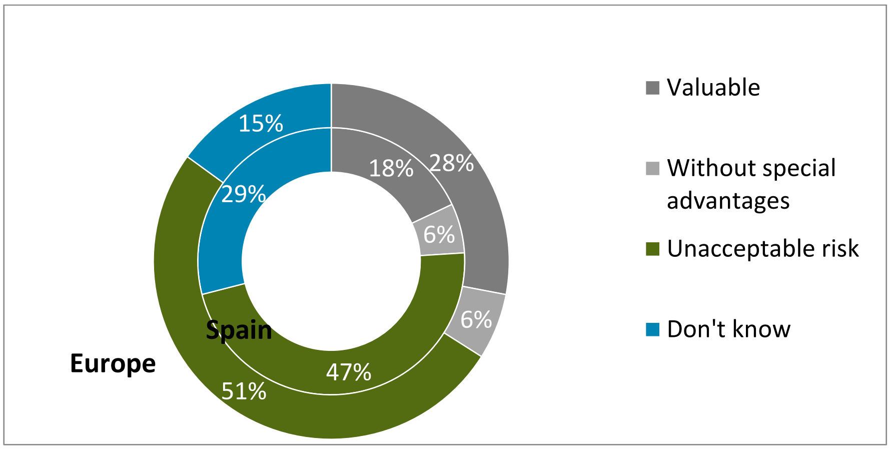

Figure 3.6.3 – How do you evaluate the NNP that are generating electricity (1990) *source: Alvarez Miranda 1990*

The scarce **longitudinal evidence at the country level** (based both on Eurobarometer and CIS data, and covering from the early 90s up to now) shows that **a majority of Spaniards (around 60%) were against nuclear energy.** The more recent series of opinion polls (from 2004) ratifies this picture with more than 50% of the population against nuclear power.

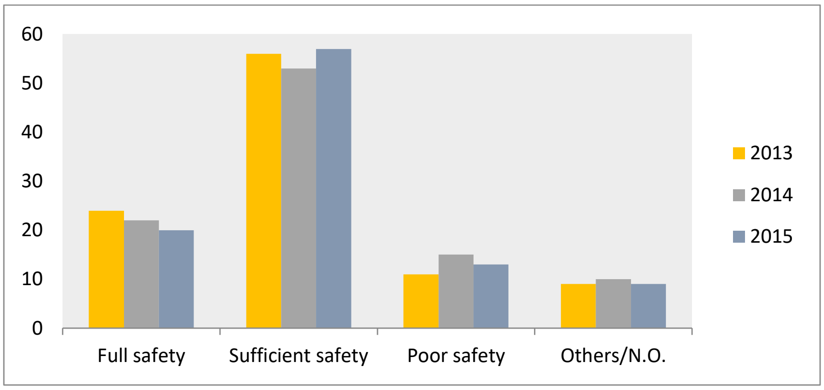

Figure 3.6.4- Spanish Nuclear Forum, dates in percentage (prepared by IPSOS)

This same series of opinion poll (now from 2013-2015) also reveals that around 20-25 % of the Spaniards thought that nuclear reactors are fully safe, while about 55% thought safety is just sufficient and about 15 % think that nuclear reactors are rarely safety.

Finally, one of the recent Eurobarometer on public attitudes towards nuclear energy provides a comparative view of the Spanish situation in the EU context. It is worth noting that the data gathering fieldwork was undertaken before the earthquake in Japan on 11 March 2011.

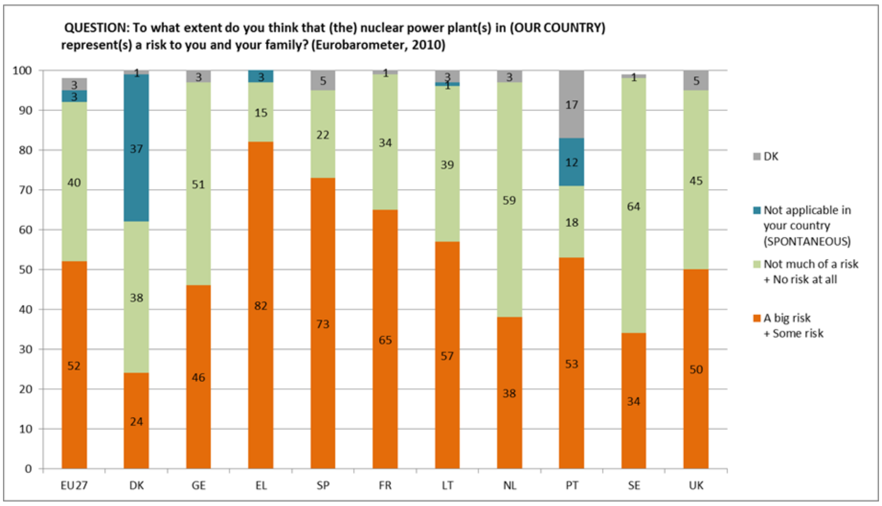

Figure 3.6.5: Perception of nuclear power risks (EB 2010)

As Figure 3.6.5 shows, public opinion on nuclear risks is not consistently linked to whether or not a country has active NPPs. However, in many countries where a substantial share of electricity production is from nuclear power a majority of citizens consider that NPPs represent a risk. This is the case especially in Spain (73%), ranking in second place in terms of fear of nuclear power plants. It is also the highest result in France (65%), Lithuania (57%).

The review of the events on the relation of nuclear energy and society in Spain reveals that communication processes –i.e. non-interactive between the parts- were favoured over genuine engagement procedures. The various actors develop different strategies and tools. During the first period (1960s-1970s), promoters disseminated information about nuclear energy essentially by press reports or the publication of special studies. During the second period (1980s-1990s), facing growing pressure by citizens, the lobby association Foro Nuclear became more active, promoting seminars and educational activities. Information Centres were created at some NPP already in the 80s (i.e., Almaraz and Trillo), and by 2000 most nuclear installations had such Informative Centres, incorporating more interactive ways of communicating with international experts, students and local population. All these initiatives are to be considered communication or, as much, consultation ones, i.e., transmitting information to the public or gathering feedback from the audiences of such informative actions.

Since 2000, NPPs have Local Information Committees (LIC), a kind of information bodies including public and private representatives at the local, regional, and national level.[207] Their functions are to inform the represented entities on the development of regulated activities, and to jointly deal with other issues of interest. In this sense, LICs entail a step towards inclusiveness, although social movements and other citizen sectors do not have a voice. In 2005, AMAC created the Local Information Commissions, including cultural, business, and union associations from the local areas.

Historically, the regulators made limited efforts to communicate with, and include the population. Recently, according to Law 33/2007 (art.15), an Advisory Committee on Information and Public Participation was set up. Chaired by the CSN President, and with a wide representation of public and private bodies,[208] the Committee is a consultative body that assess the CSN in promoting transparency, access to information, and public participation on nuclear safety and radiological protection issues. In compliance with Law 19/2013 on Transparency, the CSN's institutional, organizational, legal and economic information is available at its website. Nevertheless, it is in the management of radioactive waste, and more precisely in the ATC related decision-making process, where the Spanish evolution from the earlier top-down, unidirectional, strategies to the more comprehensive, bidirectional and participative public institutional approaches is best illustrated.

Over the years, concerned populations and social movements actively engaged in public communication and citizen participation initiatives. For example, and among others, since the 1980s, they organized public demonstrations against NPPs (mass marches, rallies, etc.), lodged complaints, presented petitions to town halls and other political institutions, drawn up manifestoes, and gave press conferences. All these actions are ways to influence the decision-making process in the nuclear question, both in formal and informal ways.

[207] Ministry of Industry, the facility, the CSN, Government Delegations and regional public authorities, General Directorate of Civil Protection and Municipalities included in Zone 1.
[208] All government tiers, nuclear sector, unions, environmental ONGs, and independent experts

4. Facts and figures

4.1 Key dates and abbreviations

1948	A secret nuclear energy programme (JIA, undercover as EPALE) started by Franco dictatorship.
1951	Nuclear Energy Board (JEN) created for nuclear research.
1956	Two consortia founded by private electricity utilities to build nuclear plants. NUCLENOR & CENUSA
1958	The first experimental reactor built in Madrid by JEN and GE.
1959	The government opens a factory to process natural uranium from domestic mines (FUA).
1962	The nuclear industry creates the lobby Spanish Atomic Forum.
1964	First nuclear Law. At least 40% of nuclear plants need to be built by local companies.
1964	First Eximbank credit authorization for the export of a turnkey nuclear project to Spain
1966	Palomares accident: four hydrogen bombs drop from a US bomber landing near the small fishing village of Palomares (Almería). One of the earliest civil contamination by plutonium.
1967	First administrative complaint filed against Irta NPP by a local group defending tourism activities.
1968	Zorita reactor by WE becomes the first to supply commercial electricity to the Spanish grid.
1971	Garoña NPP by GE connected to a regional grid.
1972	National Energy Plan foresees the installation of new nuclear 21000 MWe by 1983 (requiring at least two new nuclear stations per year).
1973	Government plans for new National companies for supply nuclear equipment (ENSA) and fuel cycle (ENUSA).
1976	Emergent local environmental antinuclear groups around the country go into the public eye.
1979	First Nuclear debate in a new democratic Parliament.
1979	The Civil Guard killed an antinuclear militant in an antinuclear protest.
1980	Law creating the CSN (Nuclear Safety Board) as the only competent body for nuclear safety and radiation protection, as an independent organism.
1981	ETA terrorist group kills the engineering Director of Lemóniz NP. A year later his substitute too.
1984	The Socialist Party's Government establishes a nuclear moratorium.
1984	Spanish Parliament creates ENRESA in 1984 as a public, non-profit organisation responsible for the management of radioactive waste.
1988	The last of 10 nuclear reactors become operational. Nuclear provides almost half of the electricity in mainland Spain.
1989	Vandellós I accident: a fire in one of the turbines-generator (classified 3 in INES). Closure of the reactor. Decommission ordered.
1994	As a consequence of the restructuring of the electricity sector, large shares of previously NPP private property ends up on the hands of ENDESA the public electricity company.
2005	Vandellós II incident: corrosion in the refrigeration system (classified 1 in INES)
2006	Government approves a plan to create a Centralized Temporal Storage Facility for nuclear waste (ATC). Once the winner location was chosen in 2011. Politically paralysed from 2014.
2006	Zorita NNP, closes down after 38 years of operation Initiating its decommission by 2009-2010.
2008	Ascó I: detection of radioactive particles during refuelling (classified as level 1 in INES scale).
2013	After seeking licence extension, and obtaining it, the owner of Garoña NPP decides shutting down the plan due to the extra cost of keeping it operative.
2015	Spanish consumers finish paying the cost of the nuclear moratorium.

Abbreviations:

AMAC	Asociación de Municipios en Areas de Centrales Nucleares (Spanish association of nuclear villages).
ATC	Almacén Temporal Centralizado (Temporary Centralized Storage for nuclear waste).
CDCVNN	Comisión de Defensa de una Costa Vasca No Nuclear (Commission in Defence of a Nuclear-Free Basque Coast, the Basque antinuclear civil organization).
CENUSA	Centrales Nucleares SA (a private joint venture for nuclear power in the South of the country).
CIEMAT	Centro de Investigaciones Energéticas Medioambientales y Tecnológicas (Public Research Agency for Energy, Environment and Technologies).
CSN	Consejo de Seguridad Nuclear (Nuclear Safety Board).
CSNI	Consejo de Seguridad de Instalaciones Nucleares (Nuclear Plants Safety Board).
ENDESA	Empresa Nacional de Electricidad SA (National Company for Electricity).
ENEA	European Nuclear Energy Agency.
ENRESA	Empresa Nacional de Residuos Radioactivos SA (National Company for Nuclear Waste).
ENSA	Equipos Nucleares SA (National Company for Nuclear Equipment).
ENUSA	Empresa Nacional de Uranio SA (National Company for Uranium).
EPALE	Estudios y Patentes de Aleaciones Especiales (the first Spanish nuclear research public body).
ETA	Euskadi ta Askatasuna (Basque Country and Freedom, terrorist group)
FECSA	Fuerzas Eléctricas de Cataluña (a private electricity utility).
FORO	Forum Atómico Español (today known as Foro Nuclear) (Nuclear Industry lobby).
GCR	Gas Coal Reactor.
GE	General Electric.
HECSA	Hidroeléctrica de Cataluña (a private electricity utility).
HIDROLA	Hidroeléctrica Española (a private electricity utility).
HIFRENSA	Hispano-francesa de Energía Nuclear (French-Spanish joint venture for Vandellós I).
IBERDUERO	A private electricity utility.
INI	Instituto Nacional de Industria (National Industry Institute).
JEN	Junta Energía Nuclear (Nuclear Energy Board).
KWU	Kraftwerk Uninion (AG plus Siemens branch for nuclear development).
NUCLENOR	Centrales Nucleares del Norte (Nuclear Power Plants of the North, a private joint venture of two utilities).
PEN	Plan Energético Nacional (Energy National Planning).
PWR	Pressurized Water Reactor.
TECNATOM	Técnicas Atómicas SA (engineering company providing services for nuclear plants).
UNESA	Unidad Eléctrica SA (Electrical managament Association).
WANO	World Association of Nuclear Operators.
WESCO	Westinghouse Corporation.
WNA	World Nuclear Association.

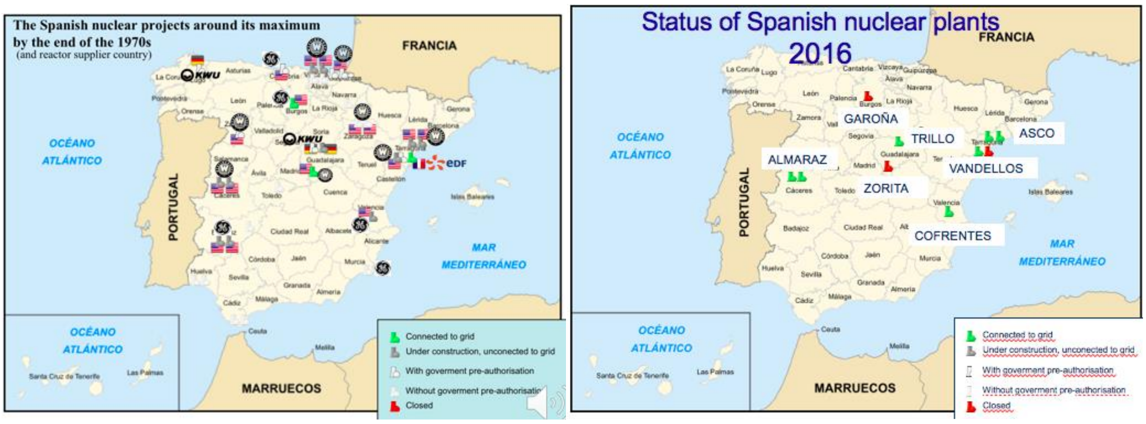

Figure 4.1 Maps of Spanish nuclear projects c.a. 1978 (by manufacturer) vs nuclear plants in Spain by 2016

Table 4.1 – Commercial nuclear power reactors currently in operation in Spain

No	Name	Reactor Supplier	Type	Mwe	First talks	Construction start date	Grid power
1	**Almaraz I**	Westinghouse	W-PWR-3 L	930	1971	1973	1982
2	**Almaraz II**	Westinghouse	W-PWR-3 L	930	1972	1974	1984
3	**Ascó I**	Westinghouse	W-PWR-3 L	930	1972	1974	1985
4	**Cofrentes**	General Electric	GE-BWR/6	900	1973	1975	1985
5	**Ascó II**	Westinghouse	W-PWR-3 L	975	1972	1975	1986
6	**Trillo I**	Kraftwerk Union	KWU-PWR-3 L	1030	1972	1975	1988
7	**Vandellós II**	Westinghouse	W-PWR-3 L	930	1974	1976	1988

Table 4.1 - List of decommissioned or closed commercial reactors in Spain

No	Name	Reactor supplier	Type	Mwe	First talks	Construction began	Grid power	Decommission
1	**Vandellós I**	Framatom	F-GCR	500	1967	1968	1972	1989
2	**José Cabrera (Zorita)**	Westinghouse	W-PWR-1L	160	1963	1964	1968	2006
3	**Garoña**	General Electric	GE-BWR/4	460	1963	1966	1971	2013

Table 4.2 - List of commercial reactors formally applied for by the utilities in Spain

No	Name	Reactor Supplier	Type	Mwe	First talks	Construction began	Abandoned (A)/ Suspended (S)/ Moratorium/(M)
1	**Irta**	Westinghouse	W-PWR-3 L	500	1966	-	
2	**Lemóniz I**	Westinghouse	W-PWR-3 L	930	1972	1973	S-1981/M-1983
3	**Lemóniz II**	Westinghouse	W-PWR-3 L	930	1972	1973	S-1981/M-1983
4	**Santillan**	General	GE-BWR	930	1973	*1975*	A-1978
5	**Punta Endata I**	Westinghouse	W-PWR	930	1973	*1975*	A-1978
6	**Punta Endata II**	-	-	930	1973	*1975*	A-1978
7	**Cabo Cope (Aguilas)**	General	GE-BRW	1000	1973	*1975*	A-1979
8	**Sayago**	Westinghouse	W-PWR	930	1973	1975	A-1983
9	**Tarifa II (Bolonia)**	Westinghouse	W-PWR-3 L	1000	1973	-	A-1979
10	**Tarifa I (Bolonia)**	Westinghouse	W-PWR-3 L	1000	1973	-	A-1979
11	**Asperillo I (Almonte)**	-	-	1000	1973	-	A-1979
12	**Asperillo II (Almonte)**	-	-	1000	1973	-	A-1979
13	**Regodola (Xove)**	Kraftwerk	KWU-PWR-	900	1973	*1979*	A-1982
14	**Tudela (Bergara)**	-	-		1973	-	*A-1978*
15	**Ea-Ispaster I**	-	-	1000	1973	-	A-1978
16	**Ea-Ispaster II**	-	-	1000	1973	-	*A-1978*
17	**Sástago I (Aragon)**	-	-	1200	1973	-	A-1978
18	**Sástago II (Aragon)**	-	-	1200	1973	-	*A-1978*
19	**Valdecaballeros I**	General	GE-BWR/6	975	1974	1975	M-1983
20	**Valdecaballeros II**	General	GE-BWR/6	975	1974	1976	M-1983
21	**Vandellós III**	Westinghouse	W-PWR-3 L	930	1974	-	A-1979
22	**Escatrón I**	Westinghouse	W-PWR-3 L	930	1974	*1977*	A-1982
23	**Escatrón II**	Westinghouse	W-PWR-3 L	930	1974	*1977*	A-1982
24	**L'Ametlla I**	-	BRW	900	1974	-	*A-1978*
25	**L'Ametlla II**	-	BRW	900	1974	-	*A-1978*
26	**Trillo II**	Kraftwerk	KWU-PWR-	1030	1975	1980	M-1983
27	**El Páramo I (Leon)**	-	BRW	1000	1975	-	*A-1978*
28	**El Páramo II (Leon)**	-	BRW	1000	1975	-	*A-1978*
29	**Chalamera (Bajo**			1000	1975		

Sources: own elaboration from archival material at Exim, nuclear industry journals (Energía Nuclear, Nuclear Engineering), official government bulleting and secondary literature. In italic those dates that require further investigation. S=suspended; A= abandoned; M=moratorium

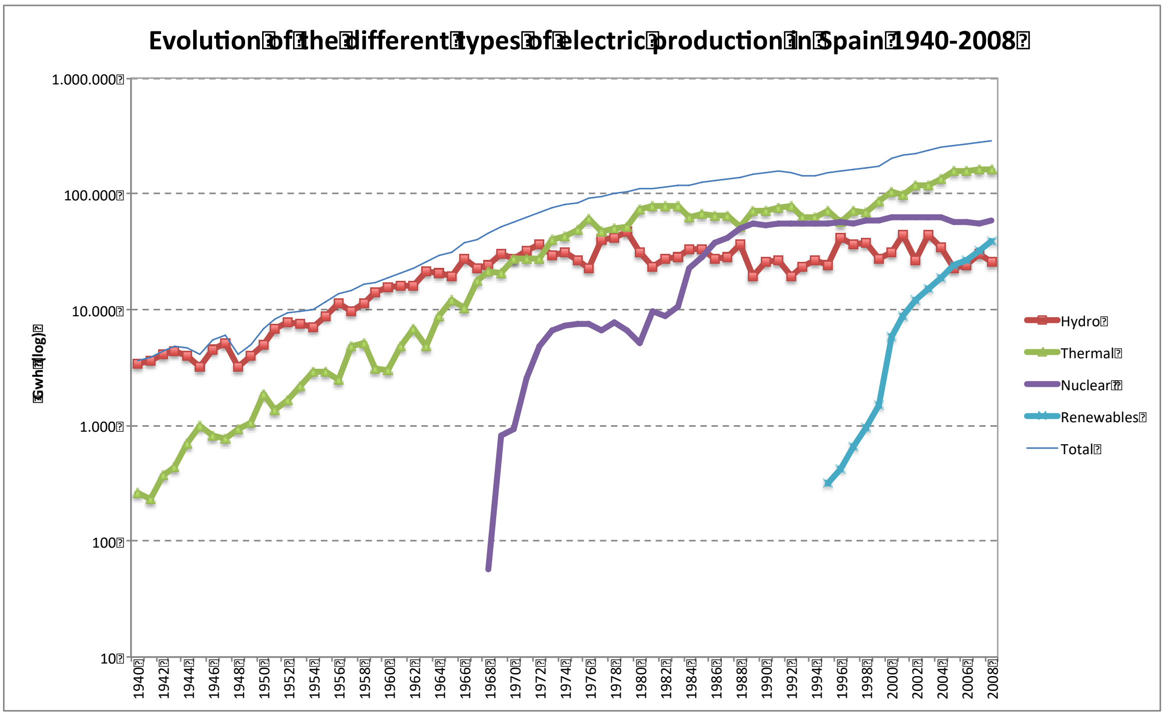

Figure 4.2 – Evolution on the different types of electric production in Spain 1940-2008

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Export-Import Bank of the United States (Exim)
Archivo Histórico de Foro Nuclear (Foro)
National Archive of the United States (NARA)
Sociedad Estatal de Participaciones Industriales (SEPI, previously INI)

NEWSPAPERS, PERIODICALS AND MAGAZINES
ABC, Andalán, Alfalfa, Actualidad Económica, Dyna, El País, El Plural, Energía Nuclear, Interviu, Nuclear Engineering, World Nuclear News

INTERVIEWS

Name of interviewed	Date of interview
Government	
Martin Gallego (General Secretary for Energy, 1982-1986)	25th February 2016
Carmen Mestre (General Director for Energy (1982-1986)	25th February 2016
Anonymous Government employee (at the time of the moratorium)	25th February 2016
Gonzalo Madrid (Last JEN director, first CIEMAT director)	25th February 2016
Agustín Alonso (JEN, Universidad Politécnica Madrid)	5th May 2016
Anti-nuclear activists	
Juan Serna (Antinuclear Activist)	5th January 2016
Pedro Costa Morata (Antinuclear Activist)	3rd March 2016
Mario Gaviria (Sociologist, Antinuclear Activist)	17th March 2016
Jose Allende (Regional Economist, Antinuclear Activist)	15th April 2016
José Manuel Naredo (Economist, Antinuclear Activist)	8th June 2016
Nuclear Industry	
Jaime Segarra (Ex Manager Nuclear Energy Europe General Electric Technical Services Co, Spain)	5th May 2016
Santiago San Antonio (Ex General Secretary Nucnet; Foro Nuclear;Tecnatom)	5th May 2016
Industrial Engineer (Wenstinghouse, different power plants)	5th May 2016
Manuel Ibáñez (UNESA, WANO)	6th May 2016
Alfonso Alvarez-Miranda (ENSA, Vice President Operations)	30th June 2016
Javier Mª Simón Adiego (ENSA, VP General and Secretary to the Board)	30th June 2016
Antonio Alonso Ramos (TECNATOM, President)	15th Dec 2016
Juan Ortega Delgado (TECNATOM, Director Business Strategy)	15th Dec 2016
Fco. Javier Guerra Saiz (TECNATOM, General Manager)	15th Dec 2016

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Sweden

Short Country Report

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CONTENTS

Executive summary

This report belongs to a collection of 20 short country reports on the History of Nuclear Energy and Society (HoNESt, project Ref.662268). The reports tackle the complex sociotechnical system around nuclear energy. Nuclear developments, notably nuclear energy, are closely intertwined with social, economic, environmental, political and cultural spheres. Nuclear energy is also a globalized system involving transnational transfers of knowledge, materials, technologies, people and products including electrical power, medical elements, toxic wastes and other environmental hazards, materials, capacities and knowledge that must be carefully safeguarded. Nuclear energy is a complex social and technological phenomenon that influences societies but is also shaped by societies.

The short country reports are designed to assemble information and research results on the history of the relations between nuclear energy and society about all the different country cases in an accessible manner, and to document the findings with references.

The purpose of the country reports is threefold, addressing three different audiences:

1. to provide basic elements of narrative and analysis for further historical research by HoNESt researchers;
2. to provide information, context and background for further analysis for HoNESt's social science researchers;
3. to provide accessible information on nuclear-societal relations in the various countries for the purposes of outreach and communication with stakeholders (civil society, industry, associations, policy makers, journalists).

This report focuses on the history of the relations between nuclear energy and society in Sweden. The first chapter gives an historical overview of Sweden´s nuclear history. An ambitious research program on nuclear energy began after WWII with both civilian and military goals. In the mid-1950s this led to a decision to build a domestic nuclear fuel cycle based on Heavy Water Reactors (HWRs), partly to enable the construction of nuclear weapons, which became a contested issue. Ten years later private power companies started ordering a number of Light Water Reactors (LWRs), because they thought these reactors would be more

economical, and the plans for a domestic fuel cycle were abandoned. In the early 1970s a strong nuclear-industrial complex had arisen.

At this time an anti-nuclear movement emerged which quickly grew in size. Two of the five parties in Parliament took an anti-nuclear stance, and after the elections in 1975 the leader of one of these became the new Prime Minister. In the following years nuclear issues were very high on the political agenda. In 1980, partly in response to the accident at Three Mile Island (TMI), an advisory referendum on nuclear power was organized. The referendum campaign engaged hundreds of thousands of activists. The outcome was a defeat for the anti-nuclear side. Parliament decided to continue nuclear expansion in the short run, but to phase out all nuclear power by the year 2010. In the 1980s Sweden became the country with most nuclear power per capita in the world, and it still is. A full phase out did not occur. However, in 1999 and 2005 the reactors in Barsebäck, very close to Copenhagen, were phased out (see Danish Country Report), in 2015 one reactor was phased out in Oskarshamn, and three more reactors (one in Oskarshamn and two in Ringhals) will be phased out by 2020.

The issue of waste disposal has been much disputed since the 1970s. In the early 1980s a number of attempts to drill in order to find a place for a repository were strongly opposed by local environmental groups. In the 1990s, SKB, the organization responsible for the nuclear waste, changed strategy, seeking cooperation with local municipalities. Two municipalities that already had nuclear plants were identified as suitable locations for a repository and a competition emerged between them for hosting it.

The second and third chapters analyse a number of events when nuclear issues were intensively debated and contested in order to illustrate the relations between the nuclear industry and civil society in Sweden. The events are

- The nuclear weapons controversy
- Public inquiries on energy futures in the 1970s
- The referendum on nuclear power in 1980
- Local protests against a repository
- Chernobyl and its political effects in Sweden
- A competition for getting a repository

For each event, the actors involved, the arguments and behaviours used, and the kind of public engagement are discussed.

1. Historical context

1.1. Introduction to the historical context

During almost three decades after WWII, Sweden experienced fast economic growth. Sweden had managed to keep its neutrality during the war and its industry was intact. The Social Democratic Party governed the country until 1976 and strived for fast economic growth in order to build a welfare society. A fast urbanization took place. In 1949 Sweden decided to remain neutral and not join NATO as its close neighbours Norway and Denmark did. This decision was combined with an ambitious strengthening of the Armed Forces.

Energy was an important issue. Sweden has very limited fossil resources, and the country´s dependency on energy imports had become very salient during the war when Sweden had had to import coal from Nazi Germany in exchange for iron ore. After the war there was a strong will to develop domestic energy sources. The hydro power resources in northern Sweden were exploited and was transmitted to southern Sweden through new high voltage lines built by the ASEA company, which became a world leader in high voltage technology in the 1950s. Sweden had large uranium resources and the option of developing nuclear energy became a very attractive future possibility. This would also enable the development of nuclear weapons and there were strong advocates for such weapons, but also critics. There was a broad political support in the post-war decades for a very ambitious nuclear program, financed by the government. This program led to the building of several research and experimental reactors in the 1950s and commercial reactors in the 1960s and onwards.

In the mid-1970s the fast economic growth came to an end partly due to the Oil Crisis and the international economic recession following it. Moreover, the long Social Democratic hegemony came to an end in 1975, when a right-centre coalition won the elections and formed a government. Energy became a vital political question anew. The Oil Crisis had demonstrated Sweden´s huge dependency on oil; imported oil provided no less than 75% of total energy supply. An environmental opposition had emerged and questioned the further exploitation of hydropower in Northern Sweden and highlighted the impact of the acidification of the environment caused by large scale use of fossil fuels. Moreover, the safety of nuclear power plants that were becoming operational was being questioned by some scientists and environmentalists. In fact, ever since the mid-1970s, nuclear power has been a central controversy in Swedish politics; it has been decisive for the outcomes of Parliamentary elections, it has toppled governments and it has been the issue of a referendum. This report focuses on the debates and conflicts around nuclear power. First a general narrative is presented in the following section, followed by a presentation of the main actors. In the following chapters a number of illustrative events will be analysed.

1.2. Contextual narrative

Coordinated Military-Civilian Nuclear Research, 1945-1955

The atomic bombs over Hiroshima and Nagasaki were the starting point of Swedish activities in the field of nuclear energy. The military and some scientists (primarily physicists and chemists) were the first to act: for the military, it was naturally of vital importance to get information about this new, extremely powerful weapon and its implications for future warfare. For the scientists, there was an element of scientific inquisitiveness and a prospect for future funding (Lindström 1991, Larsson 1987). Both groups lobbied for action, and in November 1945 the Government appointed an Atomic Commission, with the task of investigating the need for research. The commission consisted of very prestigious scientists, two who were Nobel laurates (Manne Siegbahn and The Svedberg) and two future laurates (Arne Tiselius and Hannes Alfvén), as well as high ranking public officials. In its report the commission recommended, firstly, to strengthen basic research in relevant fields of physics and chemistry at universities and research institutes, and, secondly, to establish a special organisation, the Atomic Energy Company (AE), with the task of developing reactor technology (Lindström, 1991).

These recommendations were readily adopted by the Social Democratic government; which could be seen as a bold effort, orchestrated by the state, to use the results of science for the well-being of society and which therefore suited their ideological beliefs very well. In particular, Tage Erlander, Prime Minister from 1946 to 1968, had a strong interest based on personal contacts with leading physicists, including Niels Bohr. An Atomic Energy Company, was set up in 1948 and its first major task was to build a small research reactor called R1, a 100 kW heavy-water reactor (HWR) fuelled with natural uranium. The choice of location of R1 may seem rather remarkable today; it was on the campus of the Royal Institute of Technology, only a few kilometres from the centre of Stockholm. However, the reactor was built in an excavated cave in the rock 20 meters below the ground. On July 13, 1954, the reactor was completed and heavy water was pumped into the reactor tank. When the reactor went critical, Sweden had definitively entered the nuclear age (Lindström 1991, Larsson 1981).

The nuclear research also had a military dimension. After WWII, Sweden started to build up a strong military defence. This effort was intensified when Sweden in 1949 decided not to join NATO but to remain non-aligned. A large domestic arms industry was developed and in particular the aircraft industry had a pivotal role; in fact Sweden´s Air Force became the fourth largest in the world in the 1950s. The National Defence Research Institute (FOA) established in 1945 was given a crucial role for research and technological development in the military field. One of the new institute's first actions was to secretly set up a research group on nuclear weapons led by the young nuclear physicist Sigvard Eklund (Agrell 2002, Jonter 2016).

In 1950 Eklund was recruited to AE as research director and was given the responsibility for building the R1 reactor. He was also – more secretly – responsible for coordinating the civilian and military nuclear research. He proposed that the future "civilian" reactors should be heavy water reactors fuelled by domestically mined natural uranium. Moreover they should be constructed in such a way that weapons-grade plutonium could be produced. Finally, reprocessing plants should be built to separate this plutonium from the spent fuel. In 1953 Eklund wrote a report in which he outlined a plan for the construction of ten bombs of Nagasaki-strength within ten years (Agrell 2002).

Up to the mid-1950s there was almost unanimous political support for the nuclear research program. However, the commercialization of nuclear energy still seemed uncertain and far away, and therefore the power companies and the electrical equipment industries were rather passive.

The ”Swedish Path” and the atomic weapons controversy, 1955-1965

US President Dwight Eisenhower's launching of the "Atoms for Peace" policy in late 1953, and in particular the First Geneva Conference on Atomic Energy in August 1955, raised expectations for nuclear energy in a dramatic way. The new international policy implied a change from utmost secrecy to a considerable openness in nuclear matters. Both the Swedish general public and the power industry were filled with optimism about a coming commercialization of the new technology. In late 1955 the government appointed a new Atomic Commission to formulate a long-term policy in the nuclear field. This commission outlined a very ambitious program, which came to be known as the "Swedish Path." It was adopted by Parliament the following year (SOU 1956:11).

The long-term goal of this program was the development of a domestic nuclear fuel cycle, encompassing the extraction of the vast (but low-grade) Swedish uranium resources, the construction of heavy water reactors for producing heat and electricity and the reprocessing of the spent fuel. This goal has to be seen in its historical context. Sweden has hardly any fossil resources, and during both World Wars, imports of coal and oil had been drastically reduced, causing severe problems for both industry and households. Swedish dependence on foreign energy supplies increased after World War II owing to a rapid rise in oil consumption. The resulting vulnerability was underlined during the disturbances in the global fuel markets caused by the Korean War. Increased self-sufficiency of energy supply was thus seen as a vital goal and in this context the domestic uranium deposits were seen as a crucial resource, even though the uranium percentage in these deposits was known to be low. The "Swedish Path" also had a less overt military aspect. A domestic nuclear fuel cycle was not only a way of diminishing dependence on foreign energy supplies, but also a way of enabling the production of material necessary for the construction of nuclear weapons (Lindström 1991, Agrell 2002).

The parliamentary decision in 1956 about the “Swedish Path” meant that huge resources were channelled to the nuclear domain in general and the Atomic Energy Company in particular. The staff of the Company increased rapidly from 260 employees in 1956, to 1000 in 1959, and more than 1500 in 1964. In the second half of the 1950s AE built a research facility in Studsvik with two research reactors. Moreover, it built two heavy water reactors for energy production, first a combined heat and power producing reactor and later on a larger power-producing reactor. The first reactor was built in Ågesta, just south of Stockholm. It took three years longer and cost five times more to build this plant than was originally estimated, but in 1964 the plant was completed and put into operation and produced 55 MW heat for district heating and 10 MW electricity. The second reactor was to be built in Marviken, near the city of Norrköping. The further history of this reactor is a story of time- and cost-overruns, of growing criticism both from technical experts and from politicians, and of refusal to relinquish the project because of prestige. Finally, even the management of AE had to admit that the plant did not fulfil the necessary safety requirements and the project was brought to an end in May 1970 (Schagerholm 1993, Glete 1983, Brynielsson 1989).

AE also worked with the other links of the nuclear cycle. In the early 1960s, facilities for uranium mining were built in Ranstad, east of Gothenburg. In 1965 the production capacity was tested but only on a small scale; at this time uranium could be imported for a price that was 40% lower than the production costs in Ranstad. Research was also conducted in the reprocessing field, but it was concluded that a reprocessing plant would be too costly.

In the late 1950s a strong controversy arose concerning nuclear weapons both within the governing Social Democratic Party and outside it. Growing factions within the governing party, not least its Women's Association, wanted to put a halt to the development of nuclear weapons. Also the government itself was divided on the issue with the Defence Minister supporting nuclear weapons while the Foreign Minister opposed them. The controversy threatened to cause a major disruption in the party and Prime Minister Tage Erlander set up a "study group" to investigate the matter and try to find a compromise. After more than a year of discussions, the study group presented a report recommending FOA to stop the construction of weapons but to pursue what they called "extended protective research." (Agrell 2002)

In 1958 twenty leading intellectuals including the Arch Bishop and some well-known authors and academics established Aktionsgruppen mot Svensk Atombomb (the Action group against Swedish Atomic Weapons), AMSA. AMSA had a program with two points: opposing the idea that nuclear weapons were introduced to Swedish defence program and requesting that the financial resources saved were used for development aid instead. The members of AMSA were very active and influential; they wrote articles in newspapers, participated in radio and TV debates, talked at public meetings etc. In April 1960 they made a plea for a referendum on nuclear weapons, and started to gather signatures for their plea, although they were not able to muster the necessary number of signatures. When this campaign failed, AMSA more or less dissolved. (Agrell 2002)

The following year a new organization called Kampanjen mot Atomvapen (Campaign against Atomic Weapons), was established inspired by the British organization Campaign for Nuclear Disarmament and the Danish Kampagnen mod Atomvåpen. Like these organizations it strived for different kinds of members and other types of activities than AMSA had done. KMA attracted young people, not least students, and focused on organizing marches and protests. The first major event was a 2-day long protest march from central Stockholm to FOA’s research facility in September 1961 with 800 participants. The following years similar protest marches were arranged with several thousand participants. (Agrell 1999) However, the issue of constructing Swedish nuclear weapons lost its political urgency in the early 1960s, when leading militaries changed their views on the benefit of nuclear weapons. Sweden gradually changed its foreign policy and took an active part in the international negotiations concerning the Non-Proliferation Treaty. In 1968 Sweden formally decided not to develop atomic weapons and to sign the Non-Proliferation Treaty.

The debate on nuclear weapons is analyzed in event 1 in chapter 3.

Building the first LWR plants without public debate, 1965-1972

In the mid-1960s the prospects for the Swedish Path had changed due to the decreased importance of the military aspects of the program, and the choice of reactor type was discussed at length among Swedish energy experts in particular among utilities and the leading electric manufacturer, ASEA. The Swedish power industry was made up of the State Power Board, called Vattenfall which produced about 40 % of all power and a dozen private power companies (many owned by municipalities and/or energy-intensive industries). For the power industry the national independence aspect of nuclear reactors was subordinate to their competitiveness and reliability. In the late 1950s many power companies started to question the HWR - which was an integral part of the "Swedish Path" - from a commercial point of view. They were influenced by the fact that the major US electric equipment producers were developing LWRs of two kinds; General Electric was building Boiling Water Reactors (BWR) and Westinghouse Pressurised Water Reactors (PWR). By then it was possible to buy enriched uranium from the United States, which made such LWRs a possible alternative.

When, in December 1963, General Electric signed a turn-key contract for a 520 MW reactor to be built in Oyster Creek for the sensationally low price of 68 million US dollars (equivalent to 350 million Swedish crowns), this was seen as definite proof of the economic superiority of LWRs. In retrospect it is clear that General Electric sold this plant far below the actual costs, assuming that rapidly falling costs would compensate for the sale of one or more "loss leaders". The optimism and enthusiasm resulting from the Oyster Creek plant were decisive in the establishment of a consortium of private power producers called Atomkraftkonsortiet, AKK, later renamed Oskarshamns Kraftgrupp AB, OKG, which in 1964 started negotiations with ASEA for the construction of a large BWR at Oskarshamn. In July 1965 a contract for this plant was signed. The total investment cost for this 440 MW plant was 500 million crowns (Jasper 1990).

ASEA was the leading Swedish supplier of electric technology. In 1952 it had built the world´s first 400kV high voltage line in close cooperation with the State Power Board, Vattenfall. As early as 1954 ASEA formulated a long-term strategy for its nuclear energy activities. Its goal was to become an internationally competitive producer of nuclear reactors. ASEA saw itself as the leading Swedish force in the development of commercial reactors. However, the launching of the "Swedish Path" in 1956 made it clear that the government wanted AE to play the leading role in the development of a domestic nuclear construction capacity, with ASEA being one of several suppliers. ASEA vigorously opposed this division of responsibility. It argued that AE lacked the competence necessary for the design of commercial nuclear plants. Yet, in the late 1950s and early 1960s, it was AE that had the financial power through its generous government funding. ASEA could not afford to finance the necessary development on its own, and thus became dependent upon orders from AE. ASEA built most of the Ågesta plant and the Marviken plant, and even though these reactors were not LWRs, the building of them made it possible for ASEA gradually to build up more and more competence in the nuclear field. By 1960 ASEA's nuclear division had grown to 350 people (Glete 1983).

At this time ASEA became more pessimistic about the future for nuclear energy. The economic prospects seemed gloomier with decreasing oil prices and increasing construction costs for nuclear plants (specifically the Ågesta reactor). The company also started to question whether the HWR was the best choice of reactor, and it studied several other reactors including a graphite-moderated gas-cooled reactor of the British type and a light-water boiling reactor developed in the United States. In 1964, after the spectacular Oyster Creek contract, the AKK (later OKG) started negotiations with ASEA about a large BWR of about 300-400 MW in Oskarshamn. For ASEA this would mean a big step; the Ågesta reactor was much smaller and of a different type, and ASEA did not even have experience with conventional thermal plants of this size. ASEA thus started negotiations with General Electric about a license-agreement. But ASEA found the conditions imposed by General Electric too restrictive and chose to develop its own reactor. This was a bold move; all other European companies chose to buy US licenses. But ASEA was confident of its own ability, and the fact that AE proved to be very willing to cooperate with ASEA was of considerable importance (Glete 1983).

The contract signed with the Oskarshamn-consortium in July 1965 was thus a decisive, but risky, step for ASEA. Soon after this contract Vattenfall and the largest private power company, Sydkraft, showed interest in additional reactors. However, ASEA met competition from a consortium of Swedish industries and Westinghouse. Vattenfall too was convinced of the superiority of LWRs after Oyster Creek. But it was uncertain whether BWRs or PWRs were the best solution. Furthermore, in the middle of the 1960s Vattenfall was somewhat doubtful about ASEA's capacity to design and build commercial reactors. ASEA had little previous experience with large thermal plants, and Vattenfall was not fully satisfied with an oil-fired plant that ASEA was building for it at this time. For ASEA Vattenfall was a customer of the utmost importance. In 1968 the Swedish government used this situation to almost extort ASEA into a merger with AE; it was clearly indicated that ASEA would not get Vattenfall's order if it did not comply. And soon after the merger the new company, ASEA-Atom, got a contract for one of the two reactors that Vattenfall ordered for the Ringhals plant the other was a PWR from Westinghouse.

In the following five years, ASEA-Atom got seven new reactor orders, two from the Forsmark-consortium with Vattenfall as the dominant party, three from the private Swedish power industry and two from the Finnish power consortium, TVO. ASEA's 1954 long-term goal of becoming an internationally competitive producer of nuclear power plants now seemed to have been achieved, even though it had been forced to merge with its rival, AE. It was a remarkable technological achievement for ASEA; all the other companies that managed to become independent producers of reactor plants - Westinghouse, General Electric, and Siemens (KWU) - were much larger firms, devoting more personnel and financial resources to nuclear development (Jasper 1990).

On May 18, 1972 the nuclear power plant in Oskarshamn was inaugurated by the King of Sweden, Gustav VI Adolf with the following words:

> Nuclear power is a proof of man's ability to develop his surroundings. In an ever-increasing pace it has come to stand out as the rescue out of a feared energy crisis. In a time when the epoch of hydropower development is coming to a close and difficulties are being discerned regarding the supplies of fossil fuels nuclear power has been realized. Sweden's first commercial power plant thus marks the beginning of a new epoch in our country´s energy supply. The completion of this nuclear power plant is a milestone in our country´s industrial development. Swedish industry has with foresight and skillfulness independently developed a technology of which we today can see the application. The Oskarshamn power plant represents a technical achievement which well matches the great innovations in Swedish industry. (Citation in Gimstedt 1990)

The inauguration was a moment of great pride for all participants and the future for nuclear power looked very bright indeed. The participants made up what could be called a “nuclear-industrial complex” encompassing ASEA-Atom, Vattenfall and the private power companies, government and government agencies and technical universities. This complex planned to build 24 plants in the coming decades and the prospects for exporting nuclear technology were also promising. Neither the King, nor any of the prominent guests could anticipate that nuclear power would very soon be strongly contested in Sweden.

Nuclear power contested 1973-1978

Nuclear energy had long been considered a clean, environmentally benign source of energy. In the 1950s and 1960s, the largest and oldest environmental organization, Svenska Naturskyddsföreningen, SNF, had even demanded a faster introduction of nuclear power to save the remaining wild rivers from being developed into sources of hydroelectric power (Lindström 1991). Thus, very little questioning of nuclear power occurred in Sweden until the early 1970s, but from 1972 and onwards a dramatic shift took place and nuclear power became heavily criticized by many different kinds of actors. Three of these were particularly important: scientists, politicians and environmental activists.

The single person that most strongly contributed to this shift was a scientist, Hannes Alfvén. He had been awarded the Nobel Prize in physics in 1970 and thus was held in high regard as researcher. He had also been deeply involved in the nuclear research program as board member of the Atomic Energy Company. In the late 1960s he did much of his research in California and came in contact with the growing number of American scientists and engineers who began to question the safety of nuclear power plants, the difficulties of taking care of the radioactive waste from reactors, and the risk of proliferation of nuclear weapons materials. Alfvén became increasingly critical of nuclear power and started writing articles in newspapers and contacting politicians. He even wanted to give a speech at the first UN conference on the Environment organized in Stockholm in June 1972 but was not given the opportunity. Alfvén soon became a very influential nuclear critic as his knowledge and insight could not easily be questioned. Also a number of other Swedish scientists and nuclear experts were influenced by the critique formulated by Alfvén and colleagues abroad, but as many of them worked (directly or indirectly) for the Swedish nuclear industry they were hesitant to formulate their critique publicly (Anshelm 2000, Jasper 1990).

Secondly, a number of parliamentarians began to question nuclear power, some from the Centre Party, which was at the time the second largest party after the Social Democrats and some from the Communist Party. In the spring of 1973 they succeeded to get approval in parliament for a proposal that investigations about the risks of nuclear power had to be made before any decisions about new nuclear power plants were made. One of the parliamentarians also arranged a meeting between Hannes Alfvén and the party leader of the Centre Party, Torbjörn Fälldin. Fälldin was deeply impressed by Alfvén and became a dedicated opponent of nuclear power, and soon the entire party took an antinuclear stance, which fitted well with the party’s new environmental ideology. The party had traditionally been the political representative of the farmers, but with a fast decreasing population in the countryside, the party tried to attract urban voters with a "Green" policy of environmentalism and decentralism (Anshelm 2000, Lindqvist 1997).

A third category of nuclear critics were young environmental activists. In the late 1960s a new kind of environmental movement emerged, consisting of small and often local activist groups inspired by similar movements abroad. They protested against polluting industries, car traffic, acid rain and other issues. In the early 1970s they found out that their sister organizations in the United States were increasingly questioning nuclear power and realizing the huge scale of the Swedish nuclear program they started to learn about the criticism against nuclear power and disseminated it. However, this environmental movement was rather scattered in many small organizations and was as yet unable to organize a broad protest movement against nuclear power (Anshelm 2000, Daleus and Kågeson, interviews).

However, the growing criticism of nuclear power among scientists, politicians and environmental activists led to an intensive public debate. Many critical articles were published in large daily newspapers, the first critical books were published (Kågeson 1973) and environmental groups distributed many pamphlets and posters. The growing antinuclear sentiments, together with the oil crisis in 1973-1974, put energy policy at the center of the political arena. Several government commissions were appointed to study different aspects of energy such as nuclear waste treatment, research and development needs in the energy sector, and long-term prospects for the energy sector. In 1975 an Energy Bill was passed, which initiated an ambitious research and development program, ranging from nuclear research to renewable energy sources and energy efficiency (Prop. 1975:30). Furthermore, this Bill foresaw a reduction in the future growth rate of energy demand and thus a smaller expansion of nuclear energy than previously expected. A total of 13 nuclear reactors were envisaged by 1990, compared to 24 reactors a few years earlier.

In 1976, for the first time in 40 years, the non-socialist parties won over the Social Democrats in the parliamentary elections, and Fälldin became Prime Minister in a coalition government. At the end of the election campaign, Fälldin had made very clear antinuclear statements on ethical grounds, and this was probably decisive for the victory, which was very close (Holmberg et al 1977). However, the other two non-socialist parties in the government coalition had a very different, much more positive, view of nuclear energy, and the nuclear issue caused much conflict. One way to handle this was to set up a government commission with representatives from the different parties and organizations involved for trying to find compromises. This commission made a very detailed investigation and outlined four scenarios for the future but could not unite in a joint vision (SOU 1978:17).

The role of all the government commissions in the second half of the 1970s will be analyzed in event 2 in chapter 3 below.

Nuclear waste was an issue that attracted particular attention in the public debate, and in the spring of 1977 the government proposed a Nuclear Stipulation Act which was passed by Parliament. This Act stipulated that reactor owners had to demonstrate that they would be able to handle the spent fuel from their reactors in a “totally safe” way to get permission to commission new reactors. This Act spurred the Swedish power companies to jointly pursue an intensive research project about a methodology for final storage of spent fuel; alternatively of the high level waste produced if the fuel was reprocessed. However, despite this effort to find a common ground, the government split in 1978, after a confrontation about how to interpret the Nuclear Stipulation Act, and a minority government led by the Liberal Party was formed with Carl Tham as Energy Minister (Vedung 1979).

TMI and the referendum on nuclear power

The environmental movement in Sweden grew in strength during the 1970s and it increasingly focused on nuclear power. In 1978 a broad umbrella organization called Folkkampanjen mot Atomkraft, the People’s Campaign against Atomic Power, was established. There was a lively debate within the People’s Campaign about possible strategies. How would it be possible to fight the powerful nuclear industrial complex that moreover was supported by three political parties with an overwhelming majority in Parliament? A referendum emerged as the best option. However, when the People’s Campaign demanded a referendum, the nuclear friendly parties opposed it arguing that the nuclear issue was too complex for a referendum (Eriksson 1981, Interviews Daleus, Odell, Kågeson, Falk).

So the People’s Campaign started a petition for a referendum in the beginning of March 1979, and activists began to collect signatures. In the midst of this campaign, the Three Mile Island accident occurred on March 28. Swedish mass media reported extensively about it, and the accident gave the anti-nuclear movement an enormous boost (Holmberg&Asp 1984). A week later, Olof Palme announced that the Social Democrats had changed stance and now supported a referendum, and the Conservatives and Liberals soon followed suit.

The approval of the referendum was a huge success for the People´s Campaign. But the framing of the referendum, which was decided by Parliament, became a disappointment. The anti-nuclear side had foreseen a straight forward referendum with two alternatives, one for a phase-out and one for a continued expansion of nuclear power. It came as a shock to them when the pro-nuclear parties split into two alternatives instead of one, for tactical reasons (Eriksson 1981, Interviews Daleus, Odell, Kågeson, Falk). Thus Line 1 was supported by the Conservatives, Line 2 by the Social Democrats and the Liberals and Line 3 by the Centre Party, the Communists and, of course, the People´s Campaign.

Line 3 was a straight forward phasing out alternative and meant that the six operating nuclear reactors should be phased out within ten years. Line 1 and Line 2 were almost identical, and they too were framed as phase out alternatives, albeit in a far future. The crucial formulation in both was as follows: *Nuclear power will be phased out at a pace that is possible with consideration to the need for electricity for employment and welfare.* Concretely the two lines proposed that besides the six reactors already in operation, six more reactors already completed or under construction should be brought into use in the coming years. The only difference between the two alternatives was that Line 2 in addition demanded public ownership of all nuclear power plants. Line 2 was intended to appear as a "middle way" alternative and their slogan was ”phasing out, but with reason” (Holmberg&Asp 1984).

The referendum campaign dominated political life and the mass media for several months. The Line 3 campaign became a mass movement of grassroots activists all over Sweden. They organized demonstrations, public meetings, distributed campaign newspapers, and knocked on doors to talk with ordinary people. The campaigns of the other two lines were more like ordinary election campaigns, dominated by party officials and professional lobbyists and were heavily supported by Swedish industry economically. They had the resources to finance huge ads in the major newspapers (Holmberg&Asp 1984).

The outcome of the referendum was that Line 2 received 39.1% of the votes, Line 3 received 38.7% and Line 1 received 18.9%. Based on the referendum, Parliament set up the goal that all nuclear power plants should be phased out by the year 2010. But in the short term it meant a return to "business as usual". In the following five years six additional reactors, much bigger than the previous ones, were taken into operation. The outcome was of course a huge disappointment for all the members of the People’s Campaign that had campaigned so intensively in the previous months. Not surprisingly an overwhelming majority of the activists became disillusioned and quit the People's Campaign. A few joined political parties instead, not least the new Green Party that was founded in 1981 (Eriksson 1981, Interviews Daleus, Odell, Kågeson, Falk).

The referendum on nuclear power represents the peak of nuclear debate in Sweden when hundreds of thousands of Swedes were actively engaged, and it will be analyzed further in the next chapter as a showcase of interaction between nuclear industry, political parties and civil society in Sweden.

Nuclear expansion and nuclear waste

A few weeks after the referendum, the government approved fuel loading for the four reactors that were completed but not yet operating. Later on, the companies received about 4 billion crowns from the state as compensation for the delay of commissioning owing to the referendum. Furthermore, the construction of two additional, even bigger reactors was accelerated. These were completed and taken into commercial operation in 1985. Consequently, nuclear power production increased threefold from the time of the referendum to 1985, and Sweden now generated more nuclear power per capita than any other country.

Electricity consumption did not develop according to earlier forecasts in the 1980s and in order to find a market for all this additional power, Vattenfall reduced its electricity prices considerably in 1983, and the other power producers followed suit. About half of the new electricity was used for the heating of houses, and this was criticised by the nuclear opponents as a wasteful way of using electricity. For ASEA-Atom the completion of the 11th and 12th reactors in Sweden marked the end of an epoch. Since then the company has built no more reactors. Not only the Swedish market but also the international market for nuclear reactors almost vanished in the late 1970s, and the company did not get any new reactor orders after 1976. However, the nuclear fuel manufacturing division, now owned by Westinghouse, is very competitive in the international market.

Nuclear waste was another issue that had to be dealt with by power companies and government. In 1979 the power companies had presented a methodology for final storage of spent fuel in accordance with the Stipulation Act. This method, called KBS, was approved by the regulating agency SKI, and this was a condition for the commissioning of the new reactors. As a next step the power companies owning nuclear reactors had to try to find possible locations for a repository.

In April 1980, just a month after the referendum, PRAV, an organization with the task to find a place with good geological conditions for a repository, tried to set up a testing site for proof drillings at Kynnefjäll, 100 km north of Gothenburg. However, the drilling team was met by intense local protests and had to withdraw. The protesters guarded the intended site for no less than 20 years. Also in the other places that PRAV had identified as promising for a repository they met strong local protests, which could however not prevent the drillings. But these local protest groups were able to gain strong support from the local population and also from local politicians. All these local groups soon formed a national network called the Waste Chain which engaged university geologists as counter experts which strongly questioned the intended design of the repository. The local protests thus had more than a NIMBY character.

In parallel with these local controversies Swedish Parliament decided in 1981 about the financing of the future costs for handling nuclear wastes. Every reactor owner had to pay a certain amount for every produced kWh to a state Nuclear Waste Fund that would guarantee the financing of the future repository and other facilities. By the mid-1980s the power companies responsible for the final storage of spent fuel had established a new jointly owned organization, SKB, with the task to develop and build facilities for final storage. SKB reached the conclusion that it would be impossible to establish a repository at a site where the local population was strongly against it. Thus, the local opposition groups had won the first round in the controversy about final storage (Anshelm 2006a and b).

The local opposition to test drillings will be analyzed in event 3 in chapter 3 below.

The Chernobyl disaster and its effects in Sweden

The debate on nuclear power decreased after the referendum but was suddenly revived again in the spring of 1986 after Chernobyl. This disaster was in fact disclosed by Swedish nuclear experts. 30 hours after the incident increased radiation levels were detected at the Forsmark nuclear power plant in Sweden. A Crisis team was set up by the Swedish Radiation Protection Agency and after analysis of the fallout and of the meteorological conditions it identified the Chernobyl nuclear station as the probable source for the fallout over Sweden. The Swedish findings forced the Soviet government to inform the world about the disaster (DsI 1986:11).

Parts of northern and eastern Sweden were severely affected by the disaster and Swedish mass-media reported intensively about the increased radiation levels, and this caused much anxiety. The anti-nuclear movement experienced a revival as a result of Chernobyl. Demonstrations were arranged in many places all over Sweden demanding an immediate start of the nuclear power. But this revival was short-lived and soon ebbed out. The Minister of Energy phasing out of, Birgitta Dahl, had played an active role in the disclosing of the disaster and was deeply shaken by it. She rapidly commissioned an investigation of the disaster. This commission concluded that Chernobyl did not change the earlier assessments of nuclear risks in Sweden, and it further argued that an immediate phasing out of nuclear power would have severe economic consequences.

Based on this report and further investigations Birgitta Dahl presented a proposal to start the phase out in the mid-90s, with a first reactor in 1994 and a second two years later. After Parliament approved this proposal, Dahl emphasized that the decision to start the phase out was “irreversible”. This new policy was forcefully contested by industry and trade unions, representing a strong faction within the Social Democratic Party. They argued that a “premature phase out” – as they called it - would threaten jobs in industry. In the following year the Social Democratic Party experienced a strong internal conflict between an economic growth oriented faction, and an environmentally oriented faction. The former won and as a result the energy portfolio was transferred from Birgitta Dahl to the trade union leader, Rune Molin in 1990.

Molin immediately started negotiations about a revision of the energy policy with the Centre Party and the Liberal Party, and the three parties reached an agreement in 1991 in which the “premature phase out” of nuclear power in the mid-1990s was postponed to an undefined future. The agreement also contained a new element: It underlined the importance of the deregulation and internationalisation of the energy sector in general and the electricity system in particular. Thus five years Chernobyl, Parliament made a decision to continue the Swedish nuclear program unchanged. The “irreversible decision” to start the phase out in the mid-90s had in fact been reversed after a strong reaction from the pro-nuclear side, while the anti-nuclear movement was too weak to influence the process.

Chernobyl and its implications on Swedish energy policy are analysed in event 4 in chapter 3.

Municipalities competing for a repository

After the failed attempts to find a suitable location for a repository in the 1980s, SKB initiated a new strategy in the early 1990s. It adopted a much more open and cooperative attitude towards municipalities, emphasizing that a decision about a repository only would be made if a local municipality was in favour of it. Based on more developed safety analyses, SKB argued that the rock itself was not the single most important barrier but that the other components in a repository, the copper canister surrounded by bentonite clay, were also crucial parts. This meant that it was no longer necessary to search for the best possible geological location in the whole country, but that the geology in large parts of the country was sufficiently good. After a stepwise screening of potential sites all over Sweden, SKB turned to municipalities in southern Sweden that already had nuclear facilities. Preliminary studies indicated that two of these, Östhammar (where Forsmark is located) and Oskarshamn, had the best conditions with inhabitants that were not averse to nuclear facilities and suitable transport infrastructure (Anshelm 2006a, Lidskog 1998).

In 2002 more thorough studies of these two municipalities commenced including test drillings. The ensuing process was very different from previous attempts. Instead of having to deal with very reluctant local populations, SKB now had two positive local populations. After a long evaluation process SKB reached the decision in 2009 that Östhammar would be the best place for the future repository on geological grounds. To lessen the disappointment in Oskarshamn they simultaneously decided that the future plant for constructing copper canisters for the spent fuel would be located next to the existing interim storage facility in Oskarshamn.

The municipal “competition” for a repository is analysed in event 5 in Chapter 3.

Nuclear phase out or expansion?

The tripartite agreement in 1991 spurred what would become an institutional revolution in the Swedish electricity sector. New legal frameworks were introduced in 1996 in order to promote competition, and the ownership patterns changed dramatically; in particular a number of foreign power companies bought large shares of previously domestic energy companies, while Vattenfall expanded abroad, particularly in Germany where it bought power companies owning nuclear reactors and large coal mines (Högselius&Kaijser 2007). However, the nuclear issue did not disappear from the political agenda altogether. In 1997 a new tripartite energy agreement was made, this time between the governing Social Democrats, the Left party (former Communist party) and the Green party, and this agreement included a decision to start a phase out of nuclear power in the near future. As a result the two reactors at Barsebäck were closed down in 1999 and 2005 respectively. That these two reactors were chosen had to do with their location only 20 km from Copenhagen. For decades the Barsebäck plant had been a nuisance in the relations between the Swedish and the Danish governments. (See Danish Country Report)

In 2010, the time frame for phase out decided by Parliament after the referendum in 1980, ten reactors were still operating. These reactors had been upgraded and could generate more electricity than the twelve reactors did in 1985, and Sweden was still the country with most nuclear power per capita. In 2010, Parliament made a new decision on nuclear power in, which allowed the construction of new reactors, but only at existing power plants and for replacing old reactors. For a number of years electricity prices in Sweden had been low, and due to increasing safety demands on reactors, particularly after Fukushima in 2011, the reactor owners were forced to make large investments in safety improvements as well as in replacements of components that had reached the end of their technical life. In May 2015 the owners of the Ringhals nuclear power plant made a decision to close down the two oldest of their four reactors by 2020 for economic reasons, and in October the same year the owners of the Oskarshamn nuclear power plant also decided that the two oldest of their three reactors will be closed by 2020. At present it thus seems as if economic rather than political conditions will dictate the future of nuclear power in Sweden, bearing in mind that political decisions regarding taxes and subsidies in the energy sector may have substantial economic impact.

1.3. Presentation of main actors

The first two organizations of importance for nuclear energy were *the Atomic Energy Company, AE,* and *the National Defence Research Institute, FOA (now FOI)*. AE was established in 1947 as a limited company in which 4/7th of the shares were owned by the state and the rest by private industry, but the government had a dominant influence and provided most of the funding for AE. The main task of AE was to develop and design nuclear reactors, uranium mines, and reprocessing plants. FOA was established in 1945 by merging a number of separate military research institutes and became responsible for research on military applications of nuclear technology. FOA cooperated closely but discreetly with AE. Both AE and FOA had a dominance of nuclear scientists in leading positions. Public universities and in particular the technical universities, KTH and Chalmers, also played an important role early on, both for fundamental nuclear research and for educating nuclear scientists and engineers.

In the mid-1950s *ASEA*, Sweden´s leading manufacturer of electrical equipment also became involved in nuclear development. By this time, ASEA had developed the world´s first 400 kV-line in close collaboration with *the State Power Board, Vattenfall*. ASEA formulated a goal to become one of the world´s leaders in heavy electrical equipment, and it saw nuclear power as an area of vital importance for the future. ASEA had a dominance of electrical engineers in leading positions and had a long tradition of developing and manufacturing electrical plants.

The main power producers in Sweden were the state owned Vattenfall and about ten private power companies. They were ambivalent towards nuclear power in the mid-1950s. They feared that the nuclear enthusiasm might threaten the exploitation of hydropower in the still untouched rivers in northern Sweden, which was their first priority. They were also hesitant about the future costs of nuclear power. But in the 1960s they changed stance and jointly purchased nuclear reactors. Most of the Swedish nuclear power plants have been co-owned by several power producers. Until the mid-1990s these companies were fully Swedish owned, but with the liberalization of the Swedish electricity market foreign companies, i.e. the German company E.ON (now UNIPER) and the Finnish company Fortum have also become major owners.

From 1956 there was a division of labor dictated by government in which AE developed and designed nuclear reactors (HWRs), ASEA built them and Vattenfall operated them – and the government funded it all. Both ASEA and Vattenfall challenged AEs role as main developer. They had collaborated closely in the development of high-voltage technology in the 1940s and 50s, and wanted to continue a similar cooperation in the nuclear field, but had to accept AEs leading role. However, in the mid-60s private Swedish power companies decided to purchase light water reactors, LWRs, from ASEA, and the latter managed to develop and build such reactors on its own without licenses from General Electric or Westinghouse, which was unique in Western Europe. In 1969 the reactor development part of AE merged with ASEA to form ASEA-Atom, and this new company came to harbour most of the country's nuclear reactor expertise. Research and materials testing activities at Studsvik remained in a reduced AE, now Studsvik AB, a private company.

Also the government and government agencies supported nuclear energy. Most of the research and development work up till the mid-1960s was government financed from the Ministry of Trade and the Ministry of Defence. From 1968 the new Ministry of Industry took over responsibility for energy matters from the Ministry of Trade. There has been an energy unit at these Ministries responsible for preparing Energy Bills, setting up committees and new agencies and much more. The public servants in this unit, mostly engineers and economists, had a considerable de facto influence.

In 1956, Parliament passed an Atomic Energy Law, which led to the establishment of agencies for regulating fissile material and nuclear plants and their activities. At first, three temporary agencies were created, one for inspecting safety of reactors and security of fissile materials, one responsible for the siting of reactors, and one for radiation protection. In 1965 the third of these was formalized as *the State Radiation Protection Institute, SSI*. In 1974, the first two were merged and became *the Swedish Nuclear Power Inspectorate, SKI*. Finally, in 2008 SKI and SSI were merged and became *the Swedish Radiation Safety Authority, SSM*.

In 1972 a new company was established on government initiative for coordinating the purchase of nuclear fuel, *SKBF*. It was owned jointly by the reactor owning companies. In the late 1970s this company was given an additional task, to develop a method for final storage of spent nuclear fuel and it changed its name to *SKB*.

In a fairly small country the organizations supporting the development of nuclear energy have been rather few, and the leading persons in these organizations have all known each other and formed a rather tight network, even though there have also at times been conflicts within the network. Around 1970 a very powerful ”nuclear-industrial complex” had emerged, and there was a broad political support for nuclear power in Sweden from all political parties and from civil society as well, including influential organizations like the Federation of Swedish Industry and the Swedish central labour union, LO.

There was very little criticism of nuclear power before 1972. In the late 1950s there had been an opposition against nuclear *weapons*, and these critics had also questioned that the early reactors were designed to enable weapons materials. But they had not questioned nuclear energy as such.

In the early-1970s an anti-nuclear movement emerged. It started among some scientists and engineers, which were influenced by the critique launched by American colleagues. Some environmental organizations also became critical of nuclear power due to close contacts with sister organizations abroad. In the 1970s the anti-nuclear movement gradually gained momentum also beyond the environmental organizations, in particular among young ”counter-culture” people with experience from the student revolt in the late 1960s and the Vietnam and Chile solidarity movements, but also among peace organizations, women´s organizations, and religious groups. In 1973 also two of the five parties in Parliament took an anti-nuclear stance, *the Centre Party*, with its base in the country side, and *the Communist Party*.

The anti-nuclear movement was heterogeneous and organizationally scattered and to overcome this, an umbrella organization called *the People’s Campaign against Atomic Power, FMA*, was established in 1978. FMA decided to demand a referendum on the future of nuclear power, which was first rejected by a Parliamentary majority but later approved due to the strong sentiments caused by the TMI accident. The referendum campaign led to an enormous increase of the FMA membership and hundreds of thousands were engaged. However, the outcome of the referendum was a huge disappointment and an overwhelming majority of the activists became disillusioned and quit FMA, or FMK as it had been renamed.

FMK thus lost much of its strength as a national actor, but in some places that were chosen as sites for test drillings for possible nuclear fuel repositories, active *local protest groups* emerged in the 1980s. Moreover, other environmental organizations gained strength, for example *the Swedish Society for Nature Conservation, SNF,* and *Greenpeace Sweden*, which partly changed character and became professional lobby organizations rather than grassroots based activist organizations. In 1981 *the Green Party* was established in Sweden and it won its first seats in Parliament after the election in 1988. This Party absorbed some of the activists from FMK and became a strong anti-nuclear voice in Parliament.

Mass media have also played an important role in the history of nuclear energy in Sweden. In the early decades media gave positive and uncritical accounts of nuclear technology, but in the 1970s newspapers and TV and radio became important arenas for debate about the pros and cons of nuclear energy. Media played particularly important roles in relation to the incidents at TMI, Chernobyl and Fukushima and during the referendum on nuclear power (Holmberg&Asp 1984).

2. Showcase. The referendum on nuclear power in 1980

Case history

The referendum on nuclear power that took place on March 23, 1980 represents the most intensive engagement with the nuclear power issue ever in Sweden. Hundreds of thousands of Swedes were actively engaged during the months preceding the referendum. Many leading politicians were also engaged as were representatives from industry, trade unions and lobby organizations. Mass media were filled with articles and programs about the pros and cons of nuclear power and also with advertisements from the competing sides. Thus, the referendum is a fairly obvious choice as a showcase.

Referendu in Sweden are unusual. Before 1980, there had been only three earlier referendums: one concerning a ban on alcohol in 1922, one about introducing right hand car traffic in 1955, and one about a change in the pension system in 1957. In all these three cases opinions did not follow traditional party lines and a referendum was seen as a way to overcome this. It is Parliament that decides to arrange a referendum, and it is only advisory; it is the task of Parliament to interpret the result afterwards.

A proposal to organize a referendum on nuclear power was first proposed by the Communist Party in 1975 but was rejected by the other parties (Anshelm 2000). In the autumn of 1978, the proposal to hold a referendum came up again, this time within the Folkkampanjen mot Atomkraft (the People´s Campaign against Atomic Power), FMA. The FMA had been established in March 1978 as an effort to create a national umbrella organization for the rather heterogeneous anti-nuclear movement. It encompassed a dozen organizations, some of which were non-political environmental or peace organizations, while others were political organizations, including the Centre Party and Communist Party, and also many parties not represented in Parliament, primarily from the left but also including the Christian Democrats.

The nuclear friendly parties in Parliament - the Social Democrats, the Conservatives and the Liberals – were still negative about a referendum and argued that the nuclear issue was too technically complicated for a referendum. To put political pressure behind the demand for a referendum the FMA in the beginning of March 1979 launched a nationwide campaign to collect signatures on a petition for a referendum. On March 28, in the midst of this campaign, the Three Mile Island accident occurred, and all Swedish mass media reported extensively about it. The accident had a major impact on the public opinion, and a week later, Olof Palme, the party leader of the Social Democrats announced that he and his party had changed stance and now supported a referendum. The Conservatives and Liberals soon followed suit. For these parties a referendum was a way to separate the nuclear issue from partisan politics, thus preventing the TMI accident from becoming a big issue in the upcoming elections in September 1979. The decision to organize a referendum was complemented by a decision to postpone the fuel loading of four new reactors until after the referendum (Fjaestad 2008).

The details of the referendum were decided after the general elections, which brought a new non-socialist coalition into office, with Fälldin as Prime Minister. After negotiations among the five parties in Parliament, an agreement was reached in mid-December 1979. When demanding a referendum, the FMA had foreseen a straight forward referendum with two alternatives, one for a phase-out and one for a continued expansion of nuclear power. However, the pro-nuclear parties split into two alternatives instead of one, for tactical reasons. The Social Democrats did not want to support the same alternative as the Conservatives. There were thus going to be three alternatives in the referendum that was to take place on March 23, 1980. Line 1 was supported by the Conservative Party, Line 2 by the Social Democrats and the Liberals and Line 3 by the Center Party and the Communists (and the FMA). Each of the three lines was given 18 Million Swedish Krona to finance its campaign.

The ballots of Line 1 and Line 2 were largely identical. They proposed that besides the six reactors already in operation, six more reactors that were already completed or under construction should be brought into use. Beyond this no further expansion of nuclear power would be allowed. Line 2 had some additional points concerning, inter alia, public ownership of nuclear power plants and a ban on electric heating of dwellings. Line 3 proposed that the six operating nuclear reactors should be phased out within ten years and that no new reactors should be put in operation.

The ballots of Line 1 and 2 both began with the following sentence: *Nuclear power will be phased out at a pace that is possible with consideration to the need for electricity for employment and welfare.* They thus presented themselves as phase-out alternatives too, but in a far future. In the short term their proposals implied a threefold increase of nuclear production. In particular Line 2 had the aim to look like a "middle way" alternative and their slogan was ”phasing out, but sensibly”. The anti-nuclear movement was very upset both about the arrangement with three alternatives instead of two and about the other lines´ efforts to look as phase-out alternatives, but it could not do anything about it (Kågeson&Kjellström 1984, Eriksson 1981, Interviews Daleus, Odell, Kågeson, Falk)).

The referendum campaign started in mid-January and dominated political life and the mass media for two months with a peak in the weeks preceding the referendum. The three lines had very different organizational set ups and modes of campaigning and arguing (Holmberg&Asp 1984, Anshelm 2000).

Line 1 was closely linked to the Conservative Party and to industry. The campaign general was a 32 old year parliamentarian, Per Unckel, who was fairly unknown to the general public. The board of Line 1 also encompassed leading industrialists and scientists. The Swedish Federation of Industry established a lobby organization called Industries Energy Information to support Line 1.

Line 2 was linked to the Social Democratic Party, the Liberal Party and the main trade union, LO. The Social Democrats were in majority as they were a much bigger party. The trade union leader Rune Molin was appointed as the main spokesman of Line 2, while the liberal diplomat and former Foreign Minister Hans Blix was his second. Also the Social Democratic parliamentarian Birgitta Dahl had a leading role and represented Line 2 in many debates. Line 2 strived to mobilize the trade unions to campaign at work places all over the country.

Line 3 was the most heterogeneous line with more than 30 supporting organizations including, the Centre Party, the Communist Party, the Christian Democrats, parties far to the left and environmental and peace organizations. Its campaign general was Lennart Daleus, an unknown 33 year old environmentalist representing Friends of the Earth. Line 3 also included social democrats, liberals and trade unionists that were anti-nuclear. The most prominent of these “turncoats” was Ulla Lindström, a former Minister and a grand old lady in the Social Democratic Party. The Line 3 quickly developed into a mass movement with several hundred thousand people organized in local committees all over Sweden. Many activists took part in study circles to learn more about, energy issues, often based on the book "*Vote No*" (Kjellström&Kågeson1979) of which 170,000 copies were. These activists organized meetings, distributed campaign newspapers, and knocked on doors to talk with ordinary people (Eriksson 1981, Interviews Daleus, Odell, Kågeson, Falk).

In addition to the spokesmen and other representatives directly linked to the three lines the ordinary party leaders also played an active role in the campaign and did their best to try to convince their traditional voters to support "their" line.

A good illustration of the differing characters of the three campaigns is the way they arranged their major activity before the election (Holmberg&Asp 1984, 100ff). Line 1 organized its final meeting in a sober concert hall in Stockholm with speeches by a handful of the campaign leaders. The main point on the program was a presentation making use of sophisticated audio visual aids of a possible future "crisis scenario", describing a conflict in the Middle East leading to rationing of petrol (as had actually happened in 1956 and 1973), and with the underlying argument that Sweden would be much better off if it expands nuclear power.

Line 2 had its final meeting in the labour movement´s bastion "The People's House" in Stockholm. The theme of the day was "Don't make the 80's more difficult", and very prominent politicians and trade union leaders all argued that Line 3's proposal to phase out nuclear power in 10 years would create huge economic difficulties. "It's not only about the stereo and the car, it is about our jobs and social security" as the leader of LO put it.

Line 3 arranged demonstrations in a hundred towns all over Sweden one week before the referendum. In Stockholm 25 000 demonstrators marched to the main sports arena, where a number of musicians and actors participated and Lennart Daleus was the main speaker focusing on the safety problems with nuclear power. The slogan of the demonstration was "Say yes to life – say no to nuclear power"

These three events also illustrate the kind of argumentation that the three lines pursued. Line 1 emphasized that nuclear power was crucial for further economic growth and for decreasing the dependency on imported oil. It also argued that nuclear power was safe and that Swedish nuclear plants were more reliable than the one atTMI. Even if its ballot stated that nuclear power would be phased out "at a pace that is possible with consideration to the need for electricity for employment and welfare" the representatives of Line 1 talked very little about this future phase out, but much more about the nuclear expansion in the immediate future.

Line 2 had a similar argumentation as Line 1 and strongly emphasized that nuclear expansion was necessary for economic growth and social welfare. It also emphasized the need to develop alternative energy sources like wind and solar power but argued that it would take a long time before these sources could replace nuclear power. In the long run, sometimes the year 2010 was mentioned, a nuclear phase out should thus be feasible.

Line 3 emphasized the dangers of nuclear power; the risk of disasters in power plants, the challenge to store spent fuel for hundred thousand years, and the risk for nuclear proliferation. It argued that it would be possible to replace the six reactors in operation in the coming ten years through an ambitious program for building wind power and combined heat and power plants and through measures for increased energy efficiency, and that such a program would create many new jobs (Holmberg&Asp 1984, Anshelm 2002)).

The outcome of the referendum was that line 2 received 39.1% of the votes, line 3 received 38.7% and line 1 received 18.9%. As referendums in Sweden are only advisory it was the task of the Parliament to transform the referendum result into a political decision. In June 1980 Parliament set up four long-term goals for the energy sector:

- all nuclear power plants should be phased out by the year 2010;
- the country's dependence on oil should be reduced;
- energy efficiency should be increased;
- a transition should be made to "an energy system based as far as possible on sustainable, preferably renewable and indigenous, energy sources with least possible environmental impact".

It should be noted that the year 2010 was not in the ballot text of lines 2 or 1 but was added by Parliament. It was based on an expected (economical) lifetime for nuclear reactors of 25 years and assumed that the last two reactors would be commissioned in 1985. Parliament thus formulated goals for the energy sector implying a major redirection sometime in the distant future and it did not specify a time table for the phase out. In the short term, this decision meant a return to "business as usual," after a period of intense politicization of energy matters. A few weeks after the referendum, the government approved fuel loading of four reactors that were completed but not yet operating. Furthermore, the construction of two additional, even bigger reactors was accelerated. These were completed and taken into commercial operation in 1985.

The outcome of the referendum was a huge disappointment for all the Line 3 activists that had campaigned so intensively in the previous months. There were no plans for how to continue the nuclear opposition in the case of a defeat. Moreover, it became difficult to question the expansion of nuclear power when a referendum had approved it, and a majority of the activists became disillusioned and quit the People's Campaign.

Type of event

This is the most well-known event in the history of nuclear power in Sweden and much research has been devoted in particular to the political aspects of it. There is however not so much research on the emergence, functioning and character of the anti-nuclear movement, despite its size and importance.

Identification of actors

The referendum was initiated by FMA; an umbrella organization for environmental groups and political parties that were critical of nuclear power. When the decision about a referendum was taken, the Line 3–alternative grew very rapidly all over the country, engaging several hundred thousand people. It was a rather heterogeneous movement but a central campaign office tried to organize it and to produce campaign material that was distributed to all the local groups. Line 1 and Line 2 organized campaigns that were more similar to ordinary election campaigns enrolling party organizations, trade unions, industry and lobby organizations.

Mass media played a very important role during the referendum campaign both as arenas for debates and by describing and discussing the likely consequences of the different alternatives in the referendum. Public service radio and TV are obliged to be impartial and objective, which was not easy. They organized debates with spokesmen of the three lines that were of particular importance. Daily journals in Sweden are often linked to a political party and many took a clear stance on their editorial pages, but most opened their pages for debates with participants from all lines.

Arguments and behaviours

The anti-nuclear, Line 3, focused primarily on the dangers of nuclear power. The risk of accidents in reactors, as illustrated by TMI, was particularly emphasized, but also the unsolved final disposal of spent fuel, the environmental risks of uranium mining and the risk of nuclear proliferation. Furthermore it proposed a fast development of renewable energy sources and of more efficient energy use. Such a development, it was argued, would make it possible to phase out the six operating nuclear reactors in ten years and replace them primarily with renewables and efficiency measures.

Line 1 and Line 2 also acknowledged that nuclear power had problematic aspects and should be phased out in the long run, when there were renewable energy technologies that could replace them. But they argued that it would be an enormous economic loss not to use the reactors that had been built or were under construction and that this would threaten jobs and economic welfare. Line 2 argued that twelve reactors should be used during their technical life time, which was assessed to be about 25 years. This would mean “a phase out with sense”.

Public engagement

The referendum was organized according to strict laws and rules that govern advisory referendums in Sweden in which Parliament has the final say about the setup for such a referendum. Nuclear power and energy issues in general have never been discussed as intensively and wide spread in Sweden as during the half year preceding the referendum.

3. Events

The showcase and the five events below have been chosen primarily because of their significance in themselves, but also in such a way that they jointly reflect, different political eras, different issues (weapons, nuclear power, nuclear waste), local issues versus national issues, transnational influences, and the involvement of different kinds of actors.

The first event is the nuclear weapons controversy in the late 1960s and early 70s. This was the first time that nuclear technology was seriously debated in Sweden, and this debate took place on three different arenas with different kinds of participants. It was also influenced from abroad.

The second event concerns a number of inquiries on energy futures in the late 1970s. In Sweden government commissions are often appointed when political conflicts emerge, and when energy and in particular nuclear power became a contested area several commissions were set up, with representatives from stake holders and political parties. These commissions analyzed different future options and tried to find compromises.

The third event is about the local protests that emerged in the early 1980s in response to attempts to make drillings and investigations for locating a nuclear fuel repository. The drilling teams came without prior notice, and they often triggered a strong local opposition. These local groups formed a national network called the Waste Chain to coordinate their resistance.

The fourth event is the Chernobyl incident in 1986 and its political implications in Sweden. This disaster was disclosed to the world by a Crisis team at the Swedish Radiation Protection Agency, SSI, and the fallout over Sweden was severe. The disaster thus led to a renewed debate about the risks of nuclear power and the pace of the phasing out of Swedish reactors.

The fifth event is about the further process of locating a place for a repository in the 1990s which was a comprehensive process including both geological investigations and striving for political consent. In the end the process became almost a “beauty contest” between two municipalities, both already hosting a nuclear plant, striving to be chosen as sites for nuclear waste. Bedrock quality decided the outcome.

3.1. Event 1. The nuclear weapons controversy

Case history

In 1956 the Swedish Parliament decided on an ambitious program for the development of nuclear technology, which came to be known as the "Swedish Path". The long-term goal of this program was the development of a domestic nuclear fuel cycle in order to increase self-sufficiency of energy supply. It also had a less overt military aspect to enable the production of nuclear weapons. When the knowledge about the military aspects of the "Swedish Path" became more generally known, nuclear weapons became a contested political issue. Partly the division was on the right-left scale, with most politicians from the right and centre parties supporting nuclear weapons, while many politicians from the left were more sceptical. In particular the governing Social Democrats were divided; a growing faction within the party led, by the Social Democratic Women´s Association headed by Inga Thorsson, wanted to put a halt to the development of nuclear weapons. Also the government itself was divided on the issue with the Defence Minister, Sven Andersson, supporting nuclear weapons while the Foreign Minister, Östen Undén, was opposing them (Agrell 2002).

In 1957, the Supreme Commander, Nils Swedlund, openly demanded further funding for developing nuclear weapons, and this triggered an intensified debate. In March 1958 an influential little book entitled *Instead of the nuclear bomb* was published. It was co-authored by a well-known novelist and pacifist, Per Anders Fogelström, and a Social Democratic student leader and reservist officer, Roland Morell. They argued that Sweden should abandon the bomb and instead use the money for development aid. The book had a strong impact and was presented in newspapers, radio and even TV, which was for the first time used as an arena for political debates. The two authors were also invited to speak at meetings all over Sweden. At one of these meetings in June 1958, an initiative was taken to establish a new organization or network called Aktionsgruppen mot Svensk Atombomb (the Action group against Swedish Atomic Weapons), AMSA. In the following year the members of AMSA were very active; they wrote articles in newspapers, participated in radio and TV debates, talked at public meetings and prepared material for study circles.

AMSA chose to call itself an "action group" to demonstrate that it did not strive to become a long lasting peace organization and compete with existing organizations. It was very informal without any membership fees, no board and it was limited to the 21 people that joined from the beginning. These included some well-known authors, journalists and academics and the Arch Bishop. They had their sympathies with different political parties, but none of them was communist. One reason for not admitting more members was that AMSA did not want to be suspected to be a pro-communist organization. Moscow spurred communist parties in Western Europe to create peace organizations opposing nuclear weapons, and the Swedish Peace Committee was one of these.

There were also many that actively argued that Sweden should develop nuclear weapons in order to defend itself against possible attacks by the Soviet Union: leading militaries, researchers at FOA and AE and most parliamentarians belonging to the Conservative, Liberal and Center parties were all in favor of this option. The main Swedish daily, Dagens Nyheter, had an influential editor in chief, Herbert Tingsten, who was a former professor of political science. He argued very forcefully for Swedish nuclear weapons. Moreover, in 1959, Per Edvin Sköld, an influential Social Democrat who had been Minister of Defence during WWII and Finance Minister after the war, edited a book with the title *Swedish atomic weapons*, which was a kind of reply to AMSA and to Fogelström's and Morell's book with six contributors – members of the armed forces, researchers, a diplomat and a journalist – all pleading for the development of nuclear weapons.

Within the Social Democratic Party the opinions were much more divided. In parallel with AMSAs public campaign the nuclear weapons issue was also intensively discussed in. In fact, the nuclear weapons controversy threatened to cause a major disruption in the party, and Prime Minister Tage Erlander therefore set up a special study group in the autumn of 1958 including the main proponents and opponents within the party. He appointed his newly recruited political aide, Olof Palme, as secretary in the group with the task to try to reach a compromise concerning the future nuclear weapons research. The choice was between on the one hand "protection research" aiming at understanding nuclear weapons better in order to construct bomb safe shelters and other protective devices, and on the other hand "construction research" aiming at constructing and producing nuclear bombs. After more than a year of discussions, the study group presented its report in November 1959 and recommended what they called "extended protective research" in the coming years until 1963, when a decision whether to build bombs or not would have to be made. In reality, this compromise did not impede the efforts of the FOA researchers, as the production of plutonium in the “civilian reactors” would not start until 1964 anyway (Agrell 2002).

The main purpose of the study group was to “neutralize” the nuclear weapons issue in the coming parliamentary elections in September 1960. All parties, except the Communists, could agree on the formula of extended protective research and abstained from discussing the issue in the election campaign. However, AMSA did not want the nuclear weapons issue to be buried in this way. In April 1960 they made a plea for a referendum on nuclear weapons, and started to gather signatures for their plea, but they were not able to muster the necessary number of signatures. When this campaign failed, AMSA more or less dissolved.

One of the leading AMSA members, the journalist Bertil Svahnström, took the initiative to a form a new organization called Kampanjen mot Atomvapen (Campaign against Atomic weapons), KMA in the spring of 1961. The establishment of KMA was inspired by the British organization Campaign for Nuclear Disarmament established in 1955 and the Danish Kampagnen mod Atomvåpen, and like these organizations it strived for different kinds of members and other types of activities than AMSA had done. While AMSA was dominated by middle age intellectuals, KMA attracted young people not least students, most with a middle class background. It had a more international orientation and opposed nuclear armament in general, not only in Sweden. And it focused on organizing marches and manifestations rather than meetings and study groups. The first major event was a 2-day and 35 kilometer long protest march from a square in central Stockholm to FOA´s research facility in Ursvik in September 1961. The march assembled 800 participants and demonstrated the ability of KMA to mobilize activists. It also introduced a new kind of political manifestation in Sweden, following the examples from Britain and Denmark. The following year a new 50 kilometre march from Södertälje to Stockholm was organized during Whitsuntide attracting no less than 2000 participants, and similar marches were arranged also in 1963 and 1964, however with decreasing numbers of participants (Agrell 1999).

The issue of constructing Swedish nuclear weapons lost its political urgency in the early 1960s. The political compromise concerning “protection research” was meant to delay the issue. However, leading militaries, gradually changed their views on the military benefit of nuclear weapons, and after Nils Swedlund stepped down as Supreme Commander in 1961, no more concrete demands for nuclear weapons were expressed from the military. The same year, the Swedish foreign minister presented a plan at the United Nations in which he proposed that nuclear free countries would shape regional nuclear free zones. This so called Undén-plan was adopted by the UN in November 1961. In 1968 Sweden formally decided not to develop nuclear weapons and to sign the Non-Proliferation Treaty.

In the international negotiations concerning non-proliferation in the 1960s and disarmament in the 1970s, Sweden as a small neutral country with high competence in the nuclear domain played a prominent role. One example is Sigvard Eklund, who was appointed director of the IAEA in 1961 and remained so for no less than twenty years, when he was replaced by another Swede, Hans Blix. Eklund´s main task as head of IAEA was to prevent civilian nuclear programs from benefitting military programs, and he had the perfect background for this task, as this was something he had been doing in the previous fifteen years in Sweden. Another example is Rolf Björnerstedt, who had a senior position at FOAs division for nuclear weapons research. He took an active stance for Sweden abstaining from nuclear weapons in 1965 (Björnerstedt 1965) and was one of the founders of the Stockholm International Peace Research Institute, SIPRI. In 1969 Björnerstedt was appointed Head of the UNs Disarmament Division in New York.

It is hard to measure the direct impact of the anti-nuclear weapons movement, but official Swedish policy changed in the way this movement argued for. Sweden decided not to construct nuclear weapons and became a strong proponent internationally for nuclear disarmament.

Type of event

The nuclear weapons controversy took place in parallel both outside and within the formal political system. It was initiated in 1958 by a loose group (AMSA) of well-known intellectuals critical of nuclear weapons with access to mass media. They were able to create a media campaign and create a political debate, which in turn triggered a counter reaction from leading militaries and others. The controversy also became prominent within the Social Democratic Party, and in particular its Women's Association took a strong stand against the development of nuclear weapons. A special study group was setup to formulate a compromise. This compromise partly led to the dissolution of AMSA, which was replaced by a new political organization - inspired by the British CND - organizing protest marches and other public events. The nuclear weapons controversy has been recognized by some earlier research, but not very much.

Identification of actors

The controversy was initiated by independent intellectuals forming AMSA, by the Social Democratic Women´s Organization and by the Swedish Peace Committee, dominated by the Communist Party, which were all opposing Swedish development of atomic weapons. Later on KMA took over after AMSA.

The main proponents for developing atomic weapons were leading militaries, researchers at the National Defence Research Institute (FOA), and researchers at the Atomic Energy Company.

Leading politicians, including government members, were also strongly involved in the controversy on both sides. Others, like the Prime Minister and his assistant, tried to find a compromise to neutralize the issue which threatened to split the Social Democratic Party.

Arguments and behaviours

The opponents of atomic weapons argued that such weapons would be detrimental to Swedish security and increase the risk of nuclear warfare affecting Sweden. Some of them further argued that Swedish security would increase if the resources used for nuclear weapons research were used for development aid instead. Most opponents did not question the civilian nuclear program or a strong military defense. They demanded that research and development of nuclear weapons should cease and that no bomb material should be produced in the future Swedish reactors.

The proponents argued that Sweden needed “tactical” nuclear weapons to effectively defend itself against an attack from the Soviet Union. They argued that the Soviet Union would use tactical nuclear weapons irrespective of if Sweden had such weapons or not, and that Sweden would be much more effective in its resistance if it also possessed such weapons. Thus the possession of such weapons would reduce the risk of an attack, as the cost for the attacker would be much higher. They demanded that research and development of nuclear weapons should continue and that the future Swedish reactors should be designed to produce weapons grade plutonium.

The members of AMSA were very active communicators; they wrote booklets, articles in newspapers, participated in radio and TV debates, talked at public meetings and prepared material for study circles. The proponents of nuclear weapons tried to match AMSA and also produced booklets and articles. KMA also organized other types of events, in particular protest marches.

Within the governing Social Democratic Party a special study group was set up with party members representing both opponents and proponents of nuclear weapons. This was a rather unusual measure to avoid a splintering of the party.

Public engagement

There was no attempt by public authorities to engage the public at large. On the contrary, the agencies involved in developing nuclear weapons tried to keep this as discrete as possible. The engagement was thus initiated from below, from influential intellectuals. Within the Social Democratic Party a deliberative process was organized to handle the controversy.

3.2. Event 2. Public inquiries on energy futures in the 1970s

Case history

In Sweden government commissions have played an important role for preparing political reforms and major changes of policy. When a commission has published its final report, the Ministry in charge sends it to stakeholders to get a consultation response. The report and these responses are often an important basis for the formulation of government Bills. In the early 1970s a number of conflicts emerged in the energy sector: the further expansion of hydro power was contested by environmentalists, nuclear power was questioned as risky, and the oil crisis in 1973 demonstrated Sweden's extreme dependency on oil imports. A large number of government commissions were set up to handle these issues. Some of the commissions that were primarily intended to provide new insight had mainly experts and civil servants as members, while others that were intended to try and reach political compromises, also had politicians and representatives from interest organizations as members.

In the early 1970s there was a firm belief among public servants, politicians and experts of different kinds that the fast growth in energy consumption that had prevailed for a century would continue in coming decades (Anshelm 2002). This is clearly reflected in the final report from a government commission which presented its report in 1970 (Energikommittén SOU 1970:134). It was a pure expert commission without any politician. The commission presented a forecast for 1985 in which it presumed that the high rate of increase in energy consumption in previous decades would continue and that electricity would provide an increasing share of the total. This implied that the increase of electricity production was expected to be about 7 % per year, most of which in the form of new nuclear plants and that more than 20 reactors would need to be built by 1985. Two years later the Swedish power producers made a forecast for 1990 (CDL 1972) in which 24 reactors were planned to be built by 1990. This forecast was taken as a point of departure in two government commissions that investigated two aspects of nuclear power, the possible location of such plants close to cities to enable cogeneration of heat and power (Närförläggning av kärnkraftverk, SOU 1974:16), and the final disposal of nuclear waste (Kärnkraftens högaktiva avfall, DsI 1974:6).

This belief in an almost inexorable exponential future growth in energy consumption was modified in the mid-1970s. In the autumn of 1974, less than a year after the Oil Crisis, a government commission called the Energy Forecast Commission presented a report in which it foresaw a reduction in the rate of increase of future energy growth, from the historical growth of 4.5 % (since 1955) to between 2.4 to 3. 4 % up till 1985 and between 1.6 to 2.8 % from 1985 to 2000. In the Energy Bill presented in the spring of 1975, the Social Democratic government based its planning on the lower of these forecasts and it presented a plan for 13 nuclear reactors in 1985.

The most extensive of all the government commissions in the 1970s was the so called Energy Commission set up by Olof Johansson, the new Energy Minister in the Fälldin government that took office after the elections in 1976. Johansson was, like Fälldin, critical to nuclear power and he thus wanted the Commission to inquire different energy futures including alternative in which nuclear power was phased out. The Commission had fifteen members, half of which were politicians from all the five parties in Parliament and the rest were experts or representatives of influential organizations. Moreover, the Commission set up five expert groups concerning health, safety and environment, energy supply, energy usage, policy instruments, and R&D with about a dozen experts in each. The Commission started its work in January 1977 and presented its final 600-page report after only fourteen months (Energi, SOU 1978:17). Seven of the fifteen members formulated extensive reservations to the conclusions of the Commission. In addition the expert groups produced more than 70 (!) background reports on a very large range of topics. The Commission even gave an assignment to three environmental organizations to formulate an energy plan, and this resulted in the report MALTE 1990 (The environmental movements alternative energy plan, DsI 1978:11), which later became the basis for Line 3 in the referendum.

The task of the Commission was to prepare a basis for a coming Energy Bill concerning Swedish energy policy for the time period until 1990. It did so by first assembling and analyzing much material on environmental, economic and technical aspects of energy sources, and then formulating four different scenarios for the development up to 1990, one with a phase out of the six nuclear reactors in operation to 1985, one with a phase out to 1990, one with an expansion to thirteen reactors in 1990, and one with an expansion to fifteen reactors in 1990. The majority of the members recommended the third of these alternatives, while the reservants recommended some of the others.

In many ways the intensive work in the commission was a breeding ground for its members. Two of the politicians, Birgitta Dahl and Carl Tham, became future energy ministers and some of the others became leading spokesmen for their parties in energy matters. Two of the members, Per Kågeson and Björn Kjellström, became leading spokesmen for the People's Campaign during the referendum, and wrote a very influential book “Vote No” that became something of a bible for the Line 3 activists and was printed in 170 000 copies. Thus much of the analysis and argumentation that was used during the referendum by the different lines were first developed within the Energy Commission.

The time frame of the Commission was up to 1990, a little more than 10 years. This is a rather short time for changing a country's energy system as it often takes at least 10 years to plan and build a major energy plant, and even longer to develop new energy technologies. In 1974 a Secretariat for Futures Studies had been established as a kind of think tank within the government. This Secretariat launched an ambitious future study on energy in 1975 and presented its final results in a book titled *Solar versus Nuclear* (Lönnroth et al. 1978), published half a year after the Energy Commission had published its report. This book outlined two dedicated future alternatives thirty years into the future, one based almost entirely on nuclear energy and the other entirely on renewable energy, and the authors argued that both these alternatives were feasible in this time perspective and that the choice of energy system affected society at large; a nuclear Sweden would be centralized, police guarded and expert dependent, while a Solar Sweden would be more decentralized, democratic and community based. *Solar versus Nuclear* received much public attention and its key message, that very different future energy systems can be achieved with a clear energy policy, was important during the referendum campaign (Anshelm 2000).

The 1970s ended with two more energy commissions. After the TMI accident the new liberal Energy Minister, Carl Tham, appointed a commission to investigate if the accident motivated a reassessment of the risk of accidents in Swedish reactors. And after the decision to organize a referendum another commission was set up to investigate the consequences of a phase out of nuclear power to 1990 for the economy, employment and environment as compared with expanding to twelve reactors. The members of the former commission were all “experts” not politicians, while the latter included both categories. The first commission produced a report entitled *Safe nuclear power?* (SOU 1979:86) with an analysis of the TMI accident, suggestions for a number of measures to increase security in Swedish reactors (for example installation of filter chambers to reduce emission of radioactive isotopes in case of a reactor melt-down) and the conclusion that a reassessment of the risks was not motivated. The second commission originally had representatives from both the pro- and anti-nuclear camps, but the latter left the commission after some time because they thought that the whole approach was too biased. The commission concluded that a nuclear phase out in ten years would cause slower economic growth, an increase of unemployment and increased pollution due to higher use of fossil fuels but reduced risk of nuclear accidents (*Konsekvensutredningen,* SOU 1979:83).

All these government commissions in the 70s were mainly populated by engineers and economists and had a fairly technocratic and quantitative approach. They produced an enormous number of forecasts of future “energy balances” with the help of econometric models. And this approach affected the political debate which was often characterized by “reactor exercises” when proponents and opponents of nuclear power referred to different forecasts to substantiate their argumentation (Lindqvist 1997). But within this technocratic approach a paradigm shift occurred during the 1970s. While there was belief in a strong link between growth in GDP and energy consumption, and a conviction that energy consumption would continue to grow at a high pace in the beginning of the decade, the forecasts for future growth of energy consumption were much lower at the end of the 70s. This also affected the number of planned reactors in the 1990s which dropped from 24 to 12.

Type of event

Government commissions are an important instrument in the Swedish political system when there is a need for new reforms or policy changes, and such commissions often provide important material for government Bills. There were unusually many government commissions on energy issues in the 1970s and the work in these commissions shaped a discourse that was influential for a long time. There has not been very much research on this topic.

Identification of actors

The Ministers responsible for energy during the 1970s (Rune Johansson, Olof Johansson, Carl Tham) formulated the missions for the commissions and appointed their members. The members, and in particular the chairmen, of the commissions were of course important actors, but also the secretaries and experts working for a commission could play in important role. Many times some members/experts/secretaries participate in several commissions and they can get a particular influence through their overview. Most of the members of the commissions were economists or engineers working as civil servants or employees in energy companies, and they were often pro-nuclear. But gradually politicians and experts with dissenting opinions were also appointed to the commissions to broaden the discussions and help formulate compromises. The Secretariat of Futures Studies, which made the influential future study on energy *Solar versus Nuclear,* was a kind of a government think tank on the future with a fairly high degree of independence.

Arguments and behaviours

In particular the commissions that made energy forecasts employed a fairly technocratic and quantitative approach based on econometric models. The choice of different assumptions about key variables such as the future prices of different energy sources, or the growth or decline of different sectors of industry had a big impact on the forecasts, and the commission members would discuss such assumptions at length and outline a number of alternative scenarios including differing numbers of nuclear reactors, which was sometimes somewhat condescending referred to as “reactor exercises”. The government commissions on energy developed a specific discourse focusing on economy and technical choices, while wider societal implications were often not discussed, and also the anti-nuclear members of the commissions adjusted their argumentation to this. They were subjected to the power of the discourse.

Public engagement

The ongoing work of a government commission was not public, but the resulting published report was at times widely discussed. Moreover, in some commissions there were representatives of different stakeholders, and these representatives had intense debates and arguments that later on could influence the public debate.

3.3. Event 3. Local protests against a repository

Case history

On April 21, 1980, less than a month after the referendum, a number of heavy trucks loaded with drilling equipment were heading for Kynnefäll, a mountain area about 100 km north of Gothenburg. Their aim was to set up a testing site for test drillings to assess if Kynnefjäll was a suitable place for a nuclear spent fuel repository. However, the small forest road leading to the mountain was soft after heavy rain the previous days and the trucks gut stuck in the mud. The news about the trucks spread quickly in the vicinity of Kynnefjäll and within a day a protest action had been organized. The protesters surrounded the trucks and the drilling team realized that they would not be able to reach their intended destination and turned back. To prevent future attempts to establish a drilling site on the mountain, the protesters organized a continuous watch keeping at the road towards the mountain. At first a tent was set up, somewhat later it was replaced by a caravan, and finally a little house with four beds was built at the road site. The protesters formed an organization, Save Kynnefjäll, and were able to gain much support from the local population and from a majority of the local politicians. Partly this had to do with a previous controversy in the late 1960s when the Atomic Energy Company had proposed to build an enrichment plant in this area, which had spurred an active local resistance (Anshelm 2006a).

After the first attempt to set up a proof drilling site had failed, the organization that was responsible for the proof drillings, PRAV, organized several information meetings when their experts explained the principles of the intended repository. But Save Kynnefjäll enrolled counter experts that questioned these experts and the local population remained hostile to drillings. As a result PRAV decided to give up its attempts to establish a drilling site there. However, the members of Save Kynnefjäll were not convinced about the retreat of PRAV. They kept guarding the road to Kynnefjäll from their little house for 20 years and became a symbol for local opposition to nuclear power (Lidskog 1994). They ended their guard only in February 2000, after the Minister of the Environment, Kjell Larsson, wrote a formal guarantee that no repository would be placed at Kynnefjäll.

The background to the attempt to establish a drilling site at Kynnefjäll was that the Swedish Parliament had introduced a new law in 1977 called the Stipulation Act, which stipulated that reactor owners had to demonstrate that they would be able to handle the spent fuel from their reactors in a totally safe way to get permission to start operating new reactors. This Act had spurred the Swedish power companies to jointly pursue an intensive research project about a methodology for final storage of spent fuel, alternatively of the high level waste created if the fuel was reprocessed. In 1979 they had received approval from SKI for their so called KBS method. After the referendum the uncertainties about the future of nuclear power had disappeared and it was now clear that about 8 000 tons (from 12 reactors operating 25 years each) of spent fuel would have to be stored. Moreover, all reactor owners had to pay a fee in proportion to how much electricity they had generated to a new Nuclear Waste Fund (Kärnavfallsfonden) to cover the future costs for disposing nuclear waste. All this triggered a search for possible locations of a repository, and Kynnefjäll had been identified as one suitable place by PRAV, an organization established by the owners of the nuclear plants, that was responsible for the search.

PRAV had identified about a dozen potential places for drilling sites, where geologists believed that the rock had a very high quality, and after the failure at Kynnefjäll they made a new attempt in December 1980 in the valley of the river Voxna. This time they were able to set up their drilling equipment before any locals managed to organize protests. But a protest organization, Save the Voxna Valley, was soon set up and was able to get strong local support. In spite of demonstrations and petitions, PRAV started their drillings and this spurred Save the Voxna Valley to organize a blockade of the drilling site. PRAV called the police, which broke the blockade and arrested three of the protesters, which were later sentenced to fines (Anshelm 2006a, 70).

Also at the other locations that PRAV had identified as suitable for drilling local opposition groups were established as soon as the drillings commenced, following the examples from Kynnefjäll and the Voxna Valley. These groups organized demonstrations, public discussions and were often able to mobilize strong opposition. At one occasion a local resistance group (in Klipperås) demanded that independent geologists should be allowed to make an analysis of the drilling materials. When this was rejected activists dressed as Santa Claus stole 40 meter of drilling cores, and the independent geologists analyzing this material came to the conclusion that the local rock had vast deformation zones making it unsuitable for a repository (Anshelm 2006a).

All these local groups not only created strong local opposition; they also formed a national network called the Waste Chain, which engaged critical geologists, chemists and engineers in a critique of the KBS method at large. Their resistance was thus not only of a NIMBY (Not In My Back Yard) character but questioned the plans for final storage in general. For example, in 1982 a delegation with representatives from four local groups went to Stockholm and made a visit to government officials to present their views. In 1981 the power companies responsible for the final storage of spent fuel had established a new organization for this purpose, SKB (originally SKBF, also handling fuel procurement). SKB made drilling attempts in 14 different places and were met by local resistance groups every time and at a number of times they even called the police to keep protesters away from the drilling sites. Finally, SKB came to the conclusion that it would be impossible to establish a repository at a site where the local population was strongly against it, and therefore abandoned all the drillings. In the early 1990s SKB had revised its strategy and would make a new start to identify possible locations, as is described in event 5 below (Anshelm 2006a).

Type of event

This event is an example of local resistance to the nuclear industry and of rather hostile confrontations where the industry called for assistance from the police at a number of times. There has been some research conducted on this event.

Identification of actors

Local individuals, upset by the nuclear industries' intention to make proof drillings in their neighbourhood, quickly organized new organizations, like Save Kynnefjäll, with the single purpose of stopping these drillings. They were able to get a strong support from ordinary citizens and from local politicians. These local protest organizations formed a national network, the Waste Chain, and could muster support from counter experts, not least academic geologists who were critical of the nuclear industries plans for a repository.

The nuclear industry was obliged by the Stipulation Act to develop a method for storing spent nuclear fuel and for identifying a location for a repository. In the early 1980s the task of pursuing proof drillings in order to find places with suitable geological formations was given to PRAV, an organization established by the owners of the nuclear plants. In 1981 PRAV was replaced by SKB.

Arguments and behaviours

The local organizations first argued against a repository in their own backyard (NIMBY), but soon developed a more general critique of the intended method for a repository with the aid of counter experts in particular geological researcher at universities.

PRAV and later SKB argued that it was a matter of overarching ethical importance for the whole country to find places with the most suitable geological conditions for a future repository, and that proof drillings were a necessary step. PRAV tried to establish drilling sites without first informing the local public of their plans, and this proved to be very provocative and generated much resistance.

The local organizations primarily campaigned locally to get support for their opposition. At a few times they also used illegal methods, like erecting blockades and stealing materials from proof borings to let their counter experts analyze them. By forming a national network, the Waste Chain, the local groups could learn from each other and organize some joint visits to national politicians in Stockholm.

Public engagement

The local public engagement was very intense when PRAV commenced their proof drillings without informing beforehand, and the engagement thus came from below, from the opponents. There was a mutual distrust between the local protest organizations and PRAV/SKB, and very little dialogue between them.

3.4. Event 4. Chernobyl and its political effects in Sweden

Case history

Monday morning, April 28, 1986, was dramatic at the Forsmark nuclear power plant, 100 kilometres north of Stockholm. As the night shift came off work passing through the routine contamination control, the workers all showed enhanced levels of radioactivity on their clothes. Further investigation revealed a thin layer of radioactive dust on the grounds all around the power station, but no evidence of leakage or any other mishap. At 10 am, the contamination was reported to the Swedish Radiation Protection Agency (SSI) in Stockholm, which immediately assembled a Crisis team of diverse experts to investigate the situation. The nuclear specialists soon reached the conclusion that the radiation stemmed from a reactor, not a nuclear bomb test. The meteorologists analysing wind speeds and directions identified four nuclear stations in the Soviet Union as possible sources for the contamination.

When these findings were presented to the Swedish Minister for Energy, Mrs Birgitta Dahl, in the afternoon, she immediately instructed the Swedish ambassador in Moscow to ask the government what was happening. A few hours later the Soviet government confirmed it was handling a power reactor that had been ”damaged”, without specifying which reactor or what kind of damage. Further analysis by the Crisis team suggested that it was the Chernobyl nuclear plant in Ukraine that had been damaged, and it requested the Swedish Space Corporation for remote sensing images of the area. A few days later the Space Cooperation produced an image of the reactor site, with a strong heat plume from Reactor 4, proving that a major accident had indeed occurred. Thus, the radioactive measurements at Forsmark and the subsequent analysis by the Swedish Crisis team disclosed the Chernobyl disaster to the world (DsI 1986:11).

Due to North Westerly winds a fairly large part of the radioactive particles that were released during the Chernobyl disaster passed over Sweden during the night between 27th and 28th of April. In areas where it rained that night fairly high levels of radioactive fallout came to the ground. In fact, outside the Soviet Union, Sweden was the most affected country by fallout from Chernobyl. Swedish mass-media reported intensively about the disaster and the increased radiation levels, and this caused much anxiety. Many parents were afraid to let their children play outside, and the Radiation Protection Agency had a hard time informing and calming the general public. Its General Director appeared on the TV news almost every day for a couple of weeks. Farmers in the contaminated areas could not let their cows out to graze and had to dump their milk if contaminated. Reindeer herders had to discard no less than 80 % of all the reindeer in the year after the disaster (Moberg 2001).

When Chernobyl occurred, the anti-nuclear movement was severely weakened after several years of decay. The incident led to a revival. The former members put on their ”nuclear power – no thanks” badges again, and in mid May 1986, demonstrations were arranged in many places all over Sweden, and ten thousand people gathered in central Stockholm demanding an immediate start of the phasing out of nuclear power. Mass media were filled with articles about the disaster and with debates concerning the risks of nuclear power. The opponents to nuclear power argued that the disaster proved the danger of nuclear power in general, and some of them demanded an immediate phase out of all Swedish reactors. The proponents, including scientists, industrialists and trade unionists, claimed that Swedish reactors were fundamentally different from Soviet reactors, and that a disaster like the one in Chernobyl was impossible in Sweden. The poll institutes registered a large increase of negative attitudes to nuclear power (Anshelm 2000).

The governing Social Democrats were still in shock after the assassination of their party leader and the Swedish Prime Minister Olof Palme two months earlier. They were sensitive to the protests and the increase of anti-nuclear sentiments. Birgitta Dahl, the Minister of Energy and the Environment, had played an active personal role in the disclosing of the disaster and was shaken by it. Moreover, one of her closest advisors was Peter Larsson, a former leader in the anti-nuclear movement during the referendum campaign. Dahl rapidly commissioned an investigation of the disaster and its repercussions on Sweden with the heads of Nuclear Power Inspectorate, SKI, the Radiation Protection Agency, SSI, the Environmental Protection Agency, SNV, and the National Institute for Economic Research, KI, as members.

This commission worked fast and presented its report entitled *After Chernobyl. Consequences for energy policy, nuclear safety, radiation protection and environmental protection* after four months, by the end of October. It concluded that Chernobyl did not change the earlier assessment that it was extremely unlikely that an accident with radioactive releases of similar magnitude would happen during the Swedish nuclear program even if it could not be totally excluded. The Commission further argued that an immediate phasing out of nuclear power would have severe economic consequences. Based on this report Birgitta Dahl and her advisors made a Bill to Parliament in which she proposed a start of the phasing out of nuclear power in the mid-1990s; a first reactor would be decommissioned 1993-95 and a second in 1994-96. After additional investigations about the exact timing of the phase out, Dahl proposed a new Bill in 1988, with a phase out of the first reactor in 1995, and the second in 1996. After Parliament approved this Bill, Dahl emphasized that this decision to start the phase out was irreversible.

The People’s Campaign of course urged for a much faster phase out of nuclear power, but two years had passed after Chernobyl and the re-mobilization of the anti-nuclear movement had faded out, thus it didn´t have much political weight any more. The new energy policy was instead strongly contested by the more nuclear friendly Conservative Party and Liberal Party and many industrial leaders. More importantly, many leading trade unionists, which traditionally had been a strong faction within the Social Democratic Party, also opposed it. They argued that a "premature phase out" – as they called it - would lead to increased electricity tariffs, which in turn would threaten jobs in industry. In the following year the Party experienced fairly strong internal conflicts that were referred to as the "War of the Roses" (a red rose is the symbol of the Social Democratic Party), between an economic growth oriented faction around the trade unions, and a more environmentally oriented faction around the youth´s and women´s organizations of the party. As a result of this conflict the party leader and Prime Minister Ingvar Carlsson transferred the energy portfolio from Birgitta Dahl to the trade union leader, Rune Molin, who became a member of the cabinet.

Molin started negotiations about a revision of the energy policy with two other parties, the Centre Party and the Liberal Party, and in early 1991 the three parties made an Energy Agreement in which the "premature phase out" of nuclear power in the mid-1990s was postponed to an undefined time. One argument for this new policy had to do with climate change, which had become an important political issue since 1988. Parliament had formulated a goal in 1988 that future emissions of CO2 should not be increased, and this was used as an argument for postponing the phase out. Moreover, as a concession to the Centre Party, which has its traditional base among farmers, the Energy Agreement included a program for a fast increase of biomass production through subsidies and the introduction of CO2 taxes. The three parties had a majority in Parliament, and even though there was strong opposition from the new Green Party and the Left Party (former Communist Party) against the postponement of the phase out, this new energy policy was adopted by Parliament in the spring of 1991 (Högselius&Kaijser 2007).

Thus five years after Chernobyl Parliament made a decision to continue the Swedish nuclear program essentially unchanged. The initial "irreversible" decision to fasten the phase out had been revised after a strong reaction from the pro nuclear side.

Type of event

Chernobyl resulted in a short revival of the anti-nuclear movement, which organized demonstrations and public meetings. There was also an intensive debate in mass media. This in turn led to a political process in government and parliament with two successive reformulations of energy policy. This event has been recognized by earlier research.

Identification of actors

The nuclear industry and regulatory agencies played an important role in disclosing the disaster.

In the first months after the disaster, the anti-nuclear movement organized demonstrations but was not able to regain its organizational strength from the referendum campaign and soon faded away again. Scientists, experts, environmentalists, industrialists and intellectuals engaged in an intense mass media discussion about the disaster and its implications for the Swedish nuclear program. Poll institutes reported a rapid increase in negative sentiments about nuclear power. This all led to a political process within the Ministry for Energy and Environment and Parliament, and later on within the governing Social Democratic Party.

Arguments and behaviours

The anti-nuclear movement argued that Chernobyl demonstrated the dangers of nuclear power once again (after TMI) and that the phase out should therefore be hastened considerably. The pro nuclear side argued that the Soviet reactors and nuclear industry were totally different from the Swedish, and that an accident like Chernobyl with large radioactive releases was impossible in Sweden. Therefore, they argued, there was no need to revise the nuclear policy. The anti-nuclear side at first organized demonstrations and meetings, but soon most of the process took place in mass media and within the formal parliamentarian political system.

Public engagement

This was mainly a political process on the national level with much communication in mass media.

3.5. Event 5. A competition for getting a repository

Case history

In the beginning of the 1990s, SKB made a reorientation of its strategy. Previously it had tried to find sites with solid rocks without any cracks, through which water might reach to the surface. But based on more developed safety analyses SKB now started to underline that the rock itself was not the single most important barrier but that the other components in a repository, the copper canister surrounded by bentonite clay, also were crucial parts of a multiple barrier system. This reorientation meant that it was no longer necessary to search for the best possible geological location in the whole country, but that the geology in large parts of the country was sufficiently good. Other factors, like the attitude of the local population and the availability of suitable transport and other infrastructural facilities, were as important as geology.

In 1992 SKB sent a letter to all Swedish municipalities with a question if they were interested in a pre-study of a repository starting with test drillings. SKB emphasized that the process would be based on voluntariness and that no municipality would be forced to accept spent fuel against its will. Eight municipalities in northern Sweden responded positively and two of these were chosen by SKB for pre-studies, Storuman and Malå. These were both municipalities with high unemployment and a future repository, which was estimated to generate 350 jobs during 50 years, seemed a very attractive option to local politicians. Existing geological data, e.g. from prospecting for mines, were analysed in detail, and also other conditions were assessed. SKB came to the conclusion that both places could be suitable for a repository. However, local opposition had emerged in both places and it became so strong that the local politicians in both places decided to organize a local referendum. In both places a clear majority voted against a future repository (Lidskog 1998).

In 1996 SKB organized a conference in Stockholm with researchers and directors from nuclear companies in 23 European countries all sharing the same problem with local resistance to repositories. This led SKB to focus on municipalities that already had nuclear plants (Anshelm 2006a). Preliminary studies indicated that two of these, Östhammar (where Forsmark is located) and Oskarshamn, had the best conditions with inhabitants that were familiar with nuclear facilities and with suitable infrastructure. In 2002 more thorough studies of these two municipalities commenced including test drillings to investigate if the rock was acceptable. The ensuing process was very different from previous attempts. Instead of having to deal with very reluctant local populations, SKB now had two largely positive local populations, and in the following decade something of a beauty contest evolved. The local politicians in both places did their very best to convince SKB about the advantages of their place. SKB arranged a number of meetings and consultations with local people in both places to inform them about how the repository would be build. After a long evaluation process SKB reached the decision in 2009 that Östhammar would be the best place for the future repository for geological reasons. They simultaneously decided that the future plant for constructing copper canisters for the spent fuel would be located next to the existing interim storage facility in Oskarshamn.

Type of event

SKB gradually learned from previous processes and adopted a more open and cooperative attitude towards municipalities, emphasizing that a decision about a repository only would be made if a local municipality was in favor of it. When SKB turned to two municipalities with nuclear power plants both politicians and a large part of the population were favorable to a repository and even a sort of contest emerged between them. This event has been recognized by earlier research.

Identification of actors

SKB was a key actor and had a new attitude towards municipalities. In Storuman and Malå, many local politicians were initially positive to a repository that would give many jobs, but local environmentalists mobilized against it and were able to gain a majority in the local referenda.

In Östhammar and Oskarshamn a clear majority of both politicians and the local population were positive to the plans for a repository and cooperated actively with SKB in the investigations.

Arguments and behaviours

The job argument was important in all the municipalities, but in Storuman and Malå the environmental dangers with a repository became the dominant argument. In Östhammar and Forsmark the population was already accustomed to nuclear facilities and had a trust in the nuclear industry. This implied that no strong opposition emerged. On the contrary the job argument became dominant and the municipalities engaged in a sort of contest for the repository.

Moreover, SKB started to underline that the rock itself was not the single most important barrier but that the other components in a repository, the copper canister surrounded by bentonite clay, also were crucial parts of a multiple barrier system. Thus it was not necessary to find the perfect rock, only one that was good enough. SKB realised that local acceptance of a repository was a factor of crucial importance in the choice of location.

Based on the negative experiences from the 1980s, SKB adopted an open and cooperative attitude towards the municipalities. During all steps of the revised site selection process they involved the local populations in the communities studied in dialogues of various kinds.

Public engagement

SKB strived to engage the local populations in their studies. In the two northern municipalities this strategy failed in the end, but in the two municipalities which already had local power plants, the strategy was successful and many locals were actively involved in deliberations. When SKB made the decision to locate the repository in Östhammar, the large majority of the local population saw it as a positive outcome for the community.

4. Facts and figures (ca.4-5 pages)

4.1. Data summary

After a referendum in 1980, Swedish Parliament decided to phase out nuclear energy by the year 2010, but this decision was later changed and today there are 8 operating reactors that generate 40% of Swedish electricity.

4.2. Key dates and abbreviations

Key dates:

1947 Atomic energy research organization, AB Atomenergi, is established

1954 R1, a research reactor built in Stockholm, starts operation

1956 Government decision about an ambitious program, “The Swedish Path” to create a domestic nuclear fuel cycle, with uranium exploitation, HWR reactors and a reprocessing plant enabling atomic weapons.

1960 Two research reactors completed at AB Atomenergis research station in Studsvik

1964 The Ågesta HWR reactor starts operation

1965 OKG signs a contract with ASEA about the Oskarshamn 1 LWR

1969 AB Atomenergi and ASEAs nuclear division merge into ASEA-Atom

1970 The Marviken HWR reactor is completed but not taken into operation for security reasons, Sweden joins the Non Proliferation Treaty and the “Swedish Line” is definitely abandoned.

1972 O1 is inaugurated.

1974-75 Four more reactors are inaugurated.

1976 Nuclear power is a key topic in the election campaign. The Centre Party leader Thorbjörn Fälldin, who has a clear anti-nuclear stance, becomes Prime Minister.

1977 The Stipulation Act is introduced, which stipulates that reactor owners have to show that the spent fuel can be stored in a totally safe way.

1979 The TMI accident leads to a decision to organize an advisory referendum on the future of nuclear power.

1980 The pro-nuclear lines win the referendum and Parliament decides that 12 reactors shall be used until 2010, when all nuclear power shall be phased out.

1985	The 11th and 12th reactors are inaugurated.
1986	The Chernobyl accident affects Sweden substantially.
1992	An incident occurs in the cooling system of the Barsebäck 1 reactor. SKI stops it and four other reactors with the same design until it has been fixed. The Barsebäck 1 reactor is phased out.
1999	The Barsebäck 2 reactor is phased out.
2005	SKB decides to choose Östhammar as location for a future repository
2009	
2010	Parliament vote to repeal the policy to phase out the nuclear energy and to make it possible to build additional reactors at existing nuclear power plants.
2015	The owners of Oskarshamn and Ringhals decide to close down two reactors each by 2020 for economic reasons

Abbreviations**:**

SKI	Swedish Nuclear Power Inspectorate
SSI	Swedish Radiation Protection Institute
SSM	Swedish Radiation Safety Authority
IAEA	International Atomic Energy Agency
WNA	World Nuclear Organization

4.3. Map of nuclear power plants

Figure 1 represents a map of nuclear power sites in Sweden.

Figure 1 – Operating nuclear power plants in Sweden 2016. Source: WNA 2016.

4.4. List of reactors and technical, chronological details

Tables below shows the list of reactors, operators as well as date details.

Table 1 - Operational and shutdown nuclear power reactors in Sweden.
Sources: IAEA 2016; WNA 2016

No.	Name	Operator	Type	Mwe net	Construction began	Grid power	Shut down	Status	Use
1	**Agesta**	AB SVAFO	PHWR	10	1957	1964	1974	Permanent shutdown	Commercial
2	**Barseback-1**	Barsebäck Kraft AB	BWR	600	1971	1975	1999	Permanent shutdown	Commercial
3	**Barseback-2**	Barsebäck Kraft AB	BWR	600	1973	1977	2005	Permanent shutdown	Commercial
4	**Forsmark-1**	Forsmark Kraftgrupp	BWR	984	1973	1980		Operational	Commercial
5	**Forsmark-2**	Forsmark Kraftgrupp	BWR	1120	1975	1981		Operational	Commercial
6	**Forsmark-3**	Forsmark Kraftgrupp	BWR	1167	1979	1985		Operational	Commercial
7	**Oskarshamn-1**	OKG	BWR	473	1966	1971		Operational	Commercial
8	**Oskarshamn-2**	OKG	BWR	638	1969	1974	2015	Permanent shutdown	Commercial
9	**Oskarshamn-3**	OKG	BWR	1400	1980	1985		Operational	Commercial
10	**Ringhals-1**	Ringhals AB	BWR	881	1969	1974		Operational	Commercial
11	**Ringhals-2**	Ringhals AB	PWR	807	1970	1974		Operational	Commercial
12	**Ringhals-3**	Ringhals AB	PWR	1063	1972	1980		Operational	Commercial
13	**Ringhals-4**	Ringhals AB	PWR	1118	1973	1982		Operational	Commercial
	R1					1954	1970	Dismantled	Research
	R2	Studsvik AB					2005	Dismantling by 2019	Research
	R2-0					1960	2005	Dismantling by 2020	Research
	R4		heavy water	140	cancelled				Research

5. References

Nuclear power and nuclear weapons have been issues high on the political agenda in Sweden for for more than half a century. This means that it has attracted much interest not only from historians but also from social scientists, not least from political scientists. It also implies that there is very much official material in the form of reports from government commissions, government bills, discussions in Parliament etc. In addition there is material produced from the various stakeholders to be used in debates for and against nuclear power or nuclear weapons. (It is sometimes difficult to make a distinction between “research” and “debate publications”). Moreover, much of the media coverage of the nuclear history is becoming easily accessible thanks to the digitalization of major Swedish daily journals and the public service TV and radio.

All this means that it is difficult to get an overview of all the material, and the list below does not pretend to be exhaustive. It includes some of all the categories above, with an emphasis on historical research and political science research.

Within the Swedish part of the HoNEST project eight interviews have been made with some of the key actors, and these interviews are also included in the list below.

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Carl Tham, Minister of Energy 1978-1979

Alf Lindfors, Former CEO of the Forsmark Nuclear Power plant

Mats Odell, Representative of the Christian Democrats in the People´s Campaign against Nuclear Power.

Per Kågeson, Author of several influential books and leading anti-nuclear activist

Leif Josefsson, Former CEO of the Barsebäck Nuclear Power Plant

Lennart Daleus, Campaign general for the anti-nuclear side in the nuclear referendum in 1980.

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Liselott Falk, Anti-nuclear activist and member of the board of the People´s Campaign against Nuclear Power

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WP2

United Kingdom

Short Country Report

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AUTHOR

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BENEFICIARY

Science Museum

HoNESt History of Nuclear Energy and Society

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EXECUTIVE SUMMARY

This report belongs to a collection of 21 short country reports on the History of Nuclear Energy and Society (HoNESt, project Ref.662268). The reports tackle the complex sociotechnical system around nuclear energy. Nuclear developments, notably nuclear energy, are closely intertwined with social, economic, environmental, political and cultural spheres. Nuclear energy is also a globalized system involving transnational transfers of knowledge, materials, technologies, people and products including electrical power, medical elements, toxic wastes and other environmental hazards, materials, capacities and knowledge that must be carefully safeguarded. Nuclear energy is a complex social and technological phenomenon that influences societies but is also shaped by societies.

The short country reports are designed to assemble information and research results on the history of the relations between nuclear energy and society about all the different country cases in an accessible manner, and to document the findings with references.

The purpose of the country reports is threefold, addressing three different audiences:

1. to provide basic elements of narrative and analysis for further historical research by HoNESt researchers;
2. to provide information, context and background for further analysis for HoNESt's social science researchers;
3. to provide accessible information on nuclear-societal relations in the various countries for the purposes of outreach and communication with stakeholders (civil society, industry, associations, policy makers, journalists).

This report focuses on the history of the relations between nuclear energy and society in the United Kingdom (UK)[1] beginning with the opening of the world's first commercial-scale nuclear power station at Calder Hall in 1956. Extensive development of nuclear power followed quickly with two major reactor construction programmes and the development of fuel cycle

[1] The term Great Britain refers to the nations of England, Wales and Scotland, whereas the term United Kingdom refers to the combination of Northern Ireland with Great Britain and is the name of the state.

processes. As a result of the UK's early entry into the nuclear field, British discussions of nuclear power were conducted on a different time-frame from those in most of the rest of Europe. The main findings highlight the importance of reactor choice in framing and shaping the relationship between the public and nuclear energy.

The early British decision to design and develop gas-cooled reactors framed the nature of debates about nuclear power in distinctive ways. The different operating and safety characteristics of gas-cooled reactors were influentially interpreted to limit debates about nuclear safety. As many of the particular concerns raised by international campaign groups focused on the safety of the Pressurised Water Reactor (PWR), they did not apply in the UK until the completion of Sizewell B in 1995. Even then, briefly heightened public concern about reactor accidents abroad was effectively limited by trusted nuclear authorities who stressed that the UK did not possess any reactors of the specific kind involved.[2](Corner et al., 1990a; HM Chief Inspector of Nuclear Installations, 2011) As a result, UK reactors have usually been regarded by the public as safe though expensive, and arguments have focused on cost-management more than safety.

Public communication has been largely led by the government and industry actors, although early exhibitions such as the British Atomic Scientists' Association 'Atomic Train' introduced nuclear power and nuclear weapons to the British public as early as 1947. Unlike in other Western European nations, where the US Atoms for Peace initiative was a founding element in many nation's nuclear programmes (see, for example The Netherland Short Country Report), Britain's early development of nuclear power and early public exhibitions such as the Atom Train meant that the appeal of the US initiative was limited.(Laucht, 2012)

Unlike the rest of Western Europe, there have been few national-scale protests about solely focused on nuclear power and relatively little national representation of 'green' politics. Public opinion in the UK has usually hovered around 40% in favour, 30% unsure and 30% opposed to nuclear power (see Figure 2). When compared with similar nations in Western Europe, debates about nuclear power have been infrequent, taken place in relatively small

[2] The slight differences between the BWR damaged at Fukushima, and the PWR at Sizewell were explicitly highlighted by UK authorities.

sections of society and have focused on individual topics of concern such as cost-management, reactor choice or pollution. This does not mean that nuclear power has been uncontroversial, and Pidgeon et al. have identified that there has been a fragile 'tolerability' of nuclear risk in the UK. (Butler, Parkhill and Pidgeon, 2011). In cases where tolerance has been broken, the public have engaged in active opposition to nuclear power.

There has been notable public activism in the UK on the issue of nuclear waste, delaying the establishment of a UK waste repository, and pushing the industry to adopt more dialogic practices. Indeed, since the late-1970s, even as dialogic processes were explored, attempts to test suitable waste repository sites failed due to public activism and protest, In Scotland, it is also important to note, nuclear power has been more controversial than it has been in the rest of the UK. During the late-1970s, public protest led to the abandonment of site selection for waste facilities, and the early 1980s saw the UK's largest anti-nuclear power protests at the Torness construction site. Around 4-5,000 protested the construction of a nuclear station 30 miles from the centre of Edinburgh, organised by the Scottish Campaign to Resist the Atomic Menace.(Welsh, 2001) In the mid-2000's the election of a Scottish National Party government to the devolved Scottish Parliament led to significant divergence from UK nuclear power policy. In 2008, the Scottish government voted against new stations (just as the rest of the UK planned its 'nuclear renaissance') and in 2007, the Scottish government voted to retain waste near surface and near site, rather than in the planned UK Geological Disposal Facility.(Scottish Government, 2007; The Scotsman, 2008)

However, the major way in which the UK public have influenced nuclear energy decisions has not been through their actions, but through the way in which they have been imagined by decision-makers. An imagined public sensitivity to safety at any cost led to the indigenous development of gas-cooled and heavy-water-cooled reactors which were claimed to be safer than their light water-cooled counterparts. The study of nuclear energy in the UK highlights the importance of imagined as well as real publics in shaping and directing nuclear energy decisions.

1. Historical context (narrative)

1.1. Introduction to the historical context

On 17 October 1956, the UK became the first nation in the world to export power from a nuclear generating plant to a national grid. The British nuclear research programme had begun as a weapons programme in 1940 (known as "Tube Alloys"), and the potential for nuclear fission to generate electricity was noted before the end of the second world war in 1945. In 1954, the United Kingdom Atomic Energy Authority (UKAEA), a dedicated non-departmental public agency took over responsibility for research on both nuclear energy and nuclear weapons.(Flood, 1988) Accordingly the UK nuclear energy programme had its origins in weapons research, and in satisfying the military's cold war plutonium requirements.

A major fuel crisis (caused by a lack of coal and worries about the security of supply of expensive oil) strengthened the case for nuclear power in the mid-1950s leading to the development of a large-scale programme. It was hoped both by the government and UKAEA, that the first Magnox power stations would rival the costs of coal stations.(Ministry of Fuel and Power, 1955) However, they never met this target, and similar hopes for their successor, the Advanced Gas-cooled Reactors (AGRs) were dashed by a complex manufacturing process and cost over-runs.(Burn, 1978) Pessimism about the cost-effectiveness of nuclear energy seems to have affected UK public opinion particularly as the AGRs continued to over-run continually extended construction time and cost estimates into the mid-1980s.(European Commission, 1989) Nonetheless, since privatisation in the 1990s, nuclear power stations (and particularly the AGRs) have provided 20% of British electricity requirements and do so at a cost the public view as competitive.(Department of Energy and Climate Change, 2015; Ipsos MORI, 2009)

There has been little of the major swing against nuclear power in the UK which is apparent in other nations.(Bauer, 1997) Instead, in the UK, acceptance (or lack of opinion) about nuclear power has been so pronounced that social scientists in the UK have coined the term 'reluctant acceptance' to denote the 'resignation verging on frustration that there was no avoiding some continued dependence on the nuclear sector'.(Bickerstaff et al., 2008) As early as 1977, survey results showed that reluctant acceptance was a common view amongst the public – 62% of the respondents suggested they would accept a planned nuclear power station as “something they would just have to live with”, whilst only 30% said they would consider taking some kind of action to stop or avoid the development such as protesting or moving home (White, 1977).

Governments of all parties have remained supporters of nuclear power with two exceptions. From 1986 to 2005 this support was somewhat muted as the costs of decommissioning became apparent, and in the run-up to the 1987 General Election, the opposition Labour party proposed a reduction in nuclear power (the ruling Conservatives retained power). Since 2006 governments made up of the three major parties (Labour (1997-2010, a coalition between Conservatives and Liberal Democrats (2010-2015) and a Conservative majority government (2015-present) have remained publicly committed to plans to develop eight to ten new nuclear stations in the UK, with the first of these stations, Hinkley C announced in September 2016. The events at Fukushima in 2011 have had little effect on plans, and – at the time of writing - neither have the events of the 2016 EU Referendum.(EDF, 2016; ONR, 2011; Poortinga et al., 2013) Governments remain committed in their public statements and manifestos to promoting nuclear power as a necessity in meeting the UKs energy needs and CO_2 reduction targets.

1.2. Contextual narrative

As the first nation to develop nuclear power on a commercial scale, historians examining the UK benefit from a surfeit of sources. Histories of British nuclear energy often focus on distinctive factors such as the UK's leading role in the development of nuclear power, unique and apparently mistaken reactor choices, and disappointing industrial development. Compared to other nations in Western Europe, there has been little public opposition to nuclear energy, and the public have instead focused concern on the much more controversial nuclear weapons programme.[3] As such the public and such other stakeholders as trade unions and private contractors are often missing from historical analyses of British nuclear energy. The majority of scholarship was written whilst the programme was on-going and is critical of expensive and unique reactor types which were seen to be less efficient and less exportable than rival reactor types in the USA.[4] With hindsight, a number of these judgements can be revisited. British civil nuclear power plants have never suffered a major incident (the Windscale Fire of 1957 was in a military plutonium production plant), exceeded their designed lifetimes by decades, provided reliable and relatively economic base-load electricity over sixty years (at the point of sale). Our research also shows that the views of stakeholders need to be taken into account. For instance, unions were regularly consulted by governments, and shaped policy. Although the use of nuclear reactors has never been the object of sustained national public protest, the siting and type of waste disposal has prompted more active debate.

Civil and military nuclear power are often discussed separately in the historiography, and in public. The public's concern has generally focused on concerns about nuclear weapons rather than nuclear power, although it is clear that the two realms are linked, and that the initial

[3] See the Country Reports of France, West Germany, Italy or Sweden, for example. The development of 'civil' nuclear power has never led to large scale national protest, referenda, or political crisis, whilst the development of nuclear weapons by the UK led to the formation of one of the world's most well-known protest groups, the Campaign for Nuclear Disarmament.

[4] See for example: L. Arnold, *Windscale, 1957 : anatomy of a nuclear accident*, (New York, 1992); D. Burn, *Nuclear Power and the Energy Crisis: Politics and the atomic industry,* (London, 1978); M. Gowing, with assistance of L. Arnold, *Independence and Deterrence: Britain and atomic energy, 1945-1952,* (London, 1974); T. Hall, *Nuclear Politics: The History of Nuclear Power in Britain,* (London, 1986); R.F. Pocock, *Nuclear Power: its development in the United Kingdom,* (Old Woking, 1977); R. Williams, *The Nuclear Power Decisions: British policies 1953-78,* (London, 1980).

development of civil nuclear power was due to the desire for a weapons programme. (Lowry, 1986) This is unlike discussions in Sweden, for example, where campaign groups focused on the development of nuclear weapons, drew clear linkage to the development of nuclear power. (See Sweden Short Country Report). This division, involving separate rhetoric and framing of nuclear power and nuclear weapons is discussed in the events section below.

The British nuclear power programmes

The UK's first experience of civil nuclear energy was with the opening of the Calder Hall power plant on 17 October 1956. Although the early reactors at Calder Hall and at Chapelcross were designed for the production of plutonium (to satisfy UK military requirements), electricity was generated even at these stations on a commercial scale. Their technology of gas–cooling and graphite moderation had been chosen for its ability to produce plutonium for the military programme, their inherent safety, and their use of cheaper natural (un-enriched) uranium. These Magnox reactors (named after the magnesium oxide metal which clad the uranium fuel rods) were developed into the first 'civil' nuclear stations in the UK, beginning with Berkeley commissioned in 1962.[5] The government (through the Ministry of Fuel and Power) and the UKAEA proposed a large programme of twenty stations in 1955, which was quickly cut back to twelve due to cost. (Grimston and Nutall, 2013; HMSO, 1955) Although similar reactors were developed in France, and two sales were achieved to Italy (Latina, in 1958) and Japan (Tokai Mura, in 1961), the UK was the only nation to deploy a significant number of Magnox reactors.

This first programme was followed by the development of AGRs, and their selection as the basis of the second programme of reactors in 1964. These were also gas-cooled and graphite moderated, but were fuelled by slightly enriched uranium, operated at a much high temperature and were far more thermo-dynamically efficient than Magnox reactors. Compared with the PWR and other water-cooled reactors, the AGR is physically larger, with a lower power density, and a correspondingly larger pressure vessel made of reinforced concrete rather than

[5] The extent to which these stations can be considered 'civil' has been contested. Although the UK maintains a stock of civil plutonium produced by the stations, the closure of Calder Hall and Chapelcross in (2003 and 2004 respectively), and staunch political commitment to nuclear power has raised questions as to the final destination of plutonium produced in these reactors. (Lowry, 1986; Cox et al 2016; Stirling and Johnstone 2018).

steel. Again, the second construction programme was scaled back from initial projections, but problems with construction, cost over-runs, and performance issues dogged the successful completion of the reactors, with one (Dungeness B1) taking eighteen years to commission.(Burn 1967; Burn 1978; Taylor 2016)

Experience with the AGR delayed the selection of a third reactor type. In 1974, a choice between the British designed Steam Generating Heavy Water Reactor (SGHWR), and American PWR opened up a debate concerned with the cost of nuclear power, and the support of British design and manufacture, but heavily focused on safety concerns and needs of an imagined public. Significant concerns raised by the Government Chief Scientific Advisor about the safety of the PWR's steel pressure vessel initially led the government to choose the SGHWR.(Pocock, 1977, pp. 249–259) However, by 1976, problems with the scaling-up of designs from the prototype SGHWR at Winfrith Heath led the government to cancel the project, and instead decide upon the development of a 'British' PWR.(Williams, 1980; Interviews with Walt Patterson & Geoff Vaughan)

The development of the first British PWR, based on a Westinghouse design, was intended to be the basis of a fourth nuclear power programme consisting of a fleet of ten to twelve large stations which would replace the ageing Magnox stations, and reduce the UK's reliance on coal as a generating fuel (see Figure 3). However, privatisation of the electricity supply industry (announced in 1987 and carried out between 1990-1992), the length and complexity of the public inquiry for Sizewell B (which lasted three years), and unexpectedly low demand for electricity held back the development of the planned fleet of PWRs.

Until the early 1970s electricity demand doubled every decade, as it had done for a century; thereafter, it suddenly flat-lined for thirty years. The rapid change in demand trends was not anticipated, and the industry suffered from over-capacity throughout the 1970s and 1980s.(England, 1981) Problems of forecasting were not only caused by the economic situation and industrial changes but also by the vast increase in the use of gas in the home stimulated by the discovery and exploitation of North Sea oil and gas. By the mid-2000s however, the situation was much-changed again. Ageing plant led to fears of undersupply of electricity, and the depletion of North Sea gas reserves took the UK from being a net energy exporter to an energy importer in 2005. Meanwhile, the private company running Britain's more modern nuclear stations, British Energy, was on the verge of bankruptcy. Faced with rising fuel costs in conventional stations, and an increase in focus on carbon dioxide emissions, At the same time, Labour Prime Minister Tony Blair declared that nuclear energy was 'back on the agenda with a vengeance', (Wintour and Adam, 2006; Interview with Adrian Bull) Since then, as Taylor notes, despite nuclear energy's place 'on the agenda', its development has been slow. The development of new stations was announced as early as 2008, but it took a further eight years for the first, Hinkley Point C, to begin construction.(Taylor, 2016) It is important to note, that this delay was caused by changes of government, financial austerity and a complex privatised energy market.(Interviews with Adrian Bull & Norman Bird), but was not particularly related to public opinion. Unlike nations such as Germany, Sweden, Japan and Switzerland, where the accident at Fukushima caused a reassessment of the place of nuclear power in the electricity supply system, that was not the case in the UK.

Public opinion in the nuclear power debate

Public opinion in the UK has generally been split 40:30:30 (in favour: opposed: no strong opinion/don't know) on the topic of nuclear energy.(White, 1977; European Commission, 1984, 1986, 1987, 1989, 1991, 2005, 2007, 2008; Ipsos MORI, 2010a) Although opposition to new plants increased throughout the 1970s, and was made more prominent (as various actors became prominently involved at public inquiries), the figures across large surveys have remained largely static. A key feature of the surveys is the significant difference between male and female support of nuclear power. Generally male respondents have been more likely to support the construction and development of nuclear power, and have had a favourable view of the economics of nuclear power, and the nuclear industry; whilst female respondents are more likely to express opposition or an equivocal view.(European Commission, 1987, 1989, 1991, 2007; Ipsos MORI, 2010a) Men have been more likely to state that they have some, or significant, knowledge about the nuclear industry and perceived it as less risky, whereas female respondents have considered nuclear high risk, and stated that they knew little or nothing about the industry. These differences can be quite striking, a recent Ipsos MORI poll found that 29% of men felt that they knew the nuclear energy industry "very well" or a "fair amount", whilst only

12% of women felt the same. 45% of women had “never heard of” or “heard of, but knew almost nothing” about the nuclear energy industry, whilst only 27% of men felt the same.(Ipsos MORI, 2010a)

Whilst there has been continued trust in the safety of UK reactors (especially compared with those of other nations where there have been accidents (Poortinga et al., 2013)) there has been a significant change in optimism about the cost-effectiveness of nuclear power. Ambitions to build UK nuclear that stations would rival the cost of fossil fuels, were disappointed by experience with the Magnox and AGR stations, and by the mid-1980s, few viewed nuclear as a cost-effective option.(European Commission, 1989) By 2009, however, this situation had changed dramatically – nuclear stations were providing 20% of the UK’s electricity supply, and at a cost the public viewed as competitive.(Department of Energy and Climate Change, 2015; Ipsos MORI, 2009) This positive view may be challenged by response to the price agreed for electricity produced by Hinkley Point C, which guarantees the manufacturers a price nearly double the current market rate for any generated electricity.(Watt, 2017)

Although accidents brought the issue of nuclear safety to the fore, they have often made little impact on surveyed public opinion. Surveys conducted by the European Commission suggest that in the UK the accident at Chernobyl registered a small drop in support for nuclear power lasting only a year.(European Commission, 1987) This may have been due to the production of videos, and adverts in daily newspapers and on television media as part of an extensive media campaign conducted by the Central Electricity Generating Board (CEGB) and UKAEA to inform and reassure the public that the Chernobyl accident could not occur in UK reactors.(Corner et al., 1990b)

Meanwhile, UK residents have continually rated nuclear power plants as less dangerous than chemical plants.(European Commission, 1989) Concerns about dangerous chemical plants are probably due to industrial accidents, such as the fatal explosion at in Flixborough in 1974, and the widely debated regulations on the Control of Industrial Major Accident Hazards passed as a response in 1984.(Baxter, 1986; Sirrs, 2016) Reports of deaths in heavy industries such as coal, steel, and oil were common and widely reported.(Daily Mirror, 1962; Welbourn and Robinson, 1973; Evans, 1979) Regular deaths in the coal-mining industry, and disasters (for example, the Aberfan disaster of 1966, where a collapsing spoil heap killed 116 children and 28 adults) meant that the public viewed industrial safety as whole (rather than nuclear safety specifically) as a cause of major concern.

Since 1959, the nuclear industry has been regulated by an independent government agency. The Nuclear Installations Inspectorate (NII, now known as the Office for Nuclear Regulation, ONR), seems to have retained public confidence, in spite of a general weakening of public trust in government and institutions as a whole from the 1970s to the present. The safety record of UK operators means that there have been few opportunities to challenge trust in UK regulators. (Blowers, 2010; Bickerstaff et al., 2008; Thorpe and Gregory, 2010) Media reports often cite the UK as having the 'toughest' regulators, and suggest that Chinese and Russian vendors are keen to obtain a British regulatory 'seal of approval' before attempting to enter other foreign markets.(Gosden, 2015; Ruz, 2015) However this does not mean that regulators are universally trusted; in particular local residents near Sellafield view non-governmental organisations such as Greenpeace as the most successful regulators of the industry's actions.(Poortinga and Pidgeon, 2003)

The importance of the imagined public

Anxious about public response, UK governments have always been influenced by various 'imagined publics' in the formation of policy. Concerns about the response of imagined publics can be a source of major changes to planned policy or engagement tactics.(Maranta et al., 2003; Barnett et al., 2012; Skjølsvold, 2012; Walker et al., 2010) Welsh and Wynne suggest that the UK industry 'imagined (and desired) [an] awe-struck public' in the 1950s and 1960s.(Welsh and Wynne, 2013) The 1955 White Paper 'A Programme of Nuclear Power' clearly imagined a public requiring secure, abundant and cheap energy supplies (which would have to be generated by fuels other than coal or oil), and saw investment in nuclear energy as a way of securing this.(HMSO, 1955) The clearest impact of imagined publics on the UK nuclear programme was during the debate over the third generation of nuclear power investment between 1973 and 1979. Further investigation of the role of the imagined public is dealt with in detail in the Showcase section below.

Public involvement in nuclear energy decisions:

The public planning inquiry is the formal avenue for public involvement in nuclear power.(Rough, 2011a) In the UK any large scale construction has had to be approved by local council authorities (though rules were changed in 2008 to facilitate streamlining of consent. See Johnstone (2014). If local authorities reject planning permission, then this can be challenged at a planning inquiry. At these inquiries the organisation seeking to build must provide evidence to persuade the neutral 'inspector' ('reporter' in Scotland) that their application does not break any legislation; opponents who can be made up of any number of campaign organisations or members of the public, must show that legislation has not been met. In the case of the nuclear industry many planning inquiries have been mandated by government rather than being caused by a rejected application for planning permission, notably in the cases of THORP and Sizewell B.(Patterson, 1985; Wynne, 2011)

The rise of environmental concern in the 1970s prompted the investigation of the influential Royal Commission on Environmental Pollution (1976) which raised questions over plans for nuclear waste treatment and storage, and coincided with the planning application for THORP at Sellafield.(Blowers, 2010) Various national environmental campaigning groups (particularly Friends of the Earth and Greenpeace) were involved in that planning inquiry, and have since attended all planning inquiries for nuclear facilities, providing local campaigns with access to funding and expert contacts.(Patterson, 1985) Nonetheless, little direct action has been taken (with the exception of Greenpeace's interference with at-sea-disposal operations in 1983, see below). Local groups tend to have been the most active, with the majority of campaigns taking place at the same time as planning inquiries. Groups like SCRAM (Scottish Campaign to Resist the Atomic Menace) and BOND (Britain Opposed to Nuclear Dumping) took part in (largely) passive resistance to new nuclear facilities.(Welsh, 2001)

Local, rather than national or international public opinion has often been the driver for change. Although international groups such as Greenpeace and Friends of the Earth were active in the UK from the late 1970s the groups' international focus meant that many of their concerns and much of their expertise was focused on safety issues in the PWR. Due to the UK's different reactor choices however, the relevance of their principal concerns was mitigated, and early Friends of the Earth publications were focused on cost, rather than safety as a cause for concern in Britain.(Friends of the Earth, 1975)

Davies considers that the differences in the aim of a planning inquiry (to establish whether a facility meets building regulations, and satisfies regulatory concerns as to its safety and effects on 'amenity' such as local landscapes etc.) is unsuited to discussing the less specific concerns of objectors at nuclear plant inquiries (who often object to the use of nuclear power at all, rather than solely in the specific instance under examination).(Davies, 1987) However, this does not mean that inquiries have been ineffective avenues for public impact. The earliest inquiry for a nuclear power station was held in Bradwell in 1956, and whilst local responses were often positive, the concerns raised resulted in a partnership between the UKAEA and Fine Art Commission to ensure that the beauty of remote sites was taken into account in the final design and landscaping of the station (Hansard, 1957; Luckin, 1990).

Risk perception and risk management in the UK

For those in the nuclear industry, risk perception, management and communication have changed drastically since the 1980s. Initial assessments suggested that the public over-estimated the risk of nuclear facilities because they did not understand the low risk involved. As such the CEGB and Health and Safety Executive began to discuss publicly the 'risk factor' involved in nuclear energy. Adapted from work by engineers who designed power stations to meet strict limits of 'probabilistic risk' (based on the probability of parts failing), early attempts to communicate risk focused on the probabilistic chance of risk to the public. An example of this method of communicating risk was the Health and Safety Executive's 'The Tolerability of Risk from Nuclear Power Stations' which compared the risks of nuclear energy with such diverse sources as the 'risk of death from five hours of solo rock climbing every weekend'.(Health and Safety Executive, 1992) Other risk factors, such as the danger to life posed by the Heysham AGR power stations (2.55 X 10^{-9}) are now seen to be similarly incomprehensible to the public. As Openshaw observes, such vast numbers spread over a lifetime have little meaning: even if the chances of an accident are one in one million years this does not mean that one will not occur tomorrow.(Openshaw, 1986) This conception of the public has led industry to blame public resistance to nuclear facilities on NIMBY-ism (Not In My Back Yard) and exaggerated concern stemming from a lack of knowledge.

Attempts to communicate and manage risk perceptions in this way largely failed. Research by sociologists in the late 1980s suggested that any significant difference between the public's perception of risk, and the risk factors quoted by experts undermined public trust in the knowledge and judgement of those experts rather than altering their perception of the risk itself. A report examining risk analysis, perception and management, published by the Royal Society in 1992 reflected the tension between probabilistic and social science approaches; 'the preface to the report…proclaimed that it was "not a report of the Society", that "the views expressed are those of the authors alone", and that it was merely "a contribution to the ongoing debate".(Adams and Thompson, 2002) Sociological studies of risk perception have attempted to understand why people perceive the level of risk that they do (rather than educate them that their perception of the risk is incorrect), and identified that this perception of risk is tied to a number of factors including 'concerns about social dependency, institutional trustworthiness and track-record'.(Adams and Thompson, 2002; Wynne et al., 2002) This changing conception of risk perception has influenced the way in which policy is made and decisions are announced, and has increased the opportunity for the public and non-governmental organisations to become involved in the policy process.(Adams and Thompson, 2002) It has also changed the way in which the industry tackles risk, engaging in 'up-stream' communication to discuss future risks with the public before they become an issue.(Thorpe and Gregory, 2010) Whatever the changing views of engineers and sociologists, risk perception has always been a subjective and individual experience for the public.

For the public at large, the major concern seems to have been the disposal of radioactive waste. Regular Eurobarometer surveys conducted throughout the 1980s show that even in 1986/7 UK residents viewed radioactive waste as a greater risk to themselves than a Chernobyl–like accident.(Eurobarometer, 1987) Surveys specifically on the topic of radioactive waste in 2001, 2005 and 2008 show that, for the UK public, waste is a major issue which limits support for the continued development of nuclear power.(Eurobarometer, 2001, 2005, 2008) Given that the influential Royal Commission on Environmental Pollution first suggested that no new stations should be built until the waste issue had been solved in 1976, it is perhaps unsurprising that the public view this unresolved problem as a significant continuing risk.(Flowers, 1976)

Nuclear waste in the UK

UK waste policy has been strongly directed by interactions with civil society. From 1949 to 1983 the UK disposed of most of its low-level and intermediate level waste at sea. The industry had been developing ways to treat and store waste since its beginnings, and placed a great deal of faith in the success of the Fast Breeder Reactor (FBR) programme at Dounreay to provide further options for waste treatment in the future.(Glueckauf, 1961) Waste from reactors was treated to remove plutonium, which would then be used to power the planned fleet of FBRs. However, the end of at-sea-disposal in 1984 and the closure of the FBR programme in 1994 posed significant problems for the safe disposal of UK nuclear waste, including the plutonium which had been built up to power the now non-existent FBRs.

The decision to halt at-sea-disposal was not initiated by the UK government. In 1972 the London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter banned the at-sea-disposal of High Level Waste (HLW). An advertising campaign by Greenpeace which filmed the UK's at-sea-disposal programme concerned the National Union of Seamen (NUS) and led to a global voluntary suspension of at-sea-disposal of radioactive waste in 1983 which the UK initially flouted.(Blowers and Leroy, 1994) However, the NUS (troubled by the Greenpeace campaign which involved dangerous proximity to the dumping operations) voted to refuse to handle the waste.(Cooper and Palmer, 2005; Kemp, 1991) The government had been considering other options since the publication of the Flowers Report in 1976, and, with the cooperation of Euratom and other European nations, began a small programme of drilling test boreholes for the geological disposal of waste in the late 1970s. That programme, however, was forced to end due to large scale local opposition at all the sites which had been chosen (Blowers and Leroy, 1994).

NIREX (the Nuclear Industry Radioactive Waste Executive) was formed in 1982 to discuss and develop alternative disposal routes. Settling on geological disposal of Low Level Waste (LLW), Intermediate Level Waste (ILW) and HLW in a single repository, NIREX announced a series of potential sites to the national press between 1982-7.(Blowers and Leroy, 1994) NIREX believed that the public could be educated into understanding that a proposed Geological Disposal Facility (GDF) was low-risk (following deficit-model theories); and employees were of the opinion that NIMBY-ism and lack of understanding were the sole reason for opposition in the communities where a GDF was planned.(Curd, 1990) Meanwhile members of the public felt that they should have been consulted about NIREX's plans before they were announced to the public.(Grice, 1986) This tactic of 'decide, announce, defend' has been cited as a major reason for the rapid rise of local groups opposed to the siting of a GDF nearby.(Blowers, 1999; Blowers and Leroy, 1994; Blowers and Pepper, 1987; Durant, 2007; Kemp and O'Riordan, 1988; Kemp, 1991; Mackerron and Berkhout, 2009)

Another cause for NIREX's difficulties was the political climate. Most of the sites were announced in the run-up to the 1987 general election, and the majority of sites were in Conservative constituencies. Political considerations weighed heavily in the choice to change the plans for a GDF from storing mixed level to solely low-level waste, in the hope of reassuring communities about the safety of the repository. However, this change of tactic implied that NIREX's firm statements were open to challenge and served only to increase opposition.(Blowers and Leroy, 1994; Curd, 1990) Between 1987 and 2007 Nirex attempted to regain trust by conducting a new siting survey guided by IAEA rules, and engaging in public consultations.(Nirex, 2005) However, Nirex had lost public confidence, and was integrated into the Nuclear Decommissioning Authority (NDA) in 2007 (becoming Radioactive Waste Management Ltd. in 2014).(Nirex, 2005; NDA, 2014)

NIREXs failure directly shaped policy. In 2003 the Committee on Radioactive Waste Management (CORWM) was established to provide the government, NDA and NIREX with independent advice. CORWM's report confirmed that a GDF was the most suitable solution for nuclear waste storage alongside "robust interim storage, possibly for 100 years or more, as an integral part of policy (as well as acting as a fallback should disposal fail)".(Mackerron and Berkhout, 2009) Recognising the public's response to NIREX's proposals, CORWM's report stated that a GDF could only be constructed with the consent of a local community. Their proposed strategy, outlined in Managing Radioactive Waste Safely (MRWS) focuses on the development of proposals in conjunction with local councils, activists and civil society by ensuring 'voluntarism'.(Department of the Environment, Food and Rural Affairs, 2008) This was tested in West Cumbria between 2010 and 2013 as local councils registered an interest in hosting a GDF. Although the proposals reached Stage 3 of the MRWS strategy they did not proceed further, as councils were concerned that they had no statutory right to withdraw their interest if they entered Stage 4, which involved test-drilling, and did not wish to proceed without the right to withdraw.(West Cumbria MRWS Partnership, 2013) Since this decision, it seems that the creation of alternative planning arrangements for 'Nationally Significant Infrastructure Projects' will move power further from local councils and back towards central government.(House of Commons Library, 2015; Bickerstaff, K. and Johnstone, P., 2017)

1.3. Presentation of main actors

The main supporters of nuclear energy in the United Kingdom have been government bureaucracies including various Ministries and Departments, and most notably the UKAEA which directed the vast majority of research into nuclear energy in the UK. Between 1962 and 1992, the major operators of nuclear power plants were state-owned electricity utilities which were given limited choice over the number and type of nuclear stations which they were to commission. In England and Wales, electricity was generated and transmitted via a national grid by the Central Electricity Generating Board (CEGB) to twelve regional electricity companies which then sold the electricity on to the consumer. In Scotland, meanwhile electricity was both generated and sold to the consumer by two utilities, the North of Scotland Hydro Electricity Board (NSHEB) and South of Scotland Electricity Board (SSEB). Construction of the stations was sub-contracted from the electricity utilities to a series of shifting industrial consortia that formed a single trade association to lobby on their behalf, now known as the Nuclear Industry Association.

Between 1954 and 1983 the UKAEA had a large budget and extensive powers to pursue development of UK nuclear power stations and fuel facilities with a staff, by 1959, of over 30,000 which was maintained until the mid-1970s. The UKAEA spread its research into all facets of nuclear power over at least ten sites (see Figure 1). From its privatisation in sections between 1983 and 1995 the UKAEA's role declined rapidly. Responsibility for reactor design and research was passed to the construction companies, whilst a small section of the Authority which examined fusion reactors was the only section to remain publicly funded.(Hance, 2006) Since 1997, however, much greater funds have been put into the development of decommissioning technologies, and the control and management of waste products. The Nuclear Decommissioning Authority (NDA) is now responsible for decommissioning nuclear plants and facilities and has a budget of some £3billion per annum, which includes the activities of its subsidiary Radioactive Waste Management Limited (NDA, 2014).

From 1957, the CEGB, NSHEB and SSEB, and the Electricity Council (responsible for sale to the public and local distribution), all undertook research into the operation of nuclear power stations. They had large budgets, and were able to borrow money from the government at favourable rates to cover the large capital costs involved in power station construction and operation.(Leslie, 1982) This era of extensive research was largely ended by privatisation which also led to a large cut in the number of staff employed.(Tombs, 2012) Since privatisation the number of companies involved ultimately increased. The current companies which promote nuclear power are associates of the Nuclear Industry Association, lobbying on the behalf of industry to ensure government support.

The final large group supporting the development of nuclear power have been the trades unions. Union membership reached a peak of over 13 million in 1979. Although membership in the UK declined precipitously thereafter, unions were an important political and societal actor in the post-war period.(Reitan, 2003; Toye, 2012) In the UK, unions have generally remained supportive of nuclear energy as a provider of highly paid, stable employment.[6](Unite the Union, 2015)

Supporters of nuclear energy emphasize their view that nuclear power will help secure energy independence; does not actively produce greenhouse gases that contribute to global warming or air pollution; and is a proven, developed technology with a sixty-year history of safe operation in the UK. The safety of UK reactors is also heavily emphasized and linked to the strict and well-established regulation of the UK nuclear industry.

The regulation of nuclear energy facilities is regarded as both independent, and stringent.(Openshaw, 1986; Grimston and Nutall, 2013; Ruz, 2015) Based in the Health and Safety Executive after 1976, the Nuclear Installations Inspectorate (established after the 1957 Windscale Fire) is now known as the Office of Nuclear Regulation (ONR), is responsible for inspecting all nuclear sites, and assessing the safety of proposed sites. Before any new reactor can be built in the UK the proposed design must pass the Generic Design Assessment process, created in 2008 to ensure that designs meet criteria for safety in a wide variety of fields.

Nuclear power is opposed by a variety of local and national groups. In the UK local groups tend to be short-lived and issue-specific, usually seeking to prevent the construction or

[6] Apart from the mid-late 1980s, when a variety of unions adopted policies opposing the further development of nuclear power [REF ELLIOT].

expansion of specific facilities. As noted above, since the mid-1970s, these groups have had extensive support from national groups like Friends of the Earth and Greenpeace who have staged longer, sustained campaigns in the media, and through peaceful protest against nuclear power.(Friends of the Earth 1975; Parkhill et al. 2010) As in other nations, such as the US, these campaigns call for a different assessment of the risks of nuclear power than those carried out by industry and regulators. They do not only focus on the risk of nuclear accidents or leaks, but also on the history of cost over-runs, industrial secrecy, and concerns about the future handling of nuclear waste, and the safety of its long-term disposal. However, in spite of media campaigns and media willingness to include the viewpoint of protestors and NGO's these groups and their actions have had usually only temporary and limited impacts on public opinion and policy in the UK (except in the case of waste policy, and except in Scotland).

Both supporters and opponents of nuclear energy have attempted to utilise print, film, radio and internet media to support their case. Media actors in the UK have been important in shaping the debate, but unlike in the US or Japan, have not taken a leading role. Instead, the media has often been used simply as a messenger for both factions, and have taken editorial decisions to display, rather than shape the debate set out by the two opposing sides.

2. Showcase

The importance of imagined publics in the reactor choice debate 1973-1979

Taken in a long term view, British public opinion on the use of nuclear power for electricity generation has been relatively stable. Three Mile Island, Chernobyl and Fukushima have had limited, short-term impacts with little continuing public protest or political changes. Compared to the rest of Europe, British public opinion seems incredibly resistant to external events.(See Figure 2; White, 1977; European Commission, 1984, 1986, 1987, 1989, 1991, 2005, 2007, 2008; Ipsos MORI, 2010a) This showcase focuses on the way in which UK reactor choice has shaped, and has been shaped by, the public's responses to nuclear energy.

The decision to focus on the development of gas-cooled rather than light-water cooled reactors has framed the topics and priorities of debates about nuclear power, whilst the concurrent development of nuclear weapons has diverted public attention. The major focus of debate has been the economics of nuclear stations and how (and where) waste should be disposed.(Burn, 1978; Gowing and Arnold, 1983; Hall, 1986; Williams, 1980) Obviously reactor choice has affected these debates directly. It is traditionally suggested that the UKAEA pursued a "narrow front" policy, choosing one path of reactor development and following a set and determined path of incremental development.(Burn, 1978) However, the UKAEA created and tested a variety of different reactor systems in parallel including the AGRs, their proposed sequel, the High Temperature gas-cooled Reactor (HTR), SGHWR, and the FBRs intended to reprocess spent fuel. This showcase focuses on the importance of various publics in the choice of the SGHWR system in 1974, and its abandonment in favour of the PWR in 1976.

Politicians and the public

The National Archives, at Kew contains a large number of files which highlight decision-makers' sensitivity to what the public would find acceptable (in this case an imagined public). As the public would only be able to challenge decisions about nuclear power at a public inquiry deciding on whether to site a particular station in a particular location, political concern about the public's reaction was heavily focused on the choice of reactor system, its safety, and siting.(Openshaw, 1986; Rough, 2011a, 2011b) From the mid-1970s onwards there was regular polling of the public which endeavoured to access their opinion of nuclear power (although the specific questions and focuses of each poll varied).(e.g. White, 1977) In the UK nuclear power has been mostly been perceived by the public as safe but expensive with the vast majority of controversy focused on cost and time overruns in construction, and the failure of manufacturers to achieve promised exports.

The non-nuclear context

Public debate about Britain's nuclear programme was affected by the unexpected halt in the growth of electricity demand, and an increasing concern about the environmental impact and safety of fossil fuel alternatives. Throughout the early and mid-1970s anxieties about industrial safety across all major industries were heightened by the government's attempts to pass major Health and Safety legislation, the creation of the Health and Safety Executive, which had been prompted by major accidents at industrial sites such as Aberfan in 1966 (involving the death of over 100 – mainly school children).(Sirrs, 2015, 2016) In 1974 the explosion of a chemical plant at Flixborough, killing or seriously injuring half of the workers on the site ensured that industrial safety remained a topic of strong political, public, and importantly, trade union concern as the government chose the nuclear reactor for the UK's third nuclear programme.

The SGHWR decision and the importance of the imagined public

Perhaps surprisingly, the Flixborough exploision was cited during the reactor choice debate of 1974. This decision involved politicians' and officials' conception and deployment of various 'imagined publics'. Anticipations of the general public's reaction were explicitly drawn upon in the selection of reactor as discussions focused on the system which would follow the AGR. The choice between a British SGHWR, American PWR or the rapid development of HTRs or FBRs (requiring European collaboration) also took account of concerns about British economic decline, a particularly British concern about brittle fracture in metals, and the potential impact of accidents in other countries.(Cabinet Conclusions, 1974) Unlike with earlier reactor choices, the 'nuclear establishment' (the UKAEA, constructors, and SSEB and CEGB) held different views as to which system should be chosen.

The debate, although mostly conducted in Cabinet was not entirely private. Reactor constructors, utilities and various MPs and Ministers made their views on the replacement system clear in Parliament and the press, and domestic and international companies advertised their systems in national newspapers in an attempt to shape opinion; unions, and importantly, the Trades Union Congress (TUC) met regularly with Ministers to discuss the options, and highlight their priorities. This made them active stakeholders and mediators in the debate on reactor choice, though their role has been subsequently overlooked. The TUC's priorities differed extensively from government priorities. Whilst the government was mainly concerned with public safety, cost, export potential and prestige, the TUC were focused on the number of jobs created in the proposed plants, the UK supply chain, and worker safety during operation.

There was significant political concern at a high level about the safety of the steel pressure vessels of PWRs, and whether the risk of a crack due to brittle fracture made the PWR a choice which would seem too risky to the public. PWR pressure vessels were difficult to manufacture, and the government was concerned that accidents elsewhere would have a substantial effect on public opinion:

> *…the Americans are selling LWRs to developing countries which will not have our expertise. If one of these blows up… the government will have no alternative but to shut down the LWRs in this country (CPRS, 1974)*

The Secretary of State for Energy, Eric Varley was above all concerned that 'the Government's choice of nuclear reactor would command public confidence' and determined that the government should choose the safest option (the SGHWR).(Cabinet Conclusions, 1974) Having commissioned no research to support these statements of potential public opinion Varley, the CPRS (and the Cabinet, who chose the SGHWR based on their recommendations) were clearly recommending certain choices influenced by imagined publics.

The reactor choice debate which occupied government, MPs, industry, the press, unions, and an interested public between 1973 and 1979 is a complex case highlighting the various ways in which imagined and real publics can affect nuclear decisions. Although the decision is usually thought to be one concerning a choice between inferior British technology and superior American technology, the choice of the SGHWR in 1974 was based on the concerns of two key imagined publics – the general public and union members. Concern about public confidence in the safety of reactors led the government to choose the SGHWR, based on an imagined public which put safety over expense. The heavy involvement of unions, through the TUC (which met with the Secretary of State for Energy on regular basis) represented a membership of over 12 million workers, which they imagined would value the creation of jobs in UK industry and enhanced worker safety more highly than cost to the UK Treasury. The combined effects of these two imagined publics and the priorities which they highlighted make the decision to pursue the SGHWR more understandable than is commonly portrayed.

3. Events

3.1. Critical view to the selection process of the events

The seven events chosen for this report have been carefully selected from a long list of more than thirty events to highlight the interaction of nuclear energy and society. We have chosen events which have received public attention, are relatively well-studied by academics, and for which a range of archival and media sources exist. Attention has also been paid to ensure that the chosen events cover the period of investigation for the project, stretching from 1952 to 2006, and that they involve a variety of actors (outlined below). The events focus largely on political decisions and political reactions to crises, but they do so to highlight the efforts made by politicians to shape or direct public opinion towards the benefits (or away from the risks) of nuclear energy, and thus highlight the way in which nuclear energy and society have interacted.

Although the focus of this research is the peaceful uses of nuclear energy, it was necessary to examine publicly available information about the UK's first nuclear experience – the testing of its first nuclear weapon in 1952. The event we have chosen to examine focuses attention on the communication of the test, rather than on the explosion itself. This choice highlights the image of nuclear power which politicians constructed. Understanding this event shows how nuclear power and nuclear energy were conceived of in Britain in the early 1950s.

As the UK was the first nation to utilise nuclear energy to supply its national grid, it was vital to examine the opening of the Calder Hall nuclear station in 1956 to highlight the differences and similarities between the portrayal of nuclear weapons technology and nuclear energy. The station represented the ambition of UK governments to maintain a prime place in the world as a reactor constructor, something which politicians hoped the public could take pride in, rather than fear.

Although the fire at the Windscale Plutonium Production Pile in 1957 could have damaged the reputation of UK nuclear facilities, news of the accident was carefully controlled. This event was chosen because of its surprising lack of impact on the nuclear energy-public relationship. The fire was portrayed as a local difficulty in an 'atomic factory' – couching the fire in the terms of relatable industrial accidents. Beyond the disposal of large quantities of milk, the public at large were not well-informed of the dangers posed by the fire at Windscale until the release of information by the government in the 1970s.(Arnold, 1992) The lack of public information, and a successful division between the plutonium producing pile and the nuclear energy programme, meant that the Windscale fire had no effect on the construction of reactors for energy generation in the UK. Unlike in countries such as Sweden, there has never been a strong link between protests about nuclear weapons and protests about nuclear energy (See Swedish Short Country Report)– the government's response to, and handling of the Windscale fire is vital in explaining how this division was achieved and maintained.

The reactor choice debate of 1974-76 was chosen to highlight the impact of the 'imagined public' on political decision-making. Whilst many consider the debate over the SGHWR to have been a choice between supporting British industry over American rivals, an examination of the debate in government leads us to different conclusions.(Openshaw, 1986, pp. 128–9; Pocock, 1977, pp. 258–259) Cabinet concluded that public confidence in the nuclear programme necessitated the choice of the safest possible reactor (even if it wasn't the cheapest) and supported the construction of SGHWRs.(Cabinet Conclusions, 1974) This event shows how the balance of this decision rested on the construction of an 'imagined public' by Ministers who valued safety over cost in order to maintain public confidence.

The publication of the Royal Commission on Environmental Pollution's Sixth Report, on nuclear power and the environment in 1976 proved an important turning point.(Flowers, 1976) The publication of the Report coincided with the growth and establishment of key Non-Governmental Organisations (NGOs) such as Friends of the Earth and Greenpeace. Wide press reportage of the Commission and its Report introduced the public for the first time to considerations about nuclear waste and the 'plutonium economy'. For campaigning organisations such as Greenpeace and Friends of the Earth, the Flowers Report gave legitimacy to many arguments that they had made (and would make in the future) about the continuing development of nuclear power without a dedicated waste repository, or 'technological solution' for nuclear waste.(Parmentier, 1999)

Until the announcement that Hinkley C would indeed go ahead in September 2016, the PWR at Sizewell (Sizewell B) was the only PWR in the UK, and was the last reactor to have been built in the country for just over twenty years.[7] The public inquiry held to grant planning permission for the reactor's construction was a large public event. The Sizewell B inquiry lasted for 3 years and collected 16 million words of evidence (a record at the time).(Baker, 1988) However, in spite of the large amount of evidence given, and a large press interest, there was little public engagement with the process.(Davies, 1987; Interview with Richard Davies) Although a large public venue was booked the only members of public in attendance were those waiting to give evidence.(Interview with Richard Davies) The Sizewell inquiry highlighted the difference between the inquiry's remit – to assess the suitability of the plans for the local area - and the desire for some to debate whether nuclear power stations (of any kind) were necessary at all.(Davies, 1987; Rough, 2011a) Exploring this difference is vital to explain how and why nuclear power has remained relatively uncontroversial in the UK.(Johnstone, 2014)

At first the Labour governments of 1997-2010 avoided taking any decision on nuclear power (or nuclear weapons).(Adams and Eaglesham, 2005) The early 2000s, however, witnessed a conjunction of the depletion of North Sea gas reserves from 2005 (changing Britain from a net energy exporter to an energy importer), concerns about a capacity crisis (caused by ageing plant), a severe financial crisis in the nuclear power sector (the collapse of British Energy) and the growing importance of climate change mitigation. From 2006, and in spite of financial difficulties, vocal government support for the replacement of the UK's ageing nuclear fleet with new reactors provoked action from groups such as Greenpeace and Friends of the Earth. The government's decision to actively support nuclear power in the face of opposition from NGOs has therefore been chosen to highlight the continuing lack of large scale public controversy in the UK in spite of heightened political sensitivity about the public's reaction.

[7] Although it should be noted that a PWR at Hinkley Point (also named Hinkley Point C) was, after a lengthy planning process, granted consent in 1990, that station was never built due to the industry's financial crisis from privatisation onwards (Johnstone, 2013).

3.2. Event 1: Communication of the first nuclear weapons test, 1952

Name	Role	Actor Category	Additional information
Actors supporting development of nuclear weapons			
Atomic Weapons Research Establishment (AWRE)	Based at Aldermaston (Berkshire), developed weapons for military use (1950-1987, 1987-present known as AWE)	Promoter	AWRE developed weapons and also took part in public information campaigns concerning their role.
Clement Attlee	Prime Minister (1945-51) – Labour	Promoter	Attlee kept the weapons programme secret from Parliament
Central Office of Information (COI)	Government Communications Agency	Other	Produced and distributed public information films on behalf of UKAEA.
Ernest Bevin	Foreign Secretary (1945-51)	Promoter	Ensured that the UK committed to attaining nuclear weapons.
John Cockcroft	Nuclear Physicist, Director of AERE (1946-61)	Promoter & Regulator	Directed research to provide the necessary plutonium.
Ministry of Supply (MOS)	Leading research in nuclear weapons/energy (1939-59)	Promoter	Provided funds for the weapons programme.
William Penney	Nuclear Physicist, Head of Atomic Weapons Research Establishment (1950-67), Chair of UKAEA (1962-7), Rector of Imperial College London (1967-73)	Promoter	Directed the British weapons programme, and the *Hurricane* series of tests.
Actors opposing development of nuclear weapons			
Campaign for Nuclear Disarmament (CND)	Activist group undertaking various peaceful protests against nuclear weapons (1958-present)	Receptor	Established to protest against increased global stockpiles of nuclear weapons, and to agitate for British unilateral disarmament.

Direct Action Committee (DAC)	Fore-runner of CND	Receptor	Initiated the first London-Aldermaston march which prompted the foundation of the CND.

The British nuclear weapons programme was begun in 1947 by the post-war Labour government led by Clement Attlee. After the war, the 1946 US Atomic Energy Act sometimes known as the McMahon Act excluded the UK (and other countries) from know-how obtained during the war as part of an Allied effort (American, British, French and Canadian) to produce atomic weapons.(Paul, 2000) The Foreign Secretary Ernest Bevin was a key supporter of Britain building an atomic bomb, famously insisting that 'We've got to have this thing over here whatever it costs... We've got to have the bloody Union Jack on top of it.'(DeGroot, 2011, p. 219) The programme was not common knowledge in Parliament until 1948, and not common knowledge amongst the public until the first successful weapons test on 3 October 1952.(Hennessy, 2007) Government regulated the weapons programme at an executive (Ministerial) level using small Cabinet committees to manage the nascent programmes.

Even before the cold war had begun, the government sought to maintain British prestige, and Britain's place at the 'top table' of international politics through its nuclear expertise and weapons. The bomb test was presented to the public by the news media (largely newsreels and newspapers) as a major success of independent British engineering and ingenuity at a time of austerity.(Daily Express, 1952; Central Office of Information, 1953) This was a period of trust in government and institutions in general, and as such there is very little initial evidence for anything other than public acceptance of this narrative.(Blowers, 2010; Hennessy, 2007) However, throughout the 1950s a growing concern about nuclear weapons began to emerge. Organisations such as the DAC and CND began to gather large numbers of members in the mid-1950s and engage in non-violent protest against the weapons programme. DAC and CND are noted for their 'Aldermaston Marches', initially from London to the bomb factory at Aldermaston, and (after 1959) from Aldermaston to London, which garnered much media attention. The protests also gained support from the left wing of the Labour Party (something which would manifest itself in the late 1970s and 1980s in an official Labour policy of multilateral disarmament).(Parkin, 1968; Byrne, 1988; Burkett, 2012, 2010)

Early groups like the CND were initially anti-nuclear weapons, but pro-nuclear power. (Luckin, 1990) The decision by organisations such as the CND to focus solely on protesting nuclear weapons policy and not nuclear energy policy directed critical public attention and anxiety towards the risks of nuclear weapons and away from nuclear energy. This early division between the issues surrounding nuclear weapons policy and nuclear energy policy has been a prominent and distinctive feature of the nuclear debate in the UK and was maintained and deepened by the political response to the Windscale Fire.

Event 1	**Public Information Film: “Operation Hurricane”**
Who was involved (refer to table of potential actors, above)	AWRE, UKAEA, William Penney, COI
When and where did it take place?	1953, cinemas nationwide as a pre-feature newsreel
What type of process was it? How did this change over time?	**Communication**. Part of a series of government films, this was the first major description of the British nuclear weapons programme, and the first publication of the reasoning for the programme on a nation-wide scale by the UKAEA and distributed by COI. The film carries a nuanced message as to the reasons for the weapons programme which reflected other government statements of the time: “That lethal cloud rising above Montebello marks the achievement of British science and industry in the development of atomic power, but it leaves unanswered the question of how shall this new-found power be used – for good or evil, for peace or war, for progress or destruction? The answer doesn’t lie with Britain alone, but we may have a greater voice in this great decision if we have the strength to defend ourselves and to deter aggression. That was the meaning of Montebello.”(Central Office of Information, 1953).

3.3. Event 2: First nuclear power station opens, 1956

Name	Role	Actor Category	Additional information
Actors supporting the opening of the first nuclear power station			
Atomic Energy Research Establishment (AERE)	Based at Harwell (Oxfordshire), and Risley (Cheshire) developed reactors for commercial development	Promoter	Designed the Magnox reactor used at Calder Hall.
UK Atomic Energy Authority (UKAEA)	Leading research in nuclear weapons/energy (1954-86)	Promoter	Provided the funds for reactor design and development, and for the opening ceremony.
Anthony Eden	Prime Minister (1955-57) - Conservative	Promoter	Celebrated the opening as an occasion of national importance.
Central Office of Information (COI)	Government Communications Agency	Other	Produced public information films, photographs and press releases concerning the opening.
Christopher Hinton	Director of UKAEA Industrial Group (1954-7) Chairman of CEGB (1957-64)	Promoter & Regulator	Directed the design of the Magnox reactor.
Queen Elizabeth II	Head of State of the United Kingdom	Other	Spoke at the opening ceremony, distinguishing nuclear energy as 'good' (vs. weapons).

Calder Hall nuclear power plant became the first in the world to export nuclear electricity to a national grid on 17 October 1956. The policy had been directed by the Conservative government and was implemented by UKAEA. While the programme's access to monetary and human resources was due to its importance for the nuclear weapons programme, and in maintaining security of electricity supply, which was a perceived priority for a people tired of austerity. This was a period of trust in government and institutions in general.(Blowers, 2010)

As with the first British nuclear bomb test, press coverage of the opening of Calder Hall was overwhelmingly positive.(Jay et al., 1954; Welsh and Wynne, 2013) For many, nuclear power was the 'good' face of nuclear fission, something reflected in the Queen's speech upon the plant: '…this new power, which has proved itself to be such a terrifying weapon of destruction, is harnessed for the first time for the common good of our community.'(Laucht, 2012) There is little case for a distinct 'euphoric' response amongst the British public. Indeed the focused resistance to the 'bad' face of nuclear energy (weapons) deflected public attention to the extent that Blowers describes the public as 'dormant in terms of the nuclear [energy] issue' (Blowers, 2010).

Event 2	**Public Information Film: "Atomic Achievement" (Central Office of Information, 1956)**
Who was involved (refer to table of potential actors, above)?	UKAEA, COI
When and where did it take place?	1956, cinemas nationwide as a pre-feature newsreel
What type of process was it? How did this change over time?	**Communication**. Part of a series of government films, this was the first major description of the British nuclear energy programme, presenting nuclear energy as clean, safe, and necessary. The film highlights Britain's achievements in constructing the first full-scale nuclear power station, and in other peaceful uses (such as isotope production).

3.4. Event 3: Windscale Fire, 1957

Name	Role	Actor Category	Additional information
	Those supporting nuclear power		
Harold Macmillan	Prime Minister (1959-63) – Conservative	Promoter	Ensured that published reports did not reflect badly on UKAEA competence (to protect the civil nuclear programme)
John Cockcroft	Nuclear Physicist, Director of AERE (1946-61)	Promoter & Regulator	Ensured the construction of filters on the chimneys of Windscale reactors which decreased the amount of radiation released.
Milk Marketing Board	Producer-run board and buyer of last resort (1933-2003)	Other	Paid farmers for milk which was destroyed, at the market rate.
Ministry of Defence	Requirement for plutonium and weapons development. (1957-present)	Promoter	Increased demand for tritium and plutonium (potentially a factor in the fire breaking out).
William Penney	Nuclear Physicist, Head of Atomic Weapons Research Establishment (1950-67), Chair of UKAEA (1962-7), Rector of Imperial College London (1967-73)	Promoter	Conducted an immediate review of procedures followed during the fire. Concluded that organisation failings at UKAEA were in part to blame.
	Those concerned by the Fire		
Local Community (Sellafield)	Those living in and around the Sellafield site.	Receptor	Concerned by lack of official information and (later by reports of increased leukaemia incidence).

National Farmers Union (NFU)	Union representing Farmers	Other	Concerned about the impact on farming. Arranged meetings with UKAEA staff so that their members would be informed.
National Union of Mineworkers (NUM)	Union representing miners and allied professions	Other	Local members were concerned fallout would be deposited in mines by ventilation systems. NUM arranged meetings with UKAEA staff so their members would be informed.
The legacy of the fire			
British Nuclear Fuels (Ltd)	Formerly part of Industrial Group of UKAEA, part privatised 1971, involved in fuel manufacture and reprocessing.	Promoter	Struggled throughout the 1980s and 1990s with reports that the fire had caused increased incidence of leukaemia (later suggested to be linked to other factors).
Nuclear Installations Inspectorate (NII)	UK Regulator for nuclear sites (1960-2011)	Regulator	Created after the fire to ensure that all sites took account of safety and were prepared (and trained) to deal with accidents.

The fire at one of the two Windscale plutonium production piles was the first (and at the time of writing, most significant) major accident at a nuclear facility in the UK. The fire, caused by a number of human, managerial, and scientific errors, spread a significant amount of nuclear contamination across the local area. As little was known about the limits for safe dosages of radiation Hinton encouraged workers at Windscale to conduct tests to determine whether foodstuffs, and milk in particular were safe for the local populace to consume, leading to a ban on the consumption and sale of milk from the area for a month (Arnold, 1992; Stretch, 2002).

William Penney conducted a review of the accident for UKAEA which was sent to Prime Minister Harold Macmillan. The report claimed that the Ministry of Defence's large requirement for tritium (for the H-bomb programme) had been a major cause along with defective management of the crisis by UKAEA. However, the report released by the government (some months after the fire) claimed that the cause was human error by well-trained but unfortunate plant staff.(Arnold, 1992) Public information about the fire was heavily restricted and controlled by the government. There was intense newspaper coverage of the events; however, this was dependent on the release of information from government (and UKAEA in particular). Concerns raised locally were addressed by public meetings organised by Windscale staff, and meetings with local farmers concerned about the effects of the fallout on their livestock.(Arnold, 1992; Stretch, 2002) Although a milk ban was in place for a month, farmers were protected from financial damage by compensation from the government (distributed through the Milk Marketing Board). Until the fire, the government had left regulation of the industry up to those who ran it (Hinton, Cockcroft and other UKAEA figures). After the fire, the government established the NII to inspect and licence all nuclear facilities, to ensure that they operated safely, and had adequate plans for accidents.

Although located metres from the new Calder Hall power plant, the fire at Windscale had little effect on the energy programme. Reports referred to the fire at the pile in terms similar to those of other industrial accidents and releases common at the time, and the government was very careful to ensure that a clear distinction was made between Windscale and Calder Hall.(Arnold, 1992) However, the accident did lead to changes in debates on nuclear power. The release of information in the 1980s coincided with a number of scandals at the Windscale site (renamed Sellafield in 1981 as part of a public relations exercise) which were linked heavily in press reports to mismanagement by the semi-private owners British Nuclear Fuels Limited (BNFL Ltd., a state owned, but private limited company).(Bolter, 1996) Controversy over early reports suggesting that children near the site were prone to leukaemia because of radioactive emissions also damaged trust in the safety of the site.(Keith, 1993; Wynne et al., 2002) Although impacting little on the developing nuclear power programmes of the 1960s, the Windscale fire, the government's handling of it and the secrecy around it, have been repeatedly cited as events which ought to raise suspicion and weaken trust in the institutions involved.

Event 3	Public meetings after Windscale Fire
Who was involved (refer to table of potential actors, above)?	UKAEA, members of the public, local farmers, members of the National Farmers Union and National Union of Mineworkers, Milk Marketing Board
When and where did it take place?	Late-October 1957, Windscale and local area (notably Seascale, Gosforth and Whitehaven)
What type of process was it? How did this change over time?	**Communication**. These meetings were held by various local groups (including NFU and NUM members meetings) and were attended by local UKAEA staff who sought to reassure local workers of their safety. Mineworkers feared that radioactivity would be collected in mines by ventilation systems. Farmers were concerned about the impact on their produce and livestock. (Arnold, 1992, pp. 69–70)
What rationale was given by the party that implemented the engagement?	To establish confidence in the public health measures taken.(Arnold, 1992, p. 70)

3.5. Event 4: SGHWR chosen as AGR replacement, 1974

Name	Role	Actor Category	Additional information
	Those in favour of the SGHWR		
Atomic Energy Establishment (AEE)	Based at Winfrith (Dorset) operated pilot reactors	Promoter	Supported the creation of commercial SGHWR after operating a pilot plant for some 7 years.
Alan Cottrell	Government Chief Scientific Adviser (1971-74)	Promoter& Receptor	Advised government that steel pressure vessels may be unsafe and suggested UK should rely on those with concrete pressure vessels (including SGHWR).
Central Electricity Generating Board (CEGB)	Nationalised monopoly electricity company (1957-1989)	Promoter & Regulator	A minority of staff at the CEGB were in favour of choosing a British reactor design.
Eric Varley	Secretary of State for Energy	Promoter	Varley was convinced that safety was the primary concern in reactor choice (and had a remit to encourage job creation in British industries).
Francis Tombs	Chairman of South of Scotland Electricity Board	Promoter	Supported the development of SGHWR for the SSEB's next reactor.
South of Scotland Electricity Board (SSEB)	Nationalised monopoly electricity company (1954-57)	Promoter	Had engaged in extensive planning for SGHWRs to be sited at Stake Ness, Torness, and Hunterston as part of an expansion of nuclear power.
	Those in favour of the PWR		
Arnold Weinstock	Director of General Electric Company (GEC, 1963-1996)[8]	Promoter	Publicly criticised UK reactor choices at Select Committee hearings, and

[8] This was the UK's largest electrical company, but was no relation to the similarly named US General Electric Company (GE).

			used the press to promote the PWR (which GEC would build)
Arthur Hawkins	Chairman of CEGB 1972-77	Promoter	Believed a British PWR would be exportable.
Central Electricity Generating Board (CEGB)	Nationalised monopoly electricity company (1957-1989)	Promoter & Regulator	The majority of staff at CEGB were in favour of choosing the PWR.
National Nuclear Corporation (NNC)	State/private nuclear construction company	Promoter	Majority owned by Arnold Weinstock, the NNC shared his opinion on the PWR.
Westinghouse	Reactor and Pressure Vessel Manufacturer	Promoter	In favour of the choice of their reactor type.
Those in favour of Canada Deuterium Uranium Reactor (CANDU)			
Atomic Energy of Canada Ltd	Rector Manufacturer	Promoter	In favour of the choice of their reactor type.

As with the whole nuclear programme, a complex alliance of military, political and energy requirements led to the decision in 1974 to replace the AGR system with another, newer technology. Faced with a complex decision, politicians requested information on the systems available. Staff in the UKAEA (particularly those in the AEE) supported the SGHWR which they had developed.(Fry, 2015) They were supported by Chairman of the SSEB Francis Tombs, who preferred an SGHWR for the next station to be deployed in Scotland. Some staff at AERE and a majority in the Central Electricity Generating Board including Chairman Arthur Hawkins favoured the importation of an American PWR specially modified for British regulations. They were supported in this by key figures in industry such as the Director of GEC Sir Arnold Weinstock (GEC were also the major shareholder in the NNC), who believed that “British PWR” could be readily exported to other countries.

UK governments have always been influenced by various imagined publics in the formation of policy. Concerns about the response of imagined publics can be a source of major changes to planned policy or engagement tactics.(Maranta et al., 2003; Walker et al., 2010; Barnett et al., 2012; Skjølsvold, 2012)

Whilst Weinstock and the CEGB were convinced that importing PWR technology from the USA was the most economic choice, Ministers, UKAEA, and notably Government Chief Scientific Adviser Sir Alan Cottrell were concerned about the safety of steel pressure vessels in PWRs. These were difficult to manufacture and monitor, and the government was concerned that accidents elsewhere would have a significant effect on public opinion:

> *Supposing that, with Swiss watchmaker meticulousness, we managed to make really "good" pressure vessels and incorporated into the reactor design every conceivable safeguard… we are still not out of the woods because the Americans are selling LWRs to developing countries which will not have our expertise. If one of these blows up… the government will have no alternative but to shut down the LWRs in this country (CPRS, 1974).*

The Secretary of State for Energy, Eric Varley was above all concerned that 'the Government's choice of nuclear reactor would command public confidence' and determined that in light of 'the recent disaster at the chemical plant at Flixborough' the government should choose the safest option (the SGHWR, which did not have a pressure vessel).(Cabinet Conclusions, 1974) Having commissioned no research to support these statements of potential public opinion Varley, and the Cabinet, who chose the SGHWR based on his recommendations were clearly influenced by their imagined publics.

Whilst the Cabinet were making up their minds on the new reactor system, there was intensive advertising in newspapers from companies manufacturing the alternative reactor types. Westinghouse and Atomic Energy of Canada (amongst others) advertised their PWR, BWR and CANDU systems in national newspapers, highlighting their safety, economy and reliability – hoping to influence the public debate surrounding the choice.(Atomic Energy of Canada Limited, 1974a, 1974b; Westinghouse Electric Corporation, 1974) There is little evidence that this occurred or that the public at large were involved. The imagined, and real public, fed into debate to different degrees.

Event 4	Constructor advertisements in press
Who was involved (refer to table of potential actors, above)?	Westinghouse, Atomic Energy of Canada
When and where did it take place?	National newspapers 1973-4 (e.g.(Atomic Energy of Canada Limited, 1974a, 1974b; Westinghouse Electric Corporation, 1974)
What type of process was it? How did this change over time?	**Communication** These advertisements were a common feature in the press until a decision on reactor type was announced in July 1974.

3.6. Event 5: Royal Commission on Environmental Pollution, 1976

Name	Role	Actor Category	Additional information
		Those in favour of the SGHWR	
British Nuclear Fuels (Ltd)	Formerly part of Industrial Group of UKAEA, part privatised 1971, involved in fuel manufacture and reprocessing.	Promoter	BNFL provided evidence to the Commission on the necessity of the construction of THORP, and supported CEGB and UKAEA plans for a further expansion of nuclear power.
Central Electricity Generating Board (CEGB)	Nationalised monopoly electricity company (1957-1989)	Promoter & Regulator	The CEGB provided evidence to the Commission, planning a large increase in the number of nuclear stations to meet projected electricity demand.
UK Atomic Energy Authority (UKAEA)	Leading research in nuclear weapons/energy (1954-86)	Promoter	Provided evidence on the SGHWR and Fast Breeder Reactor (FBR) promoting extension of the FBR programme to meet projected electricity demand.
		Those against nuclear power	
Friends of the Earth	Activist Organisation	Receptor	Raised concerns about the ‘plutonium economy’ and the safety of nuclear power. Criticised the UKAEA’s failure to provide a solution for nuclear waste, and (then current) methods of at-sea-disposal.
		Those assessing nuclear power	

Brian Flowers	Chair of Royal Commission on Environmental Pollution.	Regulator	Chairman of the Commission. Although a former member of UKAEA, Flowers remained neutral on whether nuclear power should be used to generate electricity.
	The legacy of the report		
Greenpeace	Activist Organisation	Receptor	Non-violent protest of at-sea-disposal, blocked UKAEA boats disposing of nuclear waste.
National Union of Seamen (NUS)	Union supplying work force for at-sea-disposal of waste	Receptor and Other	Allied with Greenpeace, and members refused to work on UKAEA boats carrying nuclear waste.

The Royal Commission on Environmental Pollution (RCEP) was in part instigated by growing concerns about the environment which had been developing in the UK throughout the mid/late 1960s. It rose to prominence in the early 1970s promoted by international environmental concerns and the formation of the campaign group Friends of the Earth and *The Ecologist,* an influential magazine devoted to environmentalism.(Prendiville, 2014) Whilst the RCEP (chaired by Sir Brian Flowers, Rector of Imperial College, former member of the UKAEA board and UKAEA researcher) was careful not to take any position on the desirability of nuclear power stations, its report (sometimes known as the Flowers Report) was critical of the lack of progress made on the treatment of waste: 'It is strange in retrospect that a matter so important for the safe development of nuclear power should have been delayed for so long'. (Flowers, 1976)

The then conventional method of ILW and HLW disposal (packaging waste in containers to dump at sea) was concerning for the RCEP who felt that 'The policy of accumulating more highly active solid wastes at AEA and BNFL sites with a view to eventual ocean disposal appears inadequate… Such disposal may prove unacceptable…'(Flowers, 1976, p. 203) Previous policy had long been to invest very heavily in a Fast Breeder Reactor (FBR) programme which would reprocess spent fuel and close the fuel cycle. Although agreeing that this could provide a solution to the waste problem, the RCEP questioned the desirability of the ‘plutonium economy’ which widespread adoption of FBRs would create. (Flowers, 1976, pp. 195) Not only were the effects of using a number of FBRs potentially unacceptable, the programme, based on the Prototype Fast Reactor (PFR) in Dounreay at the sparsely populated northern tip of Scotland, was experiencing severe difficulties. A number of coolant leaks had occurred, and the reactor had not worked safely enough to be taken to full power for a number of years.(Patterson, 1985) For the RCEP, the lack of a solution to the nuclear waste issue (given the problems with the PFR) was seen as a restraint on the desirability and environmental and social acceptability of nuclear power.

The Report concluded that: ‘There should be no commitment to a large programme of nuclear fission power until it has been demonstrated beyond reasonable doubt that a method exists to ensure the safe containment of long lived, highly radioactive waste for the indefinite future.’(Flowers, 1976, p. 202) The publication of the RCEP brought the problem of nuclear waste to a wider public audience, and waste quickly became a major public concern. A public opinion survey conducted in 1977 found that whilst a majority of the public were in favour of the construction of nuclear plants (49% to 32%), this dropped to a tie (43%, with fewer ‘don’t knows’) when the interviewee was first asked to consider the problem of nuclear waste (White, 1977).

For campaign groups like Friends of the Earth (and later Greenpeace) the Flowers Report provided a key reference for their criticisms of the nuclear power programme, and particularly the lack of a solution for nuclear waste. Greenpeace staged non-violent protests, blocking at-sea-disposal by the UKAEA using their boat *Rainbow Warrior*. Greenpeace established links with the NUS, whose members then refused to work on UKAEA boats carrying nuclear waste. This direct action changed UK policy from one of at-sea-disposal to one of dry-storage.

Increased discussion of nuclear waste issues in public led the government to examine options for geological storage of waste, culminating in the 1994 and 2013 efforts to construct a GDF for nuclear waste near Sellafield.

Event 5	RCEP publication
Who was involved (refer to table of potential actors, above)?	Brian Flowers, BNFL, CEGB, UKAEA, Friends of the Earth
When and where did it take place?	1976, London
What type of process was it? How did this change over time?	**Communication:** Publication of the report began public debate in the UK over longer-term solutions for nuclear waste and gave legitimacy to groups using this issue to attack continued deployment of nuclear power.
Event 5.1	**NUS and Greenpeace action to prevent at-sea-disposal**
Who was involved (refer to table of potential actors, above)?	Greenpeace, NUS, UKAEA
When and where did it take place?	1978-83, in the Atlantic Ocean/at UK docks
What type of process was it? How did this change over time?	**Non-Violent Protest:** Between 1978 and 1982 *Rainbow Warrior* engaged in peaceful direct action, attempting to block UKAEA vessels from disposing of nuclear waste at sea (generating much press coverage). In 1983 The NUS passed a motion directing its members to refuse to handle nuclear waste.
What rationale was given by the party that implemented the engagement?	To end at-sea-disposal of nuclear waste.

3.7. Event 6: Sizewell B public inquiry, 1982-1985

Name	Role	Actor Category	Additional information
		Those supporting nuclear power	
Central Electricity Generating Board (CEGB)	Nationalised monopoly electricity company (1957-1989)	Promoter & Regulator	Gave evidence at the inquiry, supporting their decision to build a PWR at Sizewell. The CEGB were forced to account for new safety features, the siting decision, and projected electricity demand for the new station.
British Nuclear Fuels (Ltd)	Formerly part of Industrial Group of UKAEA, part privatised 1971, involved in fuel manufacture and reprocessing.	Promoter	Gave evidence at the inquiry concerning the safety of nuclear fuel and fuel transport.
Peter Hirsch	Wolfson Chair in Metallurgy (Cambridge), Chair of UKAEA (1982-4)	Promoter	Undertook scientific work to verify the safety of metal pressure vessels, and method of detection whilst reactors were in operation.

Walter Marshall	Nuclear Physicist, Director of AERE (1968-81) Chair of UKAEA (1981-83), Chair of CEGB (1982-89)	Promoter & Regulator (at CEGB)	Promoted work to establish scientific methods of verifying the safety of steel pressure vessels. Gave evidence at the inquiry on the necessity of and safety case for the PWR at Sizewell.
UK Atomic Energy Authority (UKAEA)	Leading research in nuclear weapons/energy (1954-86)	Promoter	Provided evidence on the safety and design of the PWR to be built, and accounted for new safety features.
	Those against nuclear power		
Friends of the Earth	Activist Organisation	Receptor	Gave evidence at the inquiry criticising the projected demand figures of the UKAEA and CEGB.
	Those assessing nuclear power		
Frank Layfield	Inspector at the Sizewell B Public Inquiry	Regulator	Heard evidence at the inquiry and concluded that the reactor should go ahead if the Secretary of State for the Environment consented.

The formal avenue for public involvement in nuclear decisions has been through the public planning inquiry. In the UK any large scale construction must be approved by local council authorities. If local authorities reject planning permission, then this can be challenged at a planning inquiry. At these inquiries the organisation seeking to build must persuade the neutral ‘inspector’ (or ‘reporter’ in Scotland) that their application does not break any legislation; opponents who can be made up of campaign organisations or members of the public, must show that legislation has not been met. In the case of the nuclear industry many planning inquiries have often been mandated by government rather than being caused by a rejected application for planning permission.

The Labour government, which eventually supported the construction of PWRs from 1978 to its loss of power in May 1979, had promised that before a new reactor system was sited in the UK, a wide ranging public inquiry would be held. The new Conservative government upheld this when it recommended the construction of a modified PWR at Sizewell. However, the proposal to build a PWR led to growing concern about the importation of a foreign technology which had been characterised as less safe than existing reactors for the previous thirty years.(Davies, 1987)

Whilst the CEGB, UKAEA, BNFL, and key figures such as chairman of the CEGB Walter Marshall (former Chairman of UKAEA) were united in supporting the development of the PWR, organisations such as Friends of the Earth and Greenpeace raised concerns over the safety of steel pressure vessels which had been discussed in the 1974 decision. Since 1974 however, Marshall had led a Pressure Vessel Integrity Group with leading metallurgists such as Peter Hirsch, which sought to limit the potency of these arguments, establishing the kind of steel which should be used, ways of ensuring its high-quality manufacture, and the scientific methods of crack detection necessary to ensure a reactor was safe to operate.(Interview with Sir Peter Hirsch)

Writing before the inquiry began, Richard Davies, a Consultant Engineer to the inquiry, hoped that it would provide the public an opportunity to understand and debate the benefits and disadvantages of nuclear power, and to take a part in the decision-making process.(Davies, 1984) The CEGB had predicted public interest in the inquiry, and so arranged a daily coach from London for interested members of the public and hired the Snape Maltings venue near Sizewell – conducting the inquiry on-stage in an 800-seater concert hall. However, public inquiries are limited in their remit – they are convened to discuss whether planned infrastructure contravenes any legislation or has not taken into account its effect on the local populace adequately. Public interest was quickly lost due to the inquiry's tight remit (strictly adhered to by its legalistic inspector Frank Layfield), its complexity, and its length (the inquiry sat for more than 300 days). (Interview with Richard Davies)

This is not to say that the inquiry raised no matters of interest to the public. At the inquiry it emerged that from 1965 onwards, the CEGB first chose sites before conducting detailed investigations into their suitability for development, following a strategy which Blowers terms 'decide, announce, defend'.(Blowers, 2003) Such a strategy meant that it was hard for members of the public to trust the CEGBs assertions throughout the inquiry that the chosen site was the best (as it became clear that Sizewell was the only site investigated in detail).(Openshaw, 1986) Although it had been hoped that the inquiry would allow the public to engage in debate about the new station, its limited remit prevented the wide-ranging debate that some had hoped for, and highlighted the limited value of the planning inquiry as a forum of debate.(Davies, 1987)

Event 6	Planning inquiry
Who was involved (refer to table of potential actors, above)?	Frank Layfield, CEGB, Walter Marshall, Friends of the Earth, Greenpeace, various members of the public
When and where did it take place?	Snape Maltings, 1982-5
What type of process was it? How did this change over time?	Public Consultation Process: Planning inquiries in the UK allow those in favour of the proposed construction and those against to air their concerns. However, the legalistic nature of the setting prevents a discussion about the general concepts of the installation from being discussed. For example, at the Sizewell inquiry, organisations such as Greenpeace were unable to discuss the benefits/disadvantages of nuclear power stations in general, and instead had to demonstrate why the plans for that specific nuclear station in that particular location did not meet legislative standards.
What rationale was given by the party that implemented the engagement?	Mandated by central government to ensure public discussion of the new reactor type.

3.8. Event 7: Government repositioning on new build NPPs, 2006-8

Name	Role	Actor Category	Additional information
	Those supporting nuclear power		
Department for Business, Enterprise & Regulatory Reform (BERR)	Department with responsibility for energy policy (2007-2009)	Promoter	BERR were charged with energy policy, and in response to concerns about climate change, sought to change policy to commit the UK to building new nuclear stations.
Central Office of Information (COI)	Government Communications Agency	Other	Engaged by BERR to publicise Energy Review consultations in 2003, 2006 and 2008.
Tony Blair	Prime Minister (1997-2008) – Labour	Promoter	Announced that nuclear power was 'back on the agenda' in 2006 as the government's response to concerns about climate change.
	Those against nuclear power		
Campaign for Nuclear Disarmament (CND)	Activist group undertaking various peaceful protests against nuclear weapons (1958-present)	Receptor	From an organisation solely concerned with unilateral disarmament, CND grew to oppose all nuclear power throughout the 1970s and 1980s.
Friends of the Earth	Activist Organisation	Receptor	Invited to 2008 consultations but did not attend – arguing the decision had already been taken.
Greenpeace	Activist Organisation	Receptor	Challenged the 2006 Energy Review in Court (successfully) prompting the 2008 Energy White Paper. Did not attend 2008 consultations arguing the decision had already been taken.
Margaret Beckett	Secretary of State for the Environment Food and Rural Affairs (2001-2006) - Labour	Receptor and Other	Opposed to further development of nuclear power.
Scottish Campaign to Resist the Atomic	Activist Organisation	Receptor	Umbrella organisation established primarily to protest the construction of Torness power station 30 miles from Edinburgh in the late 1970s. Organised

Menace (SCRAM)			the largest protest concerning solely civil nuclear power in the UK with 4-5,000 in attendance.
Scottish National Party (SNP)	Party advocating for an independent Scotland, governing in the Scottish Parliament from 2007-present	Receptor and Other	Opposed to new nuclear power stations in Scotland. Opposed to the waste storage in a GDF. Displeased by UK nuclear weapons base at Faslane.
Alex Salmond	First Minister of Scotland	Receptor	Advocated for the policies of his Party (the SNP).

The new Labour government elected in 1997 had been reliant on focus groups and public engagement to formulate popular policies from 1994 onwards, and once in government promoted extensive public engagement in policy formulation.(Thorpe and Gregory, 2010) Such an approach ensured that minor controversies were avoided; however, the subject of nuclear power was not politically uncontroversial. The new Labour cabinet included members who had been in favour of unilateral disarmament and leading members of the CND in the 1970s and 1980s such as Margaret Beckett and, due to this tension, issues concerning the nuclear industry were at first avoided.

In 2003 the Department of Trade and Industry's White Paper concluded that the economics of nuclear power (alongside the costs of decommissioning and nuclear waste storage) made it 'an unattractive option for new, carbon-free generating capacity' and pledged that 'Before any decision to proceed with the building of new nuclear power stations, there would need to be the fullest public consultation and the publication of a white paper setting out the Government's proposals.'(Department of Trade and Industry, 2003) However, within three years, negotiations amongst the Labour Cabinet led to Tony Blair's announcement that climate change had put nuclear 'back on the agenda with a vengeance'. This decision has also been linked to military needs of the time. (Cox et, al. 2016; Stirling and Johnstone 2018). The 2006 Energy Review announced that 'nuclear has a role to play in the future UK generating mix alongside other low carbon generation options', but did not cite any details of the public consultations undertaken.(Department of Trade and Industry, 2006) Subsequently, this Review encountered difficulty.(Wintour and Adam, 2006; Interview with Adrian Bull). Greenpeace (which had taken part in the consultations) challenged the Review in the High Court, claiming that the government had not engaged in the 'fullest public consultation promised'.(Greenpeace UK, 2006) Siding with Greenpeace, the judge in the case agreed that 'the consultation exercise was very seriously flawed' and that the Review did not meet the promised exercise set out in 2003.(Justice Sullivan, 2007)

By contrast with the Review, the subsequent 2008 Energy White Paper on Nuclear Power published its extensive consultations in detail.(Department for Business, Enterprise & Regulatory Reform, 2008a, 2008b) Multiple agencies were contracted to host and analyse citizen's panels and focus groups which would indicate public acceptance of allowing companies to invest in nuclear power. Couched in terms of the governments' response to climate change, the public were asked their opinions on the safety and reliability of nuclear power compared with renewable sources, and the extent to which the UK should seek to replace (or increase) its nuclear generating capacity. BERR selected a number of responses which together suggested the public's view was highly complex, highlighting moral concerns about nuclear power, but also indicating a reluctant acceptance that nuclear power was a necessary part of the energy mix in a low-carbon economy.(Department for Business, Enterprise & Regulatory Reform, 2008a)

Although the 2008 consultation showed public acceptance of a role for nuclear energy in providing the UK with low-carbon electricity, it did highlight a lack of trust in the privatised operators of nuclear power plants. Members of the various consulted groups were concerned that private companies would be less prepared than the government, or a public sector body, to take choices which were expensive but safer: "Would they try to get away with only minimum standards due to concerns about their profits?"(Department for Business, Enterprise & Regulatory Reform, 2008a, p. 132) These concerns did not mean that the public rejected the use of nuclear power, or that the government changed its plans as a result; however, Greenpeace's challenge of the 2006 Energy Review has ensured the extensive use of public consultation in nuclear policy matters. Whether these consultations have been as open, full or frank as possible has been debated by sociologists who note that participation and topics of discussion are highly limited.(Johnstone, 2014)

This increase in government support for new nuclear power stations was not reflected across the whole of the UK. In Scotland, where a devolved government had been in charge of Scottish energy policy since 1997, the election of a minority government led by the Scottish National Party (SNP), headed by First Minister Alex Salmond, led to a distinct divergence in energy policy. Focused on obtaining the full independence of a Scottish nation from the union nations which constitute the UK, the SNP had long advocated against nuclear power. The party was opposed to the stationing of the UK's nuclear deterrent at Faslane within 30 miles of Glasgow (Scotland's second largest city), against continued nuclear reprocessing at Dounreay, and against any proposals for new nuclear power stations in Scotland.(Scottish National Party, 2007, 1997) As such, the Scottish government's position, confirmed at a vote in 2008 (passing with support of the Scottish Liberal Democrats, and Scottish Green Party) represented significant divergence from the UK government's support for new nuclear power stations.(The Scotsman, 2008) In 2007, as it became clear that CORWM would propose a single deep geological storage facility for the UK's nuclear waste, the Scottish government proposed that Scottish nuclear waste should be stored on, or near surface as close as possible to the site which produced it.(Scottish Government, 2007)

The SNP's policies were (and are) in part a result of Scotland's unique relationship with nuclear power. From the early 1950s, Scotland was at the forefront of nuclear development in the UK. The FBR research programme was based at Caithness on Scotland's north coast, and well into the 1970s Scotland alone was the world's largest generator of nuclear power per-capita or per-head.(Anon., 1970) However, plans for further nuclear power facilities in the late 1970s provoked extensive resistance amongst the Scottish public. Proposals to locate a nuclear waste repository in various locations across the Scottish Highlands between 1977 and 1982 led to intense protests at the sites, and local referenda supported by local authorities.(Hansard, 1977, 1979, 1982, 1982; Oldroyd, 2002) The proposed construction and beginning of works on the Torness reactor (less than 30 miles from Edinburgh) precipitated the formation of a number of protest groups under umbrella group the Scottish Campaign to Resist the Atomic Menace (SCRAM), and the UK's largest protests against civil nuclear power attended by 4-5,000.(Welsh, 2001)

Event 7a	The Future of Nuclear Power: White Paper consultation
Who was involved (refer to table of potential actors, above)?	COI, BERR, Greenpeace, Friends of the Earth, Various members of the public (see below)
When and where did it take place?	Across the country in various locations, between 23/07/08-21/09/08
What type of process was it? How did this change over time?	**Public consultation/participation processes:** Whilst termed a ‘public consultation’ the process did feedback into policy decisions being made by BERR and did have an impact on the 2008 White Paper. The consultation events were managed by a private communications group and assessed by other groups to ensure validity. Late in the process environmental organisations, Greenpeace and Friends of the Earth pulled out of the events and did not attend any events in September, as they believed the consultation was biased in favour of a decision that government had already taken. Consultation events focused on plans for new nuclear power stations and the way in which these would be regulated (by government) and managed (by the private sector). Reponses highlighted concern about private companies’ profit motivation, and the volatility of costs in constructing nuclear facilities. (Department for Business, Enterprise & Regulatory Reform, 2008a, pp. 101–230) Overall, public responses highlighted the impact of climate change on their willingness to accept the need for nuclear power. The privatised industry’s efforts to portray nuclear as a low carbon technology seem to have worked, and most UK citizens believe that nuclear will have a significant part to play in the generation of electricity in the future.(European

	Commission, 2007) A number of high profile environmental writers and campaigners have changed their minds and now support nuclear power as part of the answer to the challenges posed by climate change.(Monbiot, 2011) As climate change continues to rate as a matter of concern for the public, nuclear power is perhaps seen as a 'necessary evil'.(European Commission, 2007) Although this is defined as 'resigned acceptance' by the report's authors 'reluctant acceptance' would be the more usual term.
What rationale was given by the party that implemented the engagement?	To ensure that the 2008 White Paper met the terms of "fullest public consultation" promised in 2003
Event 7b	Divergence between Scotland and the rest of the UK concerning nuclear power policy.
Who was involved (refer to table of potential actors, above)?	The Scottish Government: the SNP, Alex Salmond The UK Government: Tony Blair, the Labour Party
When and where did it take place?	2007-2008
What type of process was it? How did this change over time?	Political implementation The SNP's policies on nuclear power and nuclear waste have their roots in Scottish responses to nuclear power.
What rationale was given by the party that implemented the engagement?	A manifesto commitment in response to gaining power in the Scottish Parliament in the 2007 elections.

4. Facts and figures

4.1. Data summary

- There are 15 operating reactors in the UK that produce 19-21% of country's electricity.
- Altogether the UK has built 45 commercial and large prototype reactors (26 –Magnox, 14 – AGR, 2 – FBR, 1 – SGHWR, 1 – PWR, 1 – HTR).
- The UK has developed and exported its own reactors abroad, to Italy and Japan.
- There are facilities to create an independent fuel cycle from separation to reprocessing.
- Public opinion about nuclear power in the UK has been broadly positive since 2006 despite the accident at Fukushima.

4.2. Key dates and abbreviations

Key dates:

1948	Nuclear energy programme commenced.
1952	UK tests first fission atomic weapon.
1954	UK Atomic Energy Authority (UKAEA) established to direct research and advise government on the development of nuclear power.
1955	White Paper, 'A programme for nuclear power' sets out the Magnox programme of reactors.
1956	Calder Hall reactor becomes the first to supply electricity commercially to a national grid.
1958	Nuclear Installations Inspectorate set up in response to a fire at a Windscale plutonium producing pile
1964	White Paper, 'The Second Nuclear Power Programme' establishes the AGR programme of reactors.
1977-8	Planning inquiry for Thermal Oxide Reprocessing Plant (THORP) held with large input from environmental groups.
1982-5	Sizewell B planning inquiry, held for the first PWR in the UK. It lasted over 340 days and took over 16 million words of evidence.
1995	Most recent reactor went in operation
2016	Government announces Hinkley C construction will begin – the first of eight new nuclear stations.

Abbreviations:

AGR	Advanced Gas-cooled Reactor
BERR	Department of Business Enterprise and Regulatory Reform
BNFL	British Nuclear Fuels
BOND	Britain Opposed to Nuclear Dumping
CANDU	Canada Deuterium Uranium reactor
CEGB	Central Electricity Generating Board (1957-1990)
CND	Campaign for Nuclear Disarmament
CoRWM	Committee on Radioactive Waste Management
FBR	Fast Breeder Reactor
GDF	Geological Disposal Facility
GEC	General Electric Company
HLW	High Level Waste
ILW	Intermediate Level Waste
LLW	Low Level Waste
MRWS	Managing Radioactive Waste Safely
NDA	Nuclear Decommissioning Authority
NII	Nuclear Installations Inspectorate
NIMBY	Not In My Back Yard
NIREX	Nuclear Industry Radioactive Waste Executive
NSHEB	North of Scotland Hydro Electricity Board
NUS	National Union of Seamen
ONR	Office for Nuclear Regulation
PFR	Prototype Fast Reactor
PWR	Pressurised Water Reactor
RCEP	Royal Commission on Environmental Pollution
SCRAM	Scottish Campaign to Resist the Atomic Menace
SGHWR	Steam Generating Heavy Water Reactor
SSEB	South of Scotland Electricity Board
THORP	Thermal Oxide Reprocessing Plant
TUC	Trades Union Congress
UKAEA	United Kingdom Atomic Energy Authority

4.3. Map of nuclear power plants

Figure 1 represents an extended map of nuclear power sites in the UK with export, and location of major fuel suppliers.

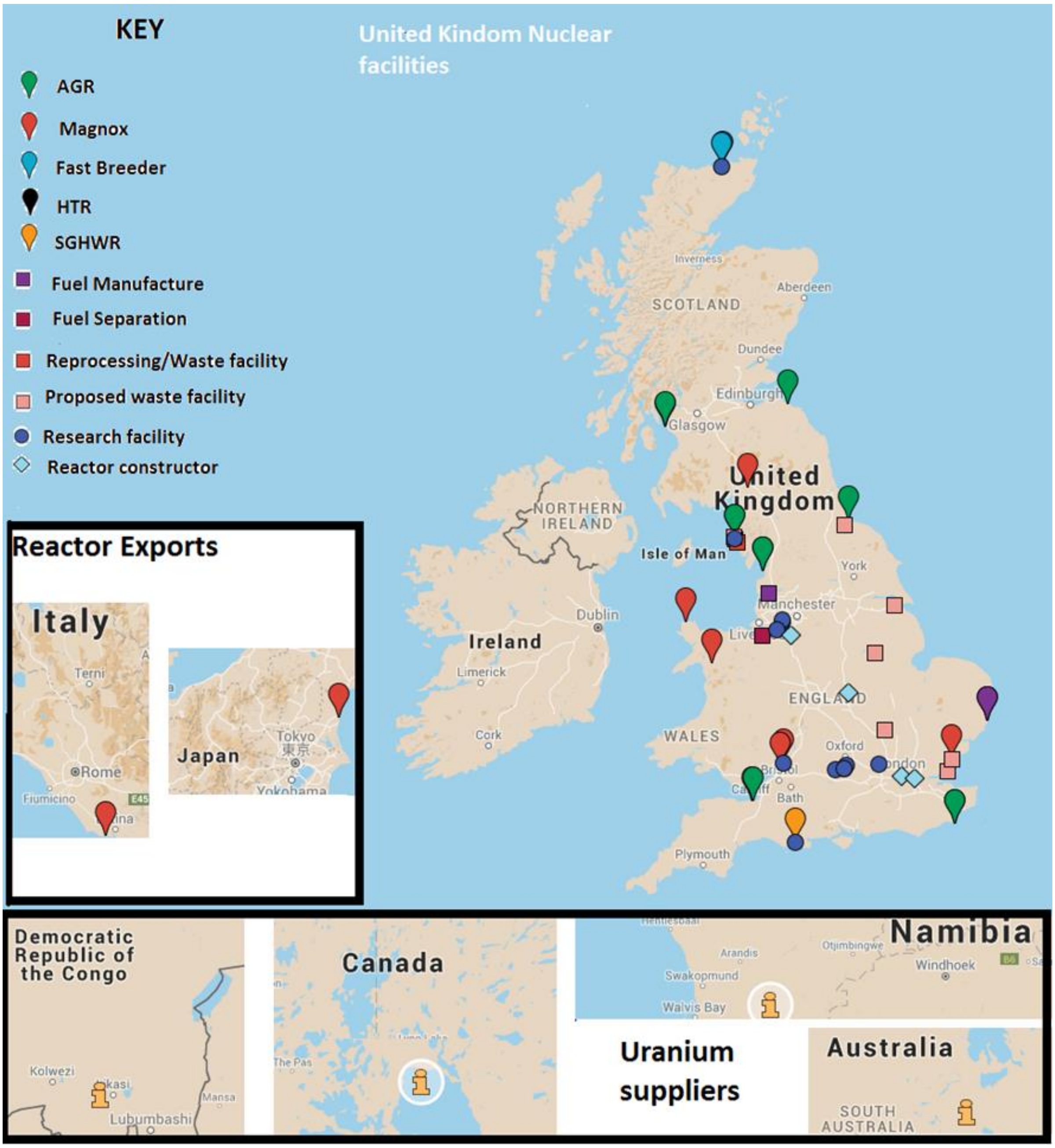

Figure 1 – Nuclear power sites in the UK

4.4. List of reactors and technical, chronological details

The tables below show the list of reactors, suppliers, operators as well as date details.

Table 1 – Operational nuclear power reactors in UK. Sources: IAEA 2016; WNA 2016.

No.	Name	Operator	Supplier	Type	MWe net	Construction began	First criticality	Grid date
1	**Dungeness-B1**	EDF UK	APC	GCR	520	1.10.1965	23.12.1982	3.4.1983
2	**Dungeness-B2**	EDF UK	APC	GCR	520	1.10.1965	4.12.1985	29.12.1985
3	**Hartlepool-A1**	EDF UK	NPC	GCR	595	1.10.1968	24.6.1983	1.8.1983
4	**Hartlepool-A2**	EDF UK	NPC	GCR	585	1.10.1968	9.9.1984	31.10.1984
5	**Heysham-A1**	EDF UK	NPC	GCR	580	1.12.1970	6.4.1983	9.7.1983
6	**Heysham-A2**	EDF UK	NPC	GCR	575	1.12.1970	3.6.1984	11.10.1984
7	**Heysham-B1**	EDF UK	NPC	GCR	610	1.8.1980	23.6.1988	12.7.1988
8	**Heysham-B2**	EDF UK	NPC	GCR	610	1.8.1980	1.11.1988	11.11.1988
9	**Hinkley Point-B1**	EDF UK	TNPG	GCR	475	1.9.1967	24.9.1976	30.10.1976
10	**Hinkley Point-B2**	EDF UK	TNPG	GCR	470	1.9.1967	1.2.1976	5.2.1976
11	**Hunterston-B1**	EDF UK	TNPG	GCR	475	1.11.1967	31.1.1976	6.2.1976
12	**Hunterston-B2**	EDF UK	TNPG	GCR	485	1.11.1967	27.3.1977	31.3.1977
13	**Sizewell-B**	EDF UK	PPC	PWR	1198	18.7.1988	31.1.1995	14.2.1995
14	**Torness-1**	EDF UK	NNC	GCR	590	1.8.1980	25.3.1988	25.5.1988
15	**Torness-2**	EDF UK	NNC	GCR	595	1.8.1980	23.12.1988	3.2.1989

Table 2 – NPPs shutdown permanently Sources: IAEA 2016; WNA 2016.

No.	Name	Operator	Supplier	Type	MWe net	Construction began	First criticality	Grid date	Shut down
1	**Berkeley-1**	ML	TNPG	GCR	138	1.1.1957	1.8.1961	12.6.1962	31.3.1989
2	**Berkeley-2**	ML	TNPG	GCR	138	1.1.1957	1.3.1962	24.6.1962	26.10.1988
3	**Bradwell**	ML	TNPG	GCR	123	1.1.1957	1.8.1961	1.7.1962	31.3.2002
4	**Bradwell**	ML	TNPG	GCR	123	1.1.1957	1.4.1962	6.7.1962	30.3.2002
5	**Calder Hall**	SL	UKAEA	GCR	49	1.8.1953	1.5.1956	27.8.1956	31.3.2003
6	**Calder Hall**	SL	UKAEA	GCR	49	1.8.1953	1.12.1956	1.2.1957	31.3.2003
7	**Calder Hall**	SL	UKAEA	GCR	49	1.8.1955	1.1.1958	1.3.1958	31.3.2003

8	**Calder Hall**	SL	UKAEA	GCR	49	1.8.1955	1.12.1958	1.4.1959	31.3.2003
9	**Chapelcross-1**	ML	UKAEA	GCR	48	1.10.1955	9.11.1958	1.2.1959	29.6.2004
10	**Chapelcross-2**	ML	UKAEA	GCR	48	1.10.1955	30.5.1959	1.7.1959	29.6.2004
11	**Chapelcross-3**	ML	UKAEA	GCR	48	1.10.1955	31.8.1959	1.11.1959	29.6.2004
12	**Chapelcross-4**	ML	UKAEA	GCR	48	1.10.1955	22.12.1959	1.1.1960	29.6.2004
13	**Dounreay DFR**	UKAEA	UKAEA	FBR	11	1.3.1955	14.11.1959	1.10.1962	1.3.1977
14	**Dounreay PFR**	UKAEA	TNPG	FBR	234	1.1.1966	1.3.1974	10.1.1975	31.3.1994
15	**Dungeness-A1**	ML	TNPG	GCR	225	1.7.1960	1.6.1965	21.9.1965	31.12.2006
16	**Dungeness-A2**	ML	TNPG	GCR	225	1.7.1960	1.9.1965	1.11.1965	31.12.2006
17	**Hinkley Point-A1**	ML	EE/B&W/T	GCR	235	1.11.1957	1.5.1964	16.2.1965	23.5.2000
18	**Hinkley Point-A2**	ML	EE/B&W/T	GCR	235	1.11.1957	1.10.1964	19.3.1965	23.5.2000
19	**Hunterston-A1**	ML	GEC	GCR	150	1.10.1957	1.8.1963	5.2.1964	30.3.1990
20	**Hunterston-A2**	ML	GEC	GCR	150	1.10.1957	1.3.1964	1.6.1964	31.12.1989
21	**Oldbury-A1**	ML	TNPG	GCR	217	1.5.1962	1.8.1967	7.11.1967	29.2.2012
22	**Oldbury-A2**	ML	TNPG	GCR	217	1.5.1962	1.12.1967	6.4.1968	30.6.2011
23	**Sizewell-A1**	ML	EE/B&W/T	GCR	210	1.4.1961	1.6.1965	21.1.1966	31.12.2006
24	**Sizewell-A2**	ML	EE/B&W/T	GCR	210	1.4.1961	1.12.1965	9.4.1966	31.12.2006
25	**Trawsfynydd-1**	ML	APC	GCR	195	1.7.1959	1.9.1964	14.1.1965	6.2.1991
41	**Trawsfynydd-2**	ML	APC	GCR	195	1.7.1959	1.12.1964	2.2.1965	4.2.1991
42	**Windscale AGR**	UKAEA	UKAEA	GCR	24	1.11.1958	9.8.1962	1.2.1963	3.4.1981
43	**Winfrith SGHWR**	UKAEA	ICL/FE	SGHWR	92	1.5.1963	1.9.1967	1.12.1967	11.9.1990
44	**Wylfa-1**	ML	EE/B&W/T	GCR	490	1.9.1963	1.11.1969	24.1.1971	30.12.2015
45	**Wylfa-2**	ML	EE/B&W/T	GCR	490	1.9.1963	1.9.1970	21.7.1971	25.4.2012

Table 3 – proposed and planned nuclear power plants. Source: WNA 2016.

No.	Name	Proponent	Type	MWe gross	Construction begins	Grid date
1	**Hinkley Point C-1**	EDF Energy	EPR	1670	2018?	2026
2	**Hinkley Point C-2**		EPR	1670	2019?	2027
3	**Sizewell C-1**	EDF Energy	EPR	1670?		?
4	**Sizewell C-2**		EPR	1670?		?

5	**Wylfa Newydd 1**	Horizon	ABWR	1380	2019	2025
6	**Wylfa Newydd 2**	Horizon	ABWR	1380	2019	2025
7	**Oldbury B-1**	Horizon	ABWR	1380		late 2020s
8	**Oldbury B-2**	Horizon	ABWR	1380		late 2020s
9	**Moorside 1**	NuGeneration	AP1000	1135	2019?	late 2025
10	**Moorside 2**	NuGeneration	AP1000	1135		2026?
11	**Moorside 3**	NuGeneration	AP1000	1135		2027?
12	**Bradwell B-1**	China General Nuclear	Hualong One	1150		
13	**Bradwell B-2***	China General Nuclear	Hualong One	1150		
	Total planned & proposed	**13 units ***		**17,900 MWe**		
	Sellafield	*GE Hitachi*	*2 x PRISM*	*2 x 311*		
	Sellafield	*Candu Energy*	*2 x Candu EC6*	*2 x 740*		

4.5. Data on public opinion and periodization of nuclear developments

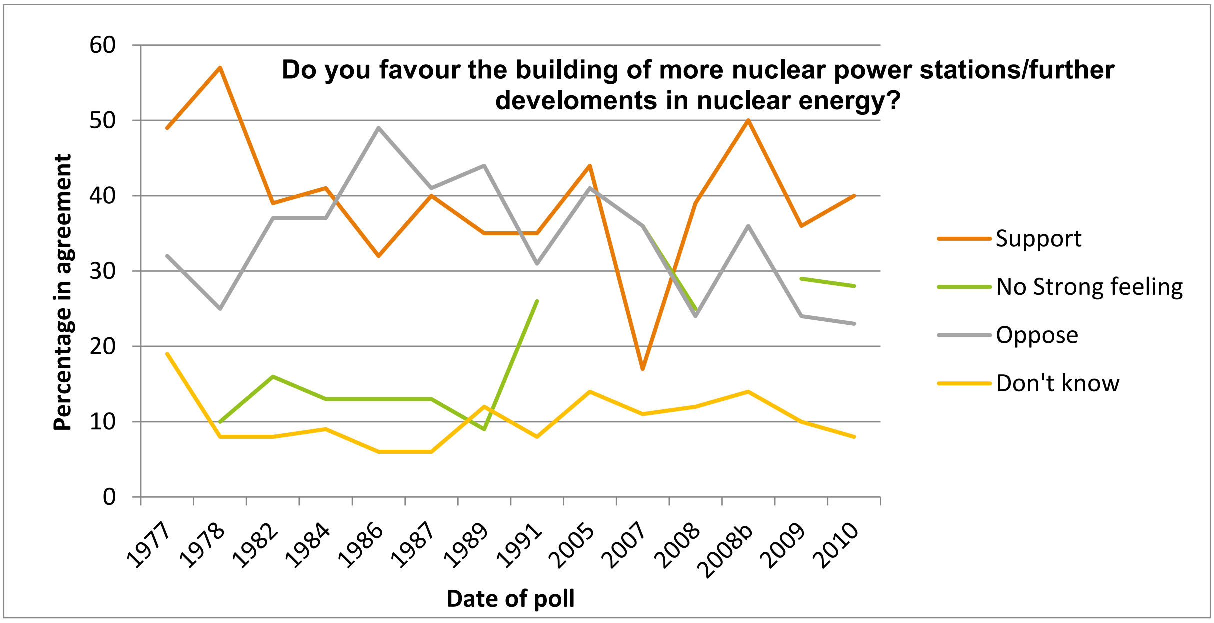

Figure 2 – Graph of public opinion in the UK, 1977-2010. Sources: (European Commission, 1982, 1984, 1986, 1987, 1989, 1991, 2005, 2007; Ipsos MORI, 2010b; White, 1977)

Public opinion has remained remarkably stable over a long period in the UK, and compared to the issues surrounding nuclear weapons, nuclear energy has remained relatively uncontroversial. As such, there were few attempts to uncover public opinion on nuclear power until the mid-late 1970s. The table below shows a completion of opinion polls from a variety of sources from 1977-2010. Although questions, methodology and sample-size differ, the aim of each poll was to elicit the subjects opinion as to whether they supported the development of nuclear power and/or the building of new nuclear power stations.

4.6. Electricity production, consumption, nuclear power share and demand forecast

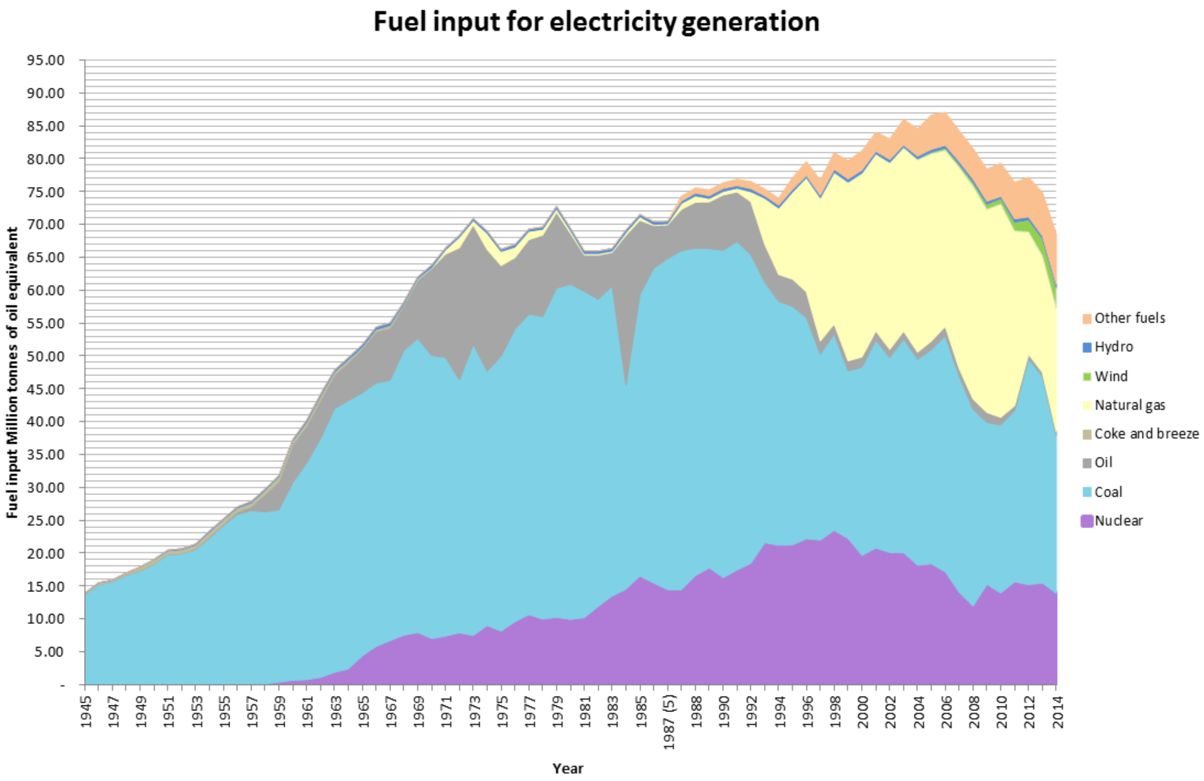

Figure 3 – Fuel input for electricity generation 1945-2013. Source: data adapted from Department for Energy and Climate Change Historical Dataset – https://www.gov.uk/government/collections/electricity-statistics#historical-data

4.7. Other related information about nuclear power in UK

Were there sales of equipment/fuel/reactors/isotopes to other nations (if so, which, when and to where)?

UKAEA arranged the sale of two Magnox reactors at Latina (Italy) to Ente Nazionale Idrocarburi and the other at Tokai (Japan) to Japan Atomic Power Corporation (see Figure 1). Both had their fuel supplied and managed (reprocessed) by UKAEA/BNFL.

From 1946 the Radiochemical Centre at Amersham (operated by UKAEA) produced and sold isotopes to institutions and governments around the world (divested in 1971 as The Radiochemical Centre Ltd, privatised as Amersham International plc. 1982, taken over by GE Healthcare 2004- present).

Where did the fuel come from?

Uranium ore for the UK nuclear programme was initially sourced from the Belgian Congo (through the Anglo-American Combined Development Agency set up during World War II). These were later supplanted in the 1950s by supplies of ore from Canada and particularly from South Africa and Australia. The ore was enriched by gaseous diffusion at Capenhurst (1953-1982), replaced by gaseous centrifuge (1976-2016) through the UKs part-ownership of Urenco. Enriched ore was manufactured into fuel at Springfields (1946-present).

Where does waste go?

Waste is stored at reactor sites, and then transferred to Sellafield or Drigg. Spent fuel rods are reprocessed at THORP (1993-present); High/Intermediate Level Waste (HLW/ILW) is vitrified and stored awaiting long-term disposal. THORP reprocesses fuel from foreign reactors under contract. Low Level Waste (LLW) is disposed of at the Drigg LLW Depository (1959-present). It was hoped that the development of FBRs could close the fuel cycle, but reliability issues and lack of resources meant that FBR work ended in 1994.The UK has sought at various times to establish a Geological Disposal Facility (GDF) for HLW/ILW, most notably 1982-7 (involving industry sponsored NIREX Ltd) and 2008-2013 (involving local government sponsored West Cumbria Managing Radioactive Waste Safely Partnership).

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Ukraine

Short Country Report

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CONTENTS

Executive summary

This report belongs to a collection of 20 short country reports on the History of Nuclear Energy and Society (HoNESt, project Ref.662268). The reports tackle the complex sociotechnical system around nuclear energy. Nuclear developments, notably nuclear energy, are closely intertwined with social, economic, environmental, political and cultural spheres. Nuclear energy is also a globalized system involving transnational transfers of knowledge, materials, technologies, people and products including electrical power, medical elements, toxic wastes and other environmental hazards, materials, capacities and knowledge that must be carefully safeguarded. Nuclear energy is a complex social and technological phenomenon that influences societies but is also shaped by societies.

The short country reports are designed to assemble information and research results on the history of the relations between nuclear energy and society about all the different country cases in an accessible manner, and to document the findings with references.

The purpose of the country reports is threefold, addressing three different audiences:

1. to provide basic elements of narrative and analysis for further historical research by HoNESt researchers;
2. to provide information, context and background for further analysis for HoNESt's social science researchers;
3. to provide accessible information on nuclear-societal relations in the various countries for the purposes of outreach and communication with stakeholders (civil society, industry, associations, policy makers, journalists).

This report focuses on the history of the relations between nuclear energy and society in Ukraine. The main findings show that Ukraine's nuclear power program, consisting of 15 reactors at 4 stations, and with the Chernobyl station closed, will always be, in some respects, connected with the explosion of Chernobyl reactor unit 4 in April 1986. The Chernobyl NPP was to be the flagship of the republic's – and the USSR's – nuclear power program with 10 RBMK (channel-graphite) reactors operating when fully complete. Instead, on April 26, 1986, it became the site of an infamous accident: the fourth of four reactors at the power station exploded and spread radioactivity over Ukraine, Belarus, parts of Russia, and much of the northern hemisphere. Over thirty years since then, Chernobyl still demands constant attention. At home Chernobyl victims – many of them children – must be supported by the state. In the international arena, Ukraine required extensive international financial and engineering assistance to build a new shelter for the destroyed unit 4.

The Chernobyl disaster has durably affected the relations between nuclear energy and society. After several years of cover-up, the extent of the disaster was finally revealed to the general public in 1989. A broad independence movement developed that was centered to a large degree on environmental concerns. A great number of Ukrainian citizens participated in anti-nuclear protests that eventually led to a moratorium on the construction of nuclear reactors. Shortly after Ukraine became independent, though, the moratorium was overturned. Starting from mid-1990s Ukrainian citizens have become much less involved in discussions about nuclear energy. Today NGOs are struggling to mobilize citizens to oppose the expansion of the industry, while they continue to produce valuable expertise on the problems that industry faces. The Chernobyl disaster and anti-nuclear protests also led industry representatives to become more open about the problems the industry faces. They have sought to develop the public understanding that Chernobyl was an unfortunate accident of past, while the expansion of nuclear power is important for Ukraine's future.

Today, especially because of Russia's proxy war in eastern Ukraine and the annexation of Crimea in 2014, many in Ukraine see nuclear power as a way to achieve energy independence from Russian oil and gas. However, the country also relies on Russia for nuclear fuel and technology for Ukraine's Soviet-designed reactors. Only recently it turned to the EU and western corporations to supply fuel and technology. On top of this the nuclear industry faces the growing costs of maintaining power stations, extending operating licenses, and the unresolved problem of spent nuclear fuel and radioactive waste storage and reprocessing. Chernobyl is a tragic reminder of the importance of broad societal discussions of all these problems, discussions where a special place for critics (and potential whistle-blowers) is always preserved.

1. Historical context (narrative)

1.1. Introduction to the historical context

Ukraine commands one of the largest nuclear power programs in the world as a share of total electricity production at roughly 50%, and one of the oldest with nuclear physics research dating to the 1930s in Kharkiv and nuclear engineering research in Kharkiv and Kyiv dating to the 1950s. Ukraine was home to one of the world's worst nuclear accidents along with Three Mile Island and Fukushima, at Chernobyl whose impact was greatest in Ukraine, Belarus, and to a lesser extent Russia, but also around the northern hemisphere. The accident was a crucial event for Ukraine in giving impetus to environmental, anti-nuclear and nationalist movements, and also for the USSR in putting the policies of glasnost and perestroika of USSR leader Mikhail Gorbachev to the test. A hastily built "sarcophagus" over the destroyed Chernobyl reactor unit number 4 that aged rapidly and faced the danger of collapse served as a constant reminder of the challenges facing the nuclear industry in post-Soviet Ukraine.

In spite of the seriousness and uniqueness of the Chernobyl accident and its meanings for Ukrainian and Soviet history, nuclear power in Ukraine resembles that in other nations when speaking about such industry goals as diversifying the energy mix, regulation, and public-industry interaction. As this report indicates, Ukraine's nuclear industry is determined to build on the Soviet heritage by extending the licenses of existing reactors and building new reactors. As part of a government strategy to lessen dependence on Russia for energy needs, most notably gas, industry and government are seeking to meet the needs for nuclear fuel by developing Ukraine's uranium, zirconium, and other capacities, and also by buying fuel from abroad, notably from Westinghouse; rather than relying on Russia exclusively for fuel and spent fuel handling and nuclear technology.

Soviet institutions to manage nuclear safety evolved later than in other countries; Ukraine did not have its own regulatory agency until the early 1990s. The Ukrainian agency has experienced significant challenges in staffing, budget, developing procedures to evaluate safety concerns and to consider license extensions of existing reactors, but has pushed ahead with its modest staff to extend licenses. Several NGOs and other actors (identified in the report) have had an active role in pushing industry and the regulatory agencies to comply with national and international safety standards and procedures.

Public-industry interactions have also evolved significantly since Ukrainian independence from the USSR in 1991. If the public insisted upon a moratorium of construction at reactor sites and the closing of Chernobyl's remaining reactors (units 1, 2, and 3) after the accident, and the Ukrainian parliament passed a law creating such a moratorium, then in 1993, in a period of economic crises, the parliament reversed itself to little public reaction. Citizens wanted electricity and heat, even if from nuclear power, and even if from Chernobyl. As industry began to push more actively for completion of mothballed reactors, license extensions, and the construction of new reactors, it also began to engage the public through new or renovated information centres that communicated about issues such as safety and energy independence. Except for NGOs and some citizens who question whether Ukraine should pursue a nuclear path, it seems that the Ukrainian public finds nuclear power an acceptable source of energy. According to a recent poll, 83% of respondents thought so, even if, at the same time, 70% considered that it was impossible to guarantee total safety of NPPs, and 71% disagreed that nuclear energy does not have environmental impacts (Kyiv International Institute of Sociology 2015: 5).

A modern massive "covering" built at a cost of €2.1 billion that was moved over the Chernobyl original "Sarcophagus" in November 2016 was thus a crucial event not only for the future of radiation safety at the Chernobyl site but for future ambitious plans for Ukraine's nuclear energy program, and for evolving public-industry relations.

1.2. Contextual narrative

History of Nuclear Physics in Soviet Ukraine

Nuclear power was built on the achievements of the Ukrainian specialists in Kharkiv and Kyiv before World War II. In Kharkiv, such physicists as Kirill Sinelnikov, the brother-in-law of Soviet atomic bomb chief Igor Kurchatov, future Nobel laureate theoretician Lev Landau, leader of the Soviet breeder reactor program A. I. Leipunskii, low temperature specialist Lev Shubnikov, the theoretician Lifshits brothers, and others led the effort even during some of the darkest days of Soviet history. In the 1930s just outside the institute walls peasants who had left the countryside for cities in search of food during the famines triggered by Stalin's collectivization campaign died on the streets in view of the windows; overall 3 million people likely died of starvation. The Purges and Great Terror of the late 1930s decimated the institute with such leading specialists as Landau, who nearly died after a year in prison, Shubnikov, who died, and others arrested and a number executed. A final blow to the health of the institute was the invasion of the Nazis who reached Kharkiv and picked the facilities clean, destroying what they could not pilfer (Josephson, 2005; Raniuk 1998, 2001).

In the postwar years the Ukrainian Physical Technical Institute (UFTI) recovered quickly from Stalinist Purges and the Nazi invasion as part of the Soviet atomic bomb project. Its physicists contributed greatly to atomic energy, for example, in the development of fuel elements, high temperature pumps, cladding and other advances in materials science. Beginning in the 1950s UFTI physicists, and those at the Institute of Physics in Kyiv, acquired such large facilities as experimental reactors (of the VVR-M series) and various particle accelerators. Owing to the expansion of its research the latter institute hived off the new Institute of Nuclear Research in 1970. Nuclear reactor development occurred largely in Russia-based facilities, while Ukrainian specialists conducted basic and applied research in support of it. When construction of power generating reactors commenced in the 1970s, Ukrainian physics institutes contributed personnel to the effort (Josephson, 2005; Raniuk 1998, 2001).

The Beginning of the Nuclear Power in Ukraine: 1970s-1980s

The Ukrainian nuclear power program started in the 1970s as a part of the Soviet nuclear program (see Section 4, Table 1). The industry built reactors at Chernobyl (the first reactor was connected to the electric grid in 1977, the second unit in 1979, the third in 1981, and the fourth in 1983, all RBMK [channel graphite] reactors), with the Zaporizhzhya – in Energodar, Rivne – in Varash (called Kuznetsovsk before 2016), Khmelnytska – in Netishyn, and the South Ukrainian – located in Iuzhnoukrainsk – stations), all pressurized water reactors (VVER in Russian acronym) in the 1980s – and two VVERs in the 2000s. By the time of the Chernobyl accident 10 reactors operated on the Ukrainian territory, 7 were under construction, including units 5 and 6 at the Chernobyl NPP, and 3 others, at a very early stage of planning, would come on line after independence. Not even Chernobyl stopped the Soviet authorities from moving forward with the construction of the new reactors in Ukraine: six more reactors, 1,000MW each, came on line in Ukraine between 1986 and 1990.

While the United States and Western Europe saw a surge of environmental and anti-nuclear movements starting from early 1970s which led to the adoption of new environmental protection regulations (for example, tightened licensing procedures, environmental impact assessments) that contributed to a slow down the nuclear development, especially after the Three Mile Island accident in Pennsylvania in 1979; in the USSR and the Eastern Europe unrestrained nuclear enthusiasm dominated up to the Chernobyl accident (see Russian Short Country Report). In Ukraine the 1970s and early 1980s was a period of intensive construction of nuclear power plants with great hopes for even more reactors during the following decades of both the PWR/VVER and RBMK types.

Chernobyl and Ukrainian Independence (see below for greater detail)

The explosion of reactor four on April 26, 1986, led to heavy radioactive contamination of regions of Ukraine, Belarus and Russia. After the extent of the disaster was finally revealed to the general public in 1989, a broad independence movement developed that was centred to a large degree on environmental concerns and the belief among many participants that Moscow's Russian-centred economic development policies had contributed to the degradation of Ukraine. In response the Ukraine parliament voted in August 1990 to adopt a moratorium that lasted until 1993 on the construction and commissioning of new nuclear power units.

When Ukraine gained its independence in 1991 upon the collapse of the USSR, it fell into economic crisis, including inflation and a sharp recession. The country's leaders therefore embarked on policies to preserve nuclear power capacity and abandoned the moratorium. They did so in an atmosphere when, after the dissolution of the Soviet Union, public attitudes toward nuclear power changed dramatically as jobs, energy production and heating became more important than environmental concerns and uncertainty about the risks of nuclear power. There was little public protest when in October 1993 the Parliament voted to overturn the 1990 moratorium on construction of new reactors and to keep Chernobyl open in order to address projected power shortages for the winter of that year. Soon after the 1993 vote construction officially resumed at Khmelnytska, Zaporizhzhya and Rivne stations that had been hampered by economic crisis and funding shortfalls. Reactor 6 at Zaporizhzhya NPP was completed in 1995, and units 2 at Khmelnytska and 4 at Rivne NPPs were brought on line in 2004.

Thus, by the turn of the twentieth century nuclear power in Ukraine began to recover and expand slowly. This appears obvious in official long-term strategies for energy and for nuclear power development. In March 2006 Ukrainian government made public its “Energy Strategy of Ukraine to 2030.” The plan forecast all 15 existing nuclear stations would operate until 2030 (in part by extending the licenses to operate the 13 older ones) and Ukraine would bring into operation an additional 7,000 MW of capacity (seven new 1,000MW pressurized water reactors of either Russian or western technology), contributing to a doubling of annual electricity production overall (Ministry of Energy 2006: 31, 43, 45).

However concrete developments in construction never reached the level of grandiose plans of political and technical discourse because of political instability and corruption in the energy sector. There was also uncertainty about how nuclear power might contribute to national independence given the industry’s dependence on the Russian nuclear enterprise. For example, the government advanced a strategy to complete Khmelnytska 3 and 4 that were, respectively 75% and 28% complete, when work stopped in 1990. In 2008 the government announced construction would resume on the two reactors in 2010 for completion in 2016 and 2017. In February 2011 the government signed a contract with Russia’s Atomstroieksport to supply reactor equipment for those units with Russia largely financing it. Construction was scheduled to begin in 2015, but Russia’s annexation of Crimea changed all bets and the cooperation with Russia on this project was halted (UNIAN 2014).

The State of Nuclear Power in Contemporary Ukraine: Nuclear Power as a Way to Energy Independence?

Today Ukraine is a major nuclear powered country. In 2016, even with the Chernobyl NPP closed, Ukraine had a total nuclear generation capacity of 13.83 MWe in fifteen reactors and is the third largest producer of electricity from nuclear power as a share of total domestic electricity consumption in the world at over 50% (behind Belgium and France). There are 38,000 people employed in the nuclear energy industry in Ukraine making it a crucial employer in a time of on-going economic and political uncertainties. Its leaders and scientists hope to increase that share, or at least modernize the industry, extend the life of existing stations, develop fuel cycle independence, and thereby secure greater financial and energy independence from Russia.

Contemporary Ukraine’s national nuclear program is about energy independence, and specifically, its leaders believe, emancipation from its powerful eastern neighbour – Russia to which Ukraine is tied as part of the Soviet legacy for its primary energy supply (mostly gas). In 1991 net imports constituted approximately 54% of Ukraine’s primary energy supply, and in 2011 it was still very high at 38% (although dropping to 26% in 2014), much of it gas and oil and three-quarters of that from Russia (International Energy Agency 1991, 2011, 2014). In 2011 Ukraine imported a total of 45 billion cubic meters of natural gas with 90% of it from Russia’s Gazprom (Rosenberger 2011:11). President Putin and Russian authorities have pushed Ukraine to stay in their orbit, offering gas and oil deliveries as both carrots and sticks. The high price of the energy dependence on Russia became particularly evident in Ukraine during the gas disputes of 2005-2006 and 2008-2009 between the pro-Western "orange" government of Ukraine and the Russian Federation. Even after the spring 2010 election of a pro-Russian President Viktor Yanukovich, Ukraine could not obtain a long-term decrease in gas prices. In 2014, Yanukovich was forced to flee the country after mass protests against his decision to abandon closer ties to the EU and turn instead to Russia. These events were followed by Russia’s annexation of Crimea, Gazprom’s decision to raise gas prices for Ukraine by 81% (reported by *BBC* on April 5, 2014), and a war by pro-Russian separatists backed by the Russian military, with great financial and human costs to Ukraine.

As Balmaceda notes, since 1991 successive Ukrainian governments proclaimed the importance of energy independence that might have been achieved by reducing consumption through improving energy efficiency (in Ukraine the levels of energy losses and energy consumption per unit of GDP per capita are among the highest in the world); increasing domestic production of energy by changing the energy mix in favour of fuels produced domestically (coal and nuclear energy in the Ukrainian case); and diversifying the sources of imports and the types of contracts. Ukraine has achieved little beyond political declarations. Among the main reasons has been the unwillingness of authorities and the people to pay the high costs necessary to restructure the economy and to modernize industry. More importantly, the energy sector is extremely corrupt and controlled by private or corporate interests, that is, groups who profit greatly from the current situation and oppose any changes (Balmaceda 2008: 65-143).

Can nuclear power ease this situation as some Ukrainian leaders and experts believe? Several issues create obstacles for the further development of the peaceful use of nuclear energy in Ukraine: 1) the Chernobyl disaster aftermaths (see Showcase section); 2) building a new institutional framework for the nuclear power in the wake of the Soviet collapse, bureaucratic changes that have blurred responsibilities for promotion and regulation of nuclear power; 3) the extension of licenses to operate aging nuclear power stations, at the same time as building new stations, and the ability of Energoatom to manage the costs and safety margins of NPPs; 4) the relationship with Russia since the industry for all Ukrainian reactors is essentially Russian-based and involves Soviet-era technologies, as well as nuclear fuel and spent nuclear fuel; 5) unsolved problems with spent nuclear fuel and radioactive waste storage and reprocessing.

Government: Administration and Promotion of Nuclear Power

Ukraine did not have its own nuclear institutions after the collapse of the Soviet Union and had to create them after gaining independence. Since the early 1990s a series of bureaucracies and agencies to promote, manage and regulate nuclear power have been created, renamed, restructured or abolished, even if the nation's industry works closely with the IAEA, the EU, and other groups to ensure compliance with international standards. Constant reforms at times left the industry with insufficient staff and with unclear and fluctuating responsibilities.

The state nuclear agency, Goskomatom (State Committee of Ukraine for the Utilization of Nuclear Energy), was formed early after Ukrainian independence. Energoatom, its utility partner, was created in 1995 and separated from Goskomatom. Goskomatom became a department within the Ministry of Energy in late 1997. The latter became restructured into the Ministry of Fuel and Energy (Mintopenergo) in 2000, in which the department responsible for the nuclear industry was even abolished for several years. Mintopenergo next became the Ministry of Energy and Coal Industry, with a tiny Department of Nuclear Energy.

In 2006 the Ukrainian government under pro-Russian Prime Minister Viktor Yanukovich government attempted to bring together all Ukrainian nuclear enterprises (most importantly, the enterprises of the nuclear fuel cycle and Turboatom, the manufacturer of turbines for NPPs located in Kharkiv) under the direction of the utility Energoatom: a state corporation called Ukratomprom was created at the end of December (Cabinet of Ministers 2006). However, this attempt to concentrate all the nuclear assets in a way similar to Russia – and symbolically Rosatom and Ukratomprom even signed a cooperative agreement in June 2007 – was fiercely opposed by Yanukovich's political rival, President Viktor Yushchenko. Consequently, Ukratomprom ceased to exist in April 2008, and instead a new corporation called "Nuclear Fuel" was formed that brought together only enterprises of the nuclear fuel cycle while excluding Energoatom and Turboatom (Cabinet of Ministers 2008).

Safety and Regulation

As for regulation and safety, the need to separate nuclear power development from safety oversight functions is recognized by officials and stipulated in the legislation of Ukraine. Changes in legislation in this area are without doubt related to efforts of the country to accede to international regimes, for example, the IAEA Convention on Nuclear Safety and the Joint Convention on the Safety of Spent Fuel and Radioactive Waste. The former, adopted in Vienna in June 1994 and adhered to by Ukraine, stipulates that "appropriate steps" have to be taken "to ensure an effective separation between the functions of the regulatory body and those of any other body or organization concerned with the promotion or utilization of nuclear energy" (IAEA 1994: art. 8.2) In practice, as in other countries, Ukraine pursued a convoluted path around this separation. The effective independence of regulatory bodies has been difficult to ensure due to inadequate human and financial resources, limited enforcement and investigative powers, corruption, constant institutional reforms and political pressures. At times, regulatory powers have been fragmented and spread out over several bodies.

The attempts to separate promotion of nuclear power from its regulation date to the Soviet era and the creation of the State Committee on the Supervision of Safe Conduct of Work in Atomic Industry (Gosatomenergonadzor) in 1983. In, February 1992, an already independent Ukraine created a regulatory institution that replaced Gosatomenergonadzor: The State Committee of Ukraine on Nuclear and Radiation Safety. It was abolished at the end of 1994 and its functions were transferred to the newly created Ministry of Environmental Protection and Nuclear Safety that included a State Inspectorate for Supervision of Nuclear Safety (Derzhatominspektsiia) (President of Ukraine 1994). The abolition of its independent status seems to be related to the fact that its head, Nikolai Shteinberg, a specialist with a distinguished record including at Chernobyl after the accident, opposed the start-up of Unit 6 at the Zaporizhzhya NPP unless it was held to higher standards. He was forced to step down, and the station was opened (Launer and Young 1997, Shteinberg 2014, 2016).

More changes followed. In 2000 the Ukrainian Ministry of Environmental Protection and Nuclear Safety underwent another name change to the Ministry of Ecology and Natural Resources. Finally, a few months later, in response to international pressures, for instance those related to the signature of the IAEA Convention on Nuclear Safety, a Presidential decree established an independent nuclear regulatory committee (President of Ukraine 2000) known since 2010 as the State Nuclear Regulatory Inspectorate of Ukraine in 2010. The inspectorate forms and enforces safety policy and laws; establishes criteria and conditions for safety of atomic energy (normative standards); licenses; and carries out inspections (Bozhko 2014, 2016). Nuclear experts point to several problems that prevent the Ukrainian regulator from functioning efficiently: extremely limited financial resources, frequent changes of staff related to changes in government, and lags in establishing training programs and funding them. However, the independent body works closely with international organizations in the spheres of energy and safety.

Licence Extensions and Insufficient Funds for Modernization

In the face of difficulties building new units, nuclear enterprise in Ukraine has focused on keeping existing capacity operational, continuing to sell electricity, and delaying or ignoring the rising costs of decommissioning.

In December 2010 the State Nuclear Regulatory Committee of Ukraine approved 20-year extensions of the operating licenses for units 1 and 2 at the Rivne NPP. According to Energoatom more than $300 million had been invested in modernization of the two units since 2004 (World Nuclear Association 2016). On October 14, 2013, the Inspectorate published a draft decision to extend lifetime of Iuzhno-Ukrains'ka unit 1 to December 2023; that reactor has been out of service since March 2013 for maintenance and upgrade. Representatives of an NGO, the National Ecological Centre of Ukraine (NECU), commissioned a report on whether in present conditions it was safe to extend the operational lifetime for ten years. The analysis revealed that the draft decision provided only summary information on 14 safety factors, while precise details were missing. Reports on specific determinations were not made public. The analysis also concluded that the reactor did not meet current requirements and standards, let alone future ones. Many of the safety standard upgrades had not been completed, and NECU disputed whether the reactor had deviated from international standards. The Centre called for a decision to be postponed until all work on safety upgrades was completed, to undertake a further feasibility study with public scrutiny, and for the EU to require their Ukrainian counterparts through policy dialogue and financial leverage to adhere fully to all nuclear safety regulations, to ensure that lifetime extensions for nuclear reactors are not considered before all safety assessments are properly done and safety upgrades fully implemented, and to ensure decommissioning plans have been completed (Holovko 2013). In spite of this criticism, the Inspectorate approved a ten-year life extension to 2023 in November 2013 (State Nuclear Regulatory Inspectorate 2013). In addition to the criticism expressed by Ukrainian ecologists, the process of extension has become costly and waylaid by delays. The effort to secure extension for South Ukraine unit 1 took one year and, according to Energoatom, cost UAH 2.4 billion (~$250 million). The Fukushima accident led to new safety measures including stress tests, as acknowledged by Andrei Bindiukov, chief engineer at the station (Agentstvo Atomnykh Novostei 2013a).

If reactor licensing has become problematic, it can be expected that this problem will grow even further in the future because of cost considerations. In 2016 the first and second blocks of Zaporizhzhya NPP had been waiting for more than four years for a decision by the Inspectorate to extend its operating lifetime by 10 years, while the station has struggled to secure necessary investment funds (Reporter-UA 2016). One of the main reasons why the Ukrainian nuclear industry does not have sufficient funds to cover the costs of safety upgrading and extension of licences is the very low state-fixed rates on the electricity produced by Energoatom. Energoatom has acknowledged in correspondence with NECU that the rates fail to cover the costs of safety upgrades and reactor maintenance.[1]

In December 2013 the members of the public council of the Inspectorate that includes among others several representatives of important Ukrainian environmental NGOs sent an open letter to the Prime Minister expressing their deep concern regarding this situation. The members of the

[1] Official correspondence from NEC Energoatom to NECU from 3.03.2012, quoted by Holovko 2012: 2.

council insisted that “the country that survived the Chernobyl disaster, deserves a more scrupulous attitude of its government to the safety in operation of existing nuclear power plants and to the fulfilment of its international obligations” (Agentstvo Atomnykh Novostei 2013b).

Nuclear Energy Dependence on Russia: Focus on the Nuclear Fuel Cycle

Having been part of the Soviet Union’s nuclear energy establishment, Ukraine relies on Russian technology for the nuclear reactors themselves, both for those operating and, until recently, for those planned for construction. To this day Ukraine remains beholden to Russia for a variety of nuclear services such as production of fuel rods and spent fuel storage. Even if Ukraine processes modest uranium resources, it has neither enrichment nor reprocessing facilities; it buys nuclear fuel from Russia and sends the spent fuel back for reprocessing. This problem has been highlighted by different experts and officials (Pisarenko 2013; Bobro 2015; Kosharna 2014, 2016) but started to be addressed only in recent years.

Thus, for example, in April 1995 the Ukrainian government approved an ambitious program for the creation of an indigenous nuclear fuel cycle to produce all nuclear fuel for Ukraine’s reactors, existing and planned, domestically.[2] The program received only 20% of the required funding and not surprisingly has not met targets. A state program “Nuclear Fuel of Ukraine” that was adopted in 2009 adjusted the earlier goals and sought “diversification of nuclear fuel supplies for nuclear power plants in Ukraine (Cabinet of Ministers 2009).” Ukrainian officials had hoped to increase domestic mining of uranium ore: Ukraine produces roughly 1,000 tons annually which constitutes around 30% of the country's requirements (UAEnergy 2014). Ukraine also mines the zirconium that is crucial for cladding of fuel rods. It has been sending both to Russia for processing, enrichment and then manufacture into fuel pellets and fuel assemblies at Russian nuclear fuel company, “TVEL,” which sends manufactured fuel back to Ukraine.

Ukraine negotiated with Russia to create a state corporation with minority Russian ownership in which the processed uranium would be manufactured into fuel assemblies in Ukraine beginning late in the 2010s. In 2006 the newly-formed Ukratomprom (replaced by the “Nuclear Fuel” concern in 2008) set out to build a fuel fabrication plant, signing a contract with “TVEL” in 2010 to build the

[2] The official texts of the programs are not available to the general public. A general description of their main ideas and objectives can be found in: Ministry of Energy 2012: 50.

facility with Ukraine. In February 2014 Ukrainian government approved the plans for its fabrication facility. Yet the construction has never commenced and seems to be finally mothballed, taking into account the on-going Ukrainian-Russian crisis.

Diversification with Westinghouse Fuel Assemblies

At the same time, to diversify nuclear fuel supplies, Energoatom adopted a plan to use US-supplied fuel in its pressurized water reactors (the Russian VVER-1000). Westinghouse entered a pilot program with Ukraine in 2000 when it won a $5 million US Department of Energy contract to provide fuel assemblies to the South Ukraine plant as part of the Department's International Nuclear Safety Program (Pfister 2007). In 2005, South Ukraine's second unit used six lead test assemblies supplied by Westinghouse, which were placed into the reactor core together with Russian fuel for a trial period. After successful trial period 42 fuel elements were loaded into unit 2 of the South Ukrainian NPP in 2010 for a three-year trial in commercial operation. However, in June 2012 routine inspection discovered deformation in the fuel assemblies. [3] This led to the replacement of all fuel in the South Ukraine units 2 and 3. A commission was established to investigate the incident. The Chief State Inspector for radiation safety of Ukraine, Mikhail Gashev, forbade further use of Westinghouse assemblies until clarification of the source of the incident. The commission completed its investigation without the results being made public (Dalrymple 2014; Verbytska 2014, 2015, 2016).

In total Westinghouse supplied a total of 630 fuel assemblies for South Ukraine 2 & 3 and Zaporizhzhya 5, and Energoatom claimed that "manufacturing defects in the fuel led to a lengthy unscheduled outage at two of the units." (World Nuclear News 2014) Westinghouse blamed operators in loading. A vice-president of Westinghouse, Mike Kirst, in an interview published in *Nuclear Intelligence Weekly*, observed that there were no design defects in the assemblies, but that the responsibility for the problem lay with Ukrainian operators (as quoted in Agenstvo Atomnykh Novostei, 2012).

[3] Problems with Westinghouse assemblies may have occurred in another VVER reactor, the Czech Republic's Temelin nuclear plant that has VVER-1000 reactors of the same type as at South Ukraine plant. But in May 2016 Temelin reported that experimental fuel assemblies had again been installed in the reactor. Westinghouse had successful experience supplying VVER-440 fuel to Loviisa Nuclear Power Plant in Finland from 2001 to 2007. See Stack 2010; World Nuclear News 2009; Foley 1997; Westinghouse, 2015.

However, Russian annexation of Crimea has contributed to Ukraine's decisive steps towards diversification. In April 2014, over the objection of Russian nuclear officials who declared it unsafe to use non-Russian assemblies, Energoatom and Westinghouse extended the contract for nuclear fuel supplies up to 2020; it will include fuel for all three reactors of the South Ukraine power plant. The Westinghouse fuel is fabricated at the Westinghouse Electric Sweden AB plant at Västerås in Sweden. According to official statistics, during the first 10 months of the 2016, Ukraine imported 34% of its fuel assemblies from Sweden and 66% from Russia (UNIAN 2016).

Adding pressure to diversify, the EC said in May 2014 that as a condition of investment, any non-EU reactor design built in the EU must have more than one source of fuel. Indeed, Westinghouse and eight European consortium partners received €2 million in funding in 2015 from the EU to establish the security of supply of nuclear fuel for Russian-designed reactors in the in Bulgaria, Czech Republic, Finland, Hungary and Slovakia with a total of 18 such reactors that are currently 100 per cent dependent on supply from Russian fuel manufacturers. The EU funding comes from the Euratom Research and Training Program, which is part of Horizon 2020, the EU's research and innovation program. The project, known as ESSANUF (European Supply of Safe Nuclear Fuel), focuses on licensing alternative nuclear fuel supplies for Russian-designed pressurized water reactors (VVERs) operating in the EU (Horizon 2020 Projects, 2015; Businesswire 2015).

Spent Nuclear Fuel (SNF), Waste, and Decommissioning

The Ukrainian state has been slow in addressing the problems of radioactive waste and SNF management, slower than in other countries of the world. Again, the problem relates to energy independence as Ukraine's industry remains reliant on Russia for reprocessing of SNF. Ukrainian VVERs store their spent nuclear fuel temporarily for further reprocessing in Russia. It costs Ukraine over $100 million per year to export this fuel (National Institute for Strategic Studies 2008). And, according to the IAEA Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management which Ukraine ratified in 2000, the country has to import back the radioactive waste resulting from reprocessing. When this will happen and where it will be stored remain unclear.

There has been some progress in dealing with SNF and waste, however. Ukraine opened dry storage of SNF at Zaporizhzhya in 2001. After wrangling and financial challenges, the parliament approved a bill in 2012 to construct the Central Spent Fuel Storage for VVER reactors at a cost of $460 million within the Chernobyl exclusion area that can hold 16,529 VVER-440 and VVER-1000 fuel assemblies (Supreme Rada of Ukraine 2012). The construction has finally begun in November 2017. The authorities have yet to make a decision about what to do with the radioactive waste from the operation of power plants and reprocessing of the Ukrainian spent fuel by Russia. Plans for reprocessing of radioactive waste on station sites and future disposal at a central repository remain uncertain. There has been little public discussion of this issue (Verbytska 2014, 2015).

1.3. Presentation of main actors

Ukrainian Nuclear Actors, late 1980s-present

NB: Pre-Independence Actors:

Please see the Russian country report for a complete list of Soviet actors crucial to Ukraine's nuclear enterprise as a Soviet republic. These included: the Ministry of Medium Machine Building, Ministry of Energy, Ministry of Health, Ministry of Defence, the Soviet Army Forces, Ministry of Internal Affairs, Committee for State Security (KGB), and other government organs, the Soviet Academy of Sciences, and the Communist Party of the Soviet Union in parallel to these ministries, all of the Ukrainian counterparts to these government and party institutions, in addition to a series of Russian-based research and design institutes connected with the nuclear industry of Ukraine, and still linked in many ways today for the nuclear fuel cycle.

It also should be noted that during the Soviet period, Ukraine did not have its own branch of Minsredmash (the Ministry of Medium Machine Building, the nuclear ministry), nor its own regulatory agency. Its stations where managed by Soviet Ministry of Energy which directly bypassed the Ukrainian Ministry of Energy.

Scientific Research Centres and Universities

National Academy of Sciences of Ukraine:

- Department of Nuclear Physics and Power Engineering has 16 institutional members including the National Science Centre "Kharkiv Institute of Physics and Technology", the Institute of Nuclear Research, several production enterprises, and research and training centres. It also includes "State Scientific and Technical Centre for Nuclear and Radiation Safety" which depends both from National Academy of Sciences and the State Nuclear Regulatory Inspectorate of Ukraine
- Department of Physical and Technical Problems of Power Engineering which includes the Institute for Safety Problems of Nuclear Power Plants.

Odessa Polytechnic Institute

Kyiv Polytechnic Institute

Taras Shevchenko University, Kyiv

Sevastopol National University (in Crimea, annexed by Russia in 2014)

Government Institutions and Actors

Nuclear bureaucracies

Ukratomenergoprom (1991) operated 15 reactors at 5 nuclear power stations, becames State Committee of Ukraine for the Utilization of Nuclear Energy (Goskomatom, 1993)

Energoatom (1996), operator of all Ukrainian stations, created from Goskomatom, while Goskomatom becomes a department within the Ministry of Energy (1997)

Ministry of Energy becomes Ministry of Fuel and Energy (Mintopenergo) in 2000, then in 2011 the Ministry of Energy and Coal Industry with its Department of Nuclear Energy and Industry

Parliament (Rada)

With committees/subcommittees:

- Subcommittee on the Chernobyl, social protection of victims of the Chernobyl disaster
- Subcommittee on the civil protection and disaster relief of man-made or natural disasters
- Subcommittee on the protection and rational use of mineral and water resources
- Subcommittee on the forest resources of flora/fauna, landscapes and natural reserve fund
- Subcommittee on the state environmental monitoring
- Committee on Fuel and Energy Complex, Nuclear Policy and Nuclear Safety
- Committee on Environmental Policy and terms of recovery

Regulators

Gosatomenergonadzor (Soviet predecessor, 1983-1991)

Derzhatomnagliad (State Committee of Ukraine on Nuclear and Radiation Safety (July 1992-late 1994)

Derzhatominspektsiia (State Inspectorate for Supervision of Nuclear Safety, 1994-), within Ministry of Environment Protection and Nuclear Safety (in 2000 it became Ministry of Ecology and Natural Resources)

State Nuclear Regulatory Inspectorate (2004-)

With public council

Industrial Actors

Energoatom (1996-), operator of all Ukrainian nuclear power stations

Turboatom (formerly Kharkiv Turbine Works), produces turbines for nuclear power stations

State Concern "Nuclear Fuel" (2008-) unites enterprises of the nuclear fuel cycle among which:

- Eastern Mining And Processing Complex (1951-), a uranium mining company;
- Ukrainian Industrial Technology Scientific Research and Project Exploration Institute (1970-), responsible for complex exploration and engineering of nuclear fuel cycle objects and production facilities;
- "Smoly" State enterprise, manufacture of ion exchangers including for nuclear industry

NGOs, Societies, Associations

Main environmental and anti-nuclear NGOs

National Ecological Centre of Ukraine (NECU)

Ukrainian Popular Movement (*Rukh,* late 1980s)

Zelenyi Svit (Green World)

Chernobyl Union

Mama-86

Bankwatch Ukraine

Greenpeace Ukraine

Local NGOs: e.g. Ekoclub-Rivne (Rivne), Grazhdanskii Dozor (Nikopol')

Pro-nuclear associations

Ukrainian Nuclear Society (1992-). Consists of 28 organizations and roughly 400 members

Ukrainian Nuclear Forum (2008-). It now counts 9 enterprises as its members including Energoatom, Turboatom, State Enterprise "Eastern Mining", etc.

2. Showcase: Chernobyl Disaster and Its Aftermath[4]

Chernobyl was to be the flagship of Ukrainian nuclear power; built near a scenic nature reserve along the Pripyat River, two kilometres from the town of Pripyat with its 50,000 inhabitants. Massive 1,000 MWe reactors would generate electricity, copious amounts of electricity, to power Ukraine into the twenty-first century, while construction provided jobs, and nuclear energy would dominate a formerly agricultural region. It became instead the site of an infamous accident that spread radioactivity over Ukraine, Belarus, parts of Russia, and much of the northern hemisphere.

On April 26, 1986, as a result of a poorly designed and carried out experiment, the fourth of four reactors at the Chernobyl nuclear power station exploded. Fuel rods, burning graphite and other material scattered on the ground and the roof of reactor unit three next door, which caught fire. The uncontrolled nuclear reactor was open, and its graphite burned, emitting visible fumes and invisible radiation. One hundred to two hundred MCi (megacuries) of more than 20 different radioactive elements with variable half-lives were released into the atmosphere over the next ten days.[5] Most radionuclides that have been released in large quantities had short radioactive periods, while radionuclides with very long half-lives were emitted in smaller quantities. Immediately after the explosion, iodine-131, which has a radioactive period of eight days, was the most important source of population irradiation. In the long term, cesium-137, with a half-life of 30 years, is the most important and poses the greatest risk to health. All the countries of Europe received deposits of cesium-137 on their soil. Ukraine, Belarus and Russia were the most affected, and to a lesser extent Scandinavia (southern Finland, northern, central and eastern parts of Sweden, central Norway) and the north of the United Kingdom. Finally, significant deposits of strontium-90 (half-life of 29 years) and plutonium were found, but they are concentrated in the area close to the plant. Plutonium isotopes will pose the most long-term problems, with the half-life of plutonium-239, for example, being 24,065 years. (International Atomic Energy Agency 2006: 23).

[4] This Showcase provides a general overview of the Chernobyl disaster and its aftermath. The events section below offers specific detail on the scope and nature of public-industry interaction on the eve of Chernobyl, after Ukrainian independence in 1991, and to the present.

[5] Of the many fine books and articles on the Chernobyl disaster on which this section is based, see: Bariakhtar 1995; Marples 1987, 1988; Medvedev 1991; Medvedev 1999; Kopchinskiï. and Shteinberg 2011; Kuchinskaya 2014; Schmid 2015)

The accident occurred early in the period of Mikhail Gorbachev's tenure as leader of the USSR. He had set forth the policies of perestroika (restructuring) and glasnost (openness) to reform the country, with the latter permitting public discussion of the political and economic problems facing the nation. Would the new Soviet leader be forthcoming – open – about the disaster with his own people, let alone with the international community in this environment? Or, like previous leaders, would he and his government be secretive to the public about the risks to public health of the Chernobyl disaster?

During the first months after the accident Soviet authorities tried to conceal the extent of the radioactive fallout and its danger for the people and the environment. They provided false or partial information (See below Event 1). This led to insufficient and inadequate measures for the protection of the nearby population which the authorities evacuated with great delay and for emergency workers sent to the accident site. Eventually but belatedly meeting Gorbachev's major test of glasnost, the authorities were open about the accident in many ways, but they continued to report better results in remediation than were achieved, lower risks and exposures than occurred, and soon regretted the openness that provoked, in their view, "radiophobia" among the public, and not a calm, reasonable response.

The Soviet authorities apparently believed that they would succeed at what they called the "liquidation" of the accident and return quickly to "normal" operation. So certain were they of the importance of nuclear power and so dismissive were they of public concerns that the authorities were determined to continue to operate the other reactors at the Chernobyl site. Indeed, on October 1, 1986, unit 1 began operation again, and on November 5, unit 2 was returned to operation. To operate the stations, the government exposed other civilians and workers to risk. On October 2, 1986, the government ordered the construction of the town Slavutich roughly 50 km from the reactor for station operators and their families; the first workers arrived in 1988.

Soviet authorities also ordered the construction of the Shelter Object (in Ukrainian, Ob'ekt "Ukrittia," but popularly known as the "Sarcophagus") to cover the open reactor building of unit 4 as quickly as possible to limit radioactive contamination from spreading further. Engineers of Soviet nuclear ministry, Minsredmash, began design of the Sarcophagus just three weeks after the explosion. Facing a dangerous task and with insufficient equipment to do so safely and remotely, the Soviet government ordered hundreds of thousands of soldiers, miners, concrete pourers and others from around the Soviet Union to the site. As such, the Sarcophagus is a symbol of technological failure, yet of the power of the state to command workers to toil in danger, at great risk, with inadequate safety equipment. The labourers spent from May 20 to mid-June preparing to build by clearing the immediate area of debris, building concrete factories, roads, and housing for workers. They engineered a concrete slab under the reactor to prevent the molten fuel from burning through to the earth, entering ground water, and perhaps triggering another explosion. Working in shifts 15 days on, 15 days off, the men used 400,000 m^3 of concrete and 7,300 tons of metal. The Sarcophagus was completed in November 1986 (Ebel 1994, 1; Kliuchnikov et al. 2006).

Ultimately the Sarcophagus was not fully sealed, both because workers could not work properly under the extreme conditions of radiation exposure and because this allowed high temperatures to dissipate. Great fears followed that the Sarcophagus would collapse or decay and trigger another nuclear incident. This led to the decision to build another covering over the Sarcophagus which was put into place only in late 2016, 30 years after the accident (see below).

Soviet authorities overestimated their ability to manage the accident and the sentiments of the affected people and did not foresee how the accident would trigger protest in Ukraine, Lithuania, Belarus and elsewhere that ultimately accelerated the break-up of the USSR (see Event 2).

Ukraine gained independence with the break-up of the USSR in 1991 with a nuclear moratorium in force and the public fully against nuclear power. However, after independence, public attitudes toward nuclear power changed dramatically as the standard of living plummeted, poverty grew, and people lost electricity and heating in an energy shortfall. To beat this problem the government repealed its moratorium, and the Chernobyl NPP reopened in 1993.

The Principal Causes of the Chernobyl Accident

One of the drawbacks in the design of the RBMK is a positive void coefficient that made the reactor unstable at low power. A positive void coefficient means that if the cooling water in the reactor core turns to steam or otherwise disappears (and thus the void content inside the reactor increases), the intensity of the nuclear fission in it, and hence the heat generation, increases. This becomes a positive feedback loop which can quickly – seemingly instantaneously in an RMBK reactor – turn all the coolant in the reactor into vapor, thus further accelerating the chain reaction until it is out of control, resulting in an explosion, caused by the enormous pressure of the vapor produced. This happened in the Chernobyl disaster. Operators at the Chernobyl station did not have a complete understanding of these drawbacks. Instead, the operators forced the reactor into a positive void to save time rather than lose time on a poorly designed experiment.

The accident happened during the cooling down of reactor four before scheduled maintenance on April 26, 1986. Operators intended to permit the turbines to spin from their own momentum after the shut down to see how long they would continue to generate electricity. In the middle of the shut down, the Kyiv grid supervisor called for more electricity. But rather than bring the reactor on line again, a timely and costly process that would prevent the experiment, the operators disabled various safety systems and removed control rods from the reactor core. Already at low power, and without safety or control systems in place, the positive void coefficient came into play: Suddenly the reactor began to surge in power that instantaneously triggered an exponential surge. The reactor core overheated, the cooling water boiled out of the core (increasing the nuclear reaction further), the core melted down, and a chemical reaction of steam with metal and/or graphite yielded an explosive mixture of hydrogen and oxygen.

Two powerful explosions ripped through the reactor destroying it and lifting its lid – at 2,000 tons – into the air and down on its side;destroying the roof of the standard factory building. Radioactive contamination spread over the next ten days into the land and water around the station and into the atmosphere spreading throughout the northern hemisphere. Fuel rods, burning graphite and other material scattered on the ground and the roof of reactor unit three next door, which, against regulations, had a flammable bitumen cover, and instantly caught fire. Inside several other areas caught on fire, but through the heroic – and mortal action of the firefighters, the most dangerous fires were extinguished by 5 a. m. But the core of the uncontrolled nuclear reactor was open, and its graphite burned, emitting visible fumes and invisible radiation into the environment. The base of the reactor was forced down four meters, the explosion having demolished the supporting structure. Highly radioactive lava of the melted nuclear fuel and construction/building materials flooded lower corridors and rooms of the building.

Citizens were, by this time, tired of the economic downturn and sought comfort in daily life. Only NGOs demanded that the moratorium remain in force (see Event 3).

Indeed, cold weather, shortages of electricity, and budget problems explain the difficulties in closing Chernobyl reactors once and for all. When, in December 1995 Ukraine and the G7 signed a Memorandum of Understanding to close Chernobyl in exchange for the possible funding for the completion of Khmelnytska 2 and Rivne 4 NPPs (Memorandum 1995), then it turned out that the amount of European funding was much lower than the Ukrainian government had hoped.

The decommissioning of the station's units 1-3 and the construction of a new shelter on top of the damaged reactor – and its Sarcophagus – was the next stage in the history of industry-public interactions surrounding the events of Chernobyl. It became a long-winded battle among dozens of different countries and international organizations over political and financial issues even with the December 1995 Memorandum of Understanding (see Event 4). The promised western financing to build a new confinement lagged until 2010.

Built at a cost of $1.3 billion, funded by the G7 and designed by French companies, the new covering, known as "New Safe Confinement" (NSC or New Shelter), a 110-meter tall and 257-meter wide arched structure, moved into place in November 2016 (See Video: European Bank for Reconstruction and Development 2016). The NSC was designed and built by a French consortium of Vinci Construction Grands Projets and Bouygues Travaux Publics. The arch-shaped 25,000 ton confinement structure is large enough to enclose the Statute of Liberty, the Stade de France or the footprint of the Eiffel Tower. It is designed to contain radioactive materials, protect workers at the site, and protect the existing object against weather damage (Novarka et al. 2016).

What of the other legacies of the Chernobyl disaster and what are the lessons that industry and society should learn from them? More than three decades later, controversies continue to rage over what made such an accident possible and the extent of its on-going public health impacts. These debates remain essential to the discussions about the future of the nuclear power as well as about the relationship of industry with the public not only in Ukraine but in other parts of the world. A number of reports, studies, testimonies and memoirs have described the accident as due to inherently Soviet causes, and thus impossible in other countries. Yet in her recent study of the Soviet nuclear program and official and dissident experts' explanations of the accident, Sonja Schmid (2015) warns against such simplistic accounts. She insists that Chernobyl was caused by many different factors that interacted simultaneously, such as the design weaknesses of the RBMK and failure to correct them, economic and political pressures leading to sacrifices in safety, a lack of safety culture and independent oversight, and poor mechanisms for transfer of reactor-operating expertise. These technical, economic, political, and social factors are potentially present in all nuclear power production. Accidents occur, unfortunately, in this industry, and the focus on Chernobyl has been misplaced. The Fukushima disaster, Schmid insists, is a tragic reminder that the international community failed to learn from previous accidents including the one in the Ukrainian NPP.

As for Chernobyl's on-going health impact, one can distinguish several categories of most affected populations. First of all are the individuals who resided in the areas most contaminated by radioactive fallout at the time of the accident. From April 26, 1986, people near the plant and those living in the regions close to Chernobyl and in the way of the radioactive cloud, were exposed to very high levels of radiation. Children and adolescents were among the most exposed in the immediate aftermath of the disaster, as their thyroids easily absorbed radioactive iodine (iodine-131) that was highly present in the first few weeks after the explosion.

Later on people continued to be irradiated by radioactive substances deposited on the soil and consumed with food. Some of this population was relocated, whether in the first weeks and months after the explosion or in the early 1990s when new disaster protection laws were adopted in Belarus, Russia and Ukraine. However, a quarter of a century after the disaster, millions of people still reside in territories considered highly contaminated. They are essentially subject to the risks of internal contamination via the consumption of contaminated food.

Finally, the so-called liquidators constitute the third important category of victims of the disaster. These were civilians and military personnel who intervened during 1986-1989 to carry out various tasks: work on the site of the damaged reactor, decontaminate the plant site and adjacent territories, building the sarcophagus, and burying radioactive waste. Plant staff and emergency personnel were exposed to particularly high levels of radiation that caused some of the symptoms of acute radiation syndrome.

Number of people affected by the Chernobyl accident (to December 2000)

	Belarus	Ukraine	Russia
Resettled people	135 000	163 000	52 400
People living on contaminated territories	1 571 000	1 140 813	1 788 600
Liquidators 1986/87	70 371	61 873	160 000
Liquidators 1988/89	37 439	488 963	40 000

Source: United Nations Development Program 2002: 32

The number of persons included in each category has been changing constantly, depending on evolving legislation in the affected countries. Starting from late 1990s the political authorities in Belarus, Russia, and Ukraine have indeed tried to reduce the sizes of the territories considered as contaminated (see the Country Reports for those nations). They also made it harder for irradiated people to qualify for the status of "liquidator" or victim of the accident and to be entitled to social and health benefits and compensations from the state (Petryna 2002; Kasperski 2012; Kasperski, Manzurova and Topçu 2016). Thus, the numbers provided above and dating to the 2001 should be considered as the minimum amount.

The most controversial assessments are those of the impact of Chernobyl on people's health, as the example of the range of the cancer deaths estimates shows. Indeed, the "Chernobyl Forum" report, made by a group of UN agencies (2005)[6] stated that "fewer than 50 deaths had been directly attributed to radiation from the disaster, almost all being highly exposed rescue workers." It also forecast that roughly 4,000 people might die from the cancers caused by the Chernobyl accident among those the most exposed (World Health Organization, International Atomic Energy Agency,

[6] The full list includes: International Atomic Energy Agency (IAEA), World Health Organization (WHO), United Nations Development Programme (UNDP), Food and Agriculture Organization (FAO), United Nations Environment Programme (UNEP), United Nations Office for the Coordination of Humanitarian Affairs (UN-OCHA), United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), and the World Bank, as well as the governments of Belarus, the Russian Federation and Ukraine.

United Nations Development Program 2005; Chernobyl Forum 2006). The Other Report on Chernobyl (known as the TORCH report), commissioned by a Green member of the European Parliament insisted in 2006 that the number of excess cancers will be from 30,000 to 60,000 deaths depending on the risk factor used (Fairlie and Sumner 2006: 12). The revised 2016 version of the TORCH report stated 40,000 deaths (Fairlie 2016). In 2006 the authors of a Greenpeace report warned that many uncertainties make the evaluation of the accident's death toll difficult and point out that "the existing research, even excluding extreme figures, indicates a death toll of anywhere between 10,000 and –200,000 additional cancer deaths." (Greenpeace 2006: 27).

However, as Olga Kuchinskaya (2014) shows in her recent study on the production of the scientific knowledge on the Chernobyl health impact and its public visibility, the answers to our questions about the exact figures of the people who will become sick or die from the accident most likely will never be known. She shows how much effort, will, time and, most importantly, resources and infrastructural solutions are needed to collect the kind of data that would satisfy the very strict conditions for the production of the scientific knowledge about these effects. Great efforts and resources are also required to sustain the public visibility of large-scale and long-term radiation exposure effects. Yet since late 1990 the efforts of the Belarusian, Russian and Ukrainian governments as well as international organizations have been, au contraire, directed to redefine and to limit the nature and scope of the Chernobyl effects. Research infrastructures have been displaced or disrupted. The loss of knowledge may have become irreversible – and this lack of knowledge is most often interpreted as a lack of effects which has led to growing public invisibility of the damage.

Ultimately, the Ukrainian government and nuclear industry have moved ahead with plans to build more NPPs, extend the licenses of existing ones, and use the Chernobyl exclusion zone to construct storage facilities for spent nuclear fuel. The public was centrally involved in anti-nuclear movements from the late Soviet period until the mid-1990s. Today NGOs are struggling to play a public role in opposing the expansion of the industry. Ukrainian citizens, worn down by years of corrupt governance and disputes about various energy futures, have become much less involved in discussions about nuclear energy. It is true that the transparency and openness of the nuclear industry has greatly improved since the Soviet period. However, there is a range of serious and rather urgent problems that nuclear enterprise in Ukraine faces. Chernobyl is a tragic reminder of the importance of broad societal discussions of all these problems, discussions where a special place for critics (and potential whistle-blowers) is always preserved.

3. Events

Several criteria guided the choice of the events chosen to describe the relationship between nuclear industry and public in Ukraine. Although we tried to cover as much as possible of the entire period of the development of the nuclear program in this former Soviet republic, none of the events cover the first decade prior to the Chernobyl disaster. The explanation for this is twofold. First, there seems to be very little interaction between nuclear industry and society due to endemic secrecy in the nuclear domain in general and the fact that the industry was managed from Moscow by all-union (national) institutions, bypassing most of the Ministries and Agencies of the Soviet Ukrainian republic. Second, data on social-political aspects of the nuclear program in Ukraine during the pre-Chernobyl period are very scarce. They consist mostly of archival and press documents related to the implementation of decisions on the construction of the plants and surrounding infrastructure including building the cities for the nuclear workers. Some of these documents reveal different problems and deficiencies in the plant construction, many of which are directly or indirectly linked to safety (see for example the archival documents related to the construction of the Chernobyl nuclear power plant in the collection published by Ukrainian historian Natallia Baranovs'ka (1996). Thus, even though the Chernobyl disaster, the first event described, happened in 1986, its discussion in the showcase and events in essence covers the period starting from the late 1970s.

The Chernobyl disaster has had a tremendous impact on the development of the nuclear power not only in Ukraine and former Soviet countries, but throughout the world. The accident and its aftermath are also crucial to understand very different types of interaction between the nuclear establishment and society: secrecy, disinformation or other communications on nuclear technology and its dangers; anti-nuclear protests related to nuclear power; and new forms of nuclear communication and public participation procedures put in place to remediate post-Chernobyl public distrust. Moreover, the years after the Chernobyl disaster coincided with and partially contributed to huge political transformation in the Soviet Union and Eastern and Central Europe including political and economic liberalization and the dissolution of the Soviet Union. Finally, Chernobyl is without any doubt the event of Ukrainian and Soviet nuclear history that has been the most studied and on which a great deal of data has been made public compared to other events and aspects of the nuclear program in former Soviet countries – including other serious accidents. All these reasons explain why the disaster, its causes and consequences, take such a prominent place in this report and is connected to several of the events described below (Event 1, Event 2, and partially, Event 4).

The extent and availability of primary sources was a final consideration. Except for Events 1 and 2, for which there are relatively more secondary sources, description and analysis is based almost exclusively on primary sources. However, for Event 3 primary data, compared to the other Events, were rather scarce. Nevertheless it was important to include this event to illustrate the surprising radical change of public attitudes toward nuclear power just a few years after large-scale post-Chernobyl anti-nuclear protests.

3.1. Event 1: Chernobyl disaster (April 26, 1986)

Summary

On April 26, 1986, as a result of a poorly designed and carried out experiment, the fourth of four reactors at the Chernobyl nuclear power station exploded. The explosion and resulting fire released massive amounts of radioactive materials into the environment. The authorities began to evacuate thousands of inhabitants in nearby towns and villages in Ukraine and Belarus only two days later; they scarcely informed residents about the extent of the accident. Hundreds of thousands of emergency-workers sent to mitigate the accident's aftermath were also inadequately informed about the risks involved in their efforts, and they had little or no protective equipment. The first "liquidators" worked with shovels and wheelbarrows as electronic equipment "fried" in the radiation. The miners and construction workers who came to build the covering ("Sarcophagus") over the destroyed reactor after fire had been extinguished also worked in the open with dump trucks, bulldozers, and concrete mixers and little safety equipment. Information about the scale of the disaster remained secret for almost three years while official media reported the heroic victory of the Soviet people over the accident and the progressive return to normal life.

Type of event: Nuclear disaster and lack of public communication about it.

General description:

After the explosion of unit 4, one hundred to two hundred MCi (megacuries) of radioactive materials filled the environment over the next ten days as the reactor continued to burn, falling onto the land and entering the water around the station, and also entered the atmosphere where it spread through the northern hemisphere. Fuel rods, burning graphite and other material scattered on the ground and the roof of reactor unit three next door, which caught fire. The uncontrolled nuclear reactor was open, and its graphite burned, emitting visible fumes and invisible radiation. Many of the firemen who rushed to the station died later of acute radiation sickness. They were not told how dangerously radioactive the smoke and the debris were, and may not even have known that the accident was anything more than a regular electrical fire. One said, “We didn’t know it was the reactor. No one had told us.” This lack of information plagued the entire radiation clean-up operation (Geist 2015).

During the months following the explosion, the Soviet authorities tried almost entirely to conceal information about the extent of the radioactive fallout and its danger for the people and the environment. The deliberate concealing of information is obvious from the secret protocols of the meetings by the Operative group of the Political Bureau of the CPUS, set up starting from the 29th of April to coordinate the emergency measures at the highest levels. Some of the protocols specifically stated the secrecy of the information related to the disaster’s impact (Iaroshinskaia 1992, Baranovs’ka 1996). This secrecy resulted in insufficient and inadequate measures of protection for the nearby population and emergency workers sent to undertake the clean-up of the accident site and the villages in its vicinity. Local people received partial and often false information about radiation levels and measures for self-protection. (Medvedev 1999; Geist 2015) The general public, including in areas of Ukraine, Belarus and Russia where radiation levels rose significantly were even less informed: the first official communication on the disaster was a 15 second message on the evening news on the main Soviet TV channel on April 28th (TV SSSR 1986). According to the announcement, an accident had occurred at the Chernobyl NPP and the situation was under control. This was followed the next day by a few lines of an easy-to-miss announcement on the third page of the main daily newspaper, *Pravda*. It was not until May 14th that the Soviet leader, Mikhail Gorbachev, made a TV appearance in which he acknowledged that a very serious accident occurred, although he also claimed that the situation was under control.

The inhabitants of the area in the direct vicinity of the plant were evacuated very late: the evacuation of the 45,000 residents (including 17,000 children) from Pripyat, the town just two kilometres from the reactor built for employees and their families to serve the station, was ordered only thirty-six hours after the explosion. Evacuation of such heavily contaminated settlements as Chernobyl (with 20,000 inhabitants) and the Gomel region of Belarus followed later in May. Sometime in August, the evacuation of 166,000 people from eighty-eight towns and villages in Ukraine, Belarus and Russia was complete. The hundreds of thousands of clean-up, social and medical workers who came from different parts of the Soviet Union to mitigate the accident's aftermath were inadequately protected, inadequately informed about the risks involved, and exposed to significant radiation doses often without any subsequent tracking of their health (Bariakhtar 1995; Marples 1987, 1988; Medvedev 1991; Medvedev 1999).

Arguments and behaviours

Between May 1986 and the beginning of 1989 the official optimistic narrative about successful "liquidation" of the accident's consequences and the return to a normal life remained dominant in the Soviet media. The information about the scale of the accident and the danger of its consequences was replaced by a vivid account of a heroic battle of emergency workers (the so-called liquidators) against what was painted as a radioactive monster, with some living creature features, an atom that went out of control or an external enemy. The press, radio, and television that were totally under the control of the State and the Communist Party described the solidarity of the Soviet people facing the disaster as one united family and the efficiency of the central and local authorities in dealing with everyday problems related to evacuation, health control, and cleaning-up operations (Kasperski: 110-128, Montaubrie 1996).

The official term of "liquidation" reflected well such aspects of the Soviet post-accident policies as treating the disaster as an external enemy that the Soviet people must fight and annihilate. It also described accurately Soviet authorities' efforts literally to erase the accident, to make the traces of it disappear both from the environment and the public sphere.

More generally, the use of military rhetoric and images was pervasive in the Soviet media. Soviet troops and military equipment were heavily involved in the clean-up and evacuation operations. The "war frame" has since become extremely important in public narratives and people's recollections of the response to the accident (Kasperski 2012: 110-128; Phillips 2004,164-165; Marples 1993). One of the reasons for this is the importance of the public memory of World War II in former Soviet countries. During the Soviet period, the Communist Party created a full-blown cult of the Great

Patriotic War (the period during which the Soviet Union was in war with Nazi Germany), or more precisely of the victory of Soviet state and people over fascism (as a reinforcement of its legitimacy) (Tumarkin 1994).

At the same time, many people did not believe in the official optimistic discourse about the liquidation of the consequences of the disaster. Interviews with inhabitants and analysis of archival sources show that many local residents were aware that the accident at Chernobyl was far more serious and dangerous than officials wanted to admit. Rumours circulated and citizens sent letters of complaint to government and party officials expressing the fears for their own and their family's health and asking for adequate protection measures and compensation[7].

Public engagement

Event 1	Chernobyl accident (1986)
Who was involved (refer to table of potential actors, above)	An *ad hoc* government commission was created to coordinate emergency response to the disaster and investigate its origins and impact. It coordinated the activities of more than 40 ministries, departments and organs of power of all kinds on federal (USSR), national (Ukrainian), regional and local level (Ministry of Medium Machine Building, Ministry of Energy, Ministry of Health, Ministry of Defence and Soviet Army Forces, Ministry of Internal Affairs, Committee for State Security (KGB) other government as well as Communist Party organs, Academy of sciences etc.) An operational group of the Political Bureau (Politburo) of the Communist Party of the Soviet Union created in parallel to the Government commission Soviet media controlled by the Communist Party and state institutions Local population, emergency clean-up, social and medical workers
When and where did it take place?	April 26, 1986, at Chernobyl NPP situated in Northern part of Ukraine close to Belarusian and Russian borders.
What type of process was it (communication, consultation or participation)? How did this	Lack of public communication on the scale of the disaster consequences and the danger for population and emergency workers. Optimistic and heroic narrative about successful "liquidation" of the accident's consequences and the return to a

[7] See reports on rumors and citizens' complaints by Ukrainian Communist party officials, for example: Liakhov 1986a, 1986b; Musienko 1986.

change over time? Please state process type, then describe in detail.	normal life in Soviet media. Secrecy maintained until the late 1988. Rumours and information circulating privately among citizens, letters of complaints sent to Party and State organs.
What rationale was given by the party that implemented the engagement (if any)?	N/A

3.2. Event 2: Post-Chernobyl anti-nuclear protests and vote on the moratorium on the construction of the new nuclear reactors (1989-1991)

Summary

After the extent of heavy radioactive fallout from the Chernobyl disaster was finally revealed to the general public in 1989, an important mobilization took place among many citizens to denounce the mismanagement of Chernobyl disaster by Soviet authorities and to claim better protection and compensation for affected populations. This mobilization was new for the citizen whose civic culture had been curtailed since the 1920s by the Communist Party, but in the period of glasnost and perestroika was permissible. The anti-Chernobyl protest became part of a broad independence movement developed that was centred to a large degree on environmental concerns and the belief among many participants that Moscow's Russian-centred economic development policies had contributed to the degradation of Ukraine. Such environmental groups as *Zelenyi Svit*, *Mama-86*, and the *Chernobyl Union* grew rapidly in 1988-1990, and sought to establish an independent Ukraine as a nuclear free zone. In response the Ukrainian parliament in August 1990 voted to adopt a moratorium on the construction and commissioning of new nuclear power units that suspended the construction of new units at Khmelnytska, Zaporizhzhya, and Rivne stations, a moratorium that lasted until 1993.

Type of event: public protest, public communication in response to protest, public consultation in form of opinion polls.

General description:

By the end of 1988, it had become increasingly difficult for Soviet federal and republican authorities to conceal information on both the impact of the Chernobyl disaster and its mismanagement by the

Soviet state. This situation related not only to the extreme gravity of radioactive contamination, but also to the progressive liberalisation of the Soviet political regime. The latter unfolded with glasnost and perestroika, introduced by Mikhail Gorbachev in 1985, which led to freer circulation of information, the weakening of censorship and the a loosening of the Communist Party's control over society; more possibilities for public expression of political and social discontent, and pluralisation of political life. The three-year-long cover-up of the impact and extent of the Chernobyl accident radioactive fall-out ultimately ended with an explosion of popular protests in Ukraine as well as in Belarus and Russia beginning in 1989 (see Belarus and Russia short country reports). Protests were also connected with environmentalism and nuclear power in Lithuania with its two operating Chernobyl-type RBMK reactors (see Lithuania short country report).

Between 1989 and 1991, the first maps of the radioactive contamination were publicly published. They appeared first in Belarusian newspapers in early February 1989 (*Gomel'skaia Prauda* 1989: 2-3). A month and a half later the Communist Party's newspaper *Pravda* printed the first contamination maps for Belarus, Russia and Ukraine (Izrael' 1989). These revelations occurred shortly before the first partially free and competitive legislative elections in the USSR, the elections to the Congress of People's Deputies that took place in the end of March 1989. The maps enabled fuller understanding of the extent of the disaster, and many critical articles on the handling of the disaster by the Soviet authorities appeared (Montaubrie 1996). Perestroika and glasnost combined with revelations about the true scale of the contamination, fuelled overlapping anti-nuclear, environmental, and nationalist movements. The Greens in Ukraine, represented by the organization *Zelenyi Svit* created in 1987 and officially registered in 1989, grew out of the Union of Ukrainian Writers, in particular those preoccupied by the environmental degradation of Ukraine and the consequences of the Chernobyl disaster (Marples 1991: 133-144; Zelenyi Svit 2016). (Writers had long played a role in voicing criticism of the Soviet development model (Breyfogle 2015).) These writers were soon joined by scientists and other representatives of the Ukrainian intelligentsia. Yurii Shcherback, author and a medical doctor who published a novel on the Chernobyl disaster in 1988 (Shcherbak 1988), became the chairman of the *Zelenyi Svit*. In 1989, during the founding congress of the Ukrainian environmental movement in Kyiv, *Zelenyi Svit* became an umbrella organization for many local environmental and anti-nuclear grass-root activists groups.

Ukrainian nationalist activists were represented by the Ukrainian Popular Movement (*Rukh*), established in early 1989. Like *Zelenyi Svit*, *Rukh* grew from the Ukrainian Writers' Union; the two movements were closely linked in the period 1989-1991. *Rukh* published its program of the "Popular Movement for Perestroika*" Literaturna Ukraina* on 17 February 1989. The program emphasized the independence of their movement from direct political control, although members recognized the general leading role of the Communist Party of the Soviet Union. The first regional organizations of *Rukh* were formed in Lviv and in Kyiv in the spring and summer of 1989, with more than 500 local branches having formed by autumn. *Rukh* strongly supported the anti-nuclear claims and protests' action even if its own environmental initiatives were quite minimal (Boreiko and Listopad 1995; Marples 1990; Paniotto 1991).

Another Chernobyl NGO was founded in 1989 by the liquidators: the *Chernobyl Union*. Its objective was to bring social, medical and economic help to the victims of the disaster, including children and disabled (Tykhyi 1998: 244).

In 1989, 1990 and 1991 dozens of rallies erupted in Kyiv and in some of the towns in the most contaminated regions; anti-nuclear activists gathered petitions, organized strikes, pickets, and blockades to protest against Chernobyl disaster mismanagement and the construction of the new nuclear units at the Khmelnytska, Chigirin, Crimea, South Ukraine and Chernobyl sites (Dawson 1996). Thus, for example, in 1989 *Rukh* organized a March from Khmelnytska NPP in Western Ukraine to Kyiv to protest against the authorities' cover-up of the disaster consequences and to claim compensation and adequate help for those affected by the accident. More than 300,000 people from five regions of Ukraine signed an appeal to the Supreme Soviet of the USSR (Tykhyi 1998: 244). *Zelenyi Svit* also organized a public investigation of the management of the state's response (1990-1992), with participation of lawyers and witnesses. The latter however did not create legal basis for victims of Chernobyl to sue state authorities (Tykhyi 1998: 244).

A number of the representatives of Chernobyl victims, such as the journalist Alla Yaroshinskaya, writers Yurii Shcherback, Volodimir Yavorivskyj, Volodymyr Shovkoshytnyj (Chernobyl Union President) were elected during the first partially free and competitive legislative elections to the Supreme Soviet of the USSR in 1989 and to the Supreme Soviet of Ukraine in 1990. These were political representatives who voiced claims on behalf of those who lived in territories affected by

Chernobyl fallout (Iaroshinskaia 2006: 70-80, 139-179).) As representatives they worked to pass a law on February 28, 1991, on “the status and social protection of citizens who had suffered due to Chernobyl catastrophe,” with funding financed through an employer wage tax. The numbers of people with benefits reached 3.2 million citizens (roughly 6% of total population) in 1995, of whom a million were children (Tykhyi 1998), although these benefits were later cut significantly due to budget shortfalls.

Anti-nuclear mobilization on the local level and in Kyiv contributed to a moratorium on the construction and commissioning of new nuclear power units by the Ukrainian Parliament in August 1990 that suspended the construction of new units at Khmelnytska, Zaporizhzhya, and Rivne stations. A year earlier, in 1989, the Ukrainian authorities took the decision to abandon the construction of the Chigirin and Crimean NPPs that have since become industrial ghosts, both because of the wave of demonstrations and the later also because of growing concerns among scientists about the seismicity of the region.

Arguments and behaviours

Activists, new political representatives, Ukrainian public intellectuals and scientists involved in the protests denounced the secrecy surrounding the consequences of Chernobyl during first years of the disaster and the mismanagement of radioactive fallout that they claimed criminally jeopardized the health and life of the Chernobyl victims, and they demanded extensive emergency protection measures, along with relocation and compensation payments.

For example, one of the fiercest controversies concerned the so-called “35 rem concept,” a threshold that corresponded to a dose of radiation that an individual living on a particular radioactively contaminated area would presumably absorb during a lifetime of 70 years. Under this threshold (which could be attained only in the most heavily contaminated territories), the official experts assumed that people could continue living without any restrictions on their behaviours, diets, and so on, and without rights to protective measures, let alone relocation. Ukrainian (and Belarusian) scientists denounced this threshold as unacceptable, because while it allowed the state and industry to save substantial money, it threatened the health and life of the people (See Belarusian Country Report).

The pre-eminence of nationalist movements in the Chernobyl protests led to the “nationalization” of dominant public narratives of the Chernobyl disaster. The accident appeared in public discourse first of all as a crime of colonial communist authorities – in Moscow, in the Kremlin – against the Ukrainian nation and its people. They considered full-blown political, economic and cultural independence of the nation as the only opportunity both for a national renaissance and to save people from Chernobyl (Dawson 1996; Phillips 2004: 159-85).

Nationalists and environmental activists believed that Moscow made decisions about building nuclear power plants in Ukraine without considering the potential danger to the Ukrainian people and local environment. Ukraine did not have its own branch of Minsredmash, nor its own regulatory agency. Yet not even Chernobyl stopped the Soviet authorities from moving forward with the construction of the new reactors in Ukraine: six more reactors, 1,000MW each, came on line in Ukraine between 1986 and 1990. This colonial attitude of the Moscow authorities fuelled strong resentment amongst the Ukrainian population that was reinforced by fears of new accidents.

State and party officials tried to keep the protest movement under surveillance, and, unsuccessfully, to control and limit its scope. At the same time the extent and vibrancy of anti-nuclear protests provoked genuine shock among nuclear scientists and engineers. In journals, whether those for a general public or professional reviews, authors debated actively how to understand and, most importantly, how to reduce public distrust. Some nuclear experts blamed the public’s lack of scientific education and its vulnerability to political manipulators who instrumentalised nuclear issues and people’s fears and emotions for their own political goals. Others, however, saw the origins of people’s distrust toward nuclear power in the atmosphere of secrecy typical for the Soviet management of civilian nuclear projects that had always been closely related to military uses.

In 1990 the Soviet Academy of Sciences and the All-Union Centre for the Study of Public Opinion carried out an important survey of public opinion on the attitudes of people toward nuclear power. They focused on the population around several nuclear power plants in the Soviet Union (in Ukraine they selected the Khmelnytska NPP). The results showed a rather even split of the population in favour and against the development of nuclear power (around 40% in each case) (Tsentr obshchestvennoi informatsii 1991b). Another opinion poll, ordered by the Soviet Ministry of Atomic Energy, was conducted in 1991. It included the population around Zaporizhzhya and South Ukraine stations where up to 80% of residents in the 30km zone around the NPPs were against their continued operation (Gedroits 1991; Tsentr obshchestvennoi informatsii 1991a). The sociologists also claimed to identify a negative link between levels of education and what respondents knew about nuclear power and the fears they expressed with regard to its development. Thus, to overcome the negative consequences of secrecy and distrust, many experts proposed informational and educational work with the public. Like the partisans of the "public understanding of science" ideas in the '70s in western countries, they believed that to restore the prestige of nuclear science and technology and overcome people's fears they needed to produce a better informed public.

In order to do so, information units were established at many stations that produced, for example, short press releases about the levels of radioactivity in the surrounding environment, important events at the plant, and educational material about nuclear power and radioactivity. Some also started organizing excursions to the station for the general public. Also, the All-Union Nuclear Society as well as the Ukrainian Nuclear Society were created in 1989 and 1992, respectively, with one of their goals to educate general public about the benefits of nuclear technologies. Nuclear information centres have spread throughout Russia and Ukraine, especially in the first decade of the twenty-first century (see below).

Public engagement

Event 2:	**Post-Chernobyl anti-nuclear protests and vote on the moratorium on the construction of the new nuclear reactors as a result of (1989-1991)**
Who was involved (refer to table of potential actors, above)	Ukrainian Popular Movement (*Rukh*) Environmental, anti-nuclear, Chernobyl NGOs: *Zelenyi Svit* (Green World) *Chernobyl Union, Mama-86.* Soviet central and national (Ukrainian) media that slowly emancipated from state and communist party control, local newspapers in the regions with nuclear power plants, including newspapers sponsored by the plants themselves. Ukrainian Academy of Sciences Supreme Soviet of Ukraine All-union Nuclear Society, Ukrainian Nuclear Society Populations affected by the Chernobyl fallout, liquidators, groups of people residing in the proximity of existing or planned nuclear facilities
When and where did it take	Protests took place in Kyiv and important regional centres,

place?	cities and villages situated in contaminated territories, regions with nuclear sites with reactors, under construction, already operating or only planned.
What type of process was it (communication, consultation or participation)? How did this change over time? Please state process type, then describe in detail.	Public protests against mismanagement of Chernobyl accident and against further development of nuclear power. Public communication in response to protests: attempts to better inform public about the operation of existing nuclear facilities and provide it with better knowledge of the specificity of nuclear technologies (publication of the information in national and local newspapers, excursions to nuclear power stations, conferences and educational activities). Public consultation in the form of opinion polls.
What rationale was given by the party that implemented the engagement (if any)?	To remediate the public distrust towards nuclear power one needs to produce a better informed and educated public

3.3. Event 3: Vote on the repeal of the moratorium and relatively weak anti-nuclear protests (1993-1994)

Summary

As a consequence of strong anti-nuclear movements in the late 1980s, Chernobyl, and the economic and political difficulties of the last years of Soviet power, virtually all of the nuclear plants under construction in Ukraine were mothballed. Indeed, in August 1990 the Ukrainian parliament adopted a moratorium on the construction and commissioning of new nuclear power units and suspended the construction of new units at Khmelnytska, Zaporizhzhya, and Rivne stations (Supreme Rada of Ukraine 1990). But in October 1993 the Verkhovna Rada (Ukrainian parliament) voted to overturn the moratorium on construction of new reactors, in part to keep the Chernobyl station open to meet projected power shortages for the winter of that year (Supreme Rada of Ukraine 1993). Soon after the vote, construction resumed at Khmelnytska, Zaporizhzhya and Rivne stations. In October 1995 the 6th unit of Zaporizhzhya NPP started operation making it the biggest one in Europe with a combined installed capacity of 6,000 MW. Environmental and anti-nuclear activists organized an anti-nuclear campaign to protest against the decision to repeal the moratorium, but if the campaign was extensive it had relatively small public impact.

Type of event: lack of public consultation, public protest

General description

When Ukraine gained its independence in 1991 upon the collapse of the USSR, it fell into economic crisis, including inflation and a sharp recession and therefore embarked on policies to preserve nuclear power generation capacity. In October 1993 the Parliament voted to overturn a 1990 moratorium on construction of new reactors and to keep Chernobyl open in order to address projected power shortages for the winter of that year. This happened even in spite of a serious new incident at the Chernobyl power plant: on October 11, 1991, a fire began in the turbine hall of reactor 2 that led to the final shutdown of the unit. Soon after the 1993 vote to repeal the moratorium, construction officially resumed at Khmelnytska, Zaporizhzhya and Rivne. Ukraine lacked money to pay for the completion of four other reactors, two of which were eventually finished in 2004, and two of which remain empty shells.

In 1992, shortly before the vote to repeal the moratorium, discussions started about the construction of a spent nuclear fuel storage at the Zaporizhzhya NPP. Nuclear authorities saw it as the only possible solution to a shortage of free space in storage pools of the station that would force the station to shut down by 1998. The storage facility, which remains today the only one existing in Ukraine for VVER reactor fuel, was completed in 2001 (Zaporizhzhya NPP 2016).

These were obvious signs of the intention of Ukrainian authorities to preserve and even to expand Ukrainian nuclear capacities in spite of a strong anti-nuclear movement that had taken place just several years earlier. However, there was little reaction from general public on the repeal of the moratorium, while only NGOs remained actively mobilized against nuclear power. Greenpeace, which established its local branch in Ukraine on the eve of the country's independence, launched an anti-nuclear campaign. In 1993 Greenpeace Ukraine conducted an educational bus tour "No new reactors!" in nine important regional cities: Lviv, Rivne, Zhytomyr, Kyiv, Odessa, Mykolaiv, Zaporizhzhya, Lugansk (from Lugansk the bus tour continued to Russia). The bus tour aimed at informing people about the problems related to the pursuit of nuclear power in Ukraine and collected signatures against the repeal of the moratorium. Over 15,000 signatures against the construction of new reactors were collected during the first 9 days of the tour (Greenpeace Ukraine 1995). The signatures were later transmitted to the Rada of Ukraine. Together with the members of such other NGOs as *Zelenyi Svit* and the Green Party of Ukraine they participated in numerous anti-nuclear pickets in Kyiv (in front of the Rada), wrote letters to the Rada, met with parliamentary representatives, and organized public roundtables discussing the moratorium (Pasyuk 2016; Tsvetkova 2016).

In addition to protest in Kyiv, an important action took place in Zaporizhzhya region near the Zaporizhzhya NPP, and first of all, in Nikopol where the protest campaign was organized by the local branch of *Zelenyi Svit* with the support of Greenpeace Ukraine. One of the highlights of the campaign was a local referendum on Zaporizhzhya NPP that took place in June 1994 in the largest towns situated in the 30 km zone around the station: Nikopol, Marganets and Kamenka – Dneprovskaia. More than 90% of participants voted against the completion of the unit 6 of the NPP, against the construction of spent fuel storage facility there, and against the exchange of the water between its cooling pond in the Dnipro river (Soiuz “Grazhdanskii dozor” 2012).

In August 1994 Greenpeace Ukraine together with *Zelenyi Svit* activists in Nikopol hung a big banner “No more Chernobyls” on the cooling towers of the station to protest against the future development of nuclear power, and handed a protest note to the nuclear power plant management (Pasyuk 2016; Tsvetkova 2016; see also the video: Greenpeace Ukraine 1994). Authorities and nuclear officials ignored the results of the referendum and the protests and continued the construction projects as intended.

Arguments and behaviours

After the dissolution of the Soviet Union, public attitudes toward nuclear power changed dramatically. The nationalist dimensions of anti-nuclear protests lost their importance in the public arena after Ukraine became an independent nation. The Ukrainian people began to see Chernobyl less as a site of colonial domination by Russia and instead as an important source of the electricity production that contributed to the nation’s economic survival and independence, including from Russia itself. The hard bargaining by the Ukrainian authorities with European countries and organizations over the closure of the Chernobyl NPP in the late 1990s-early 2000s (see Event 4) indicates how important its continued operation was for the country. As for citizens, the difficult economic situation of the early 1990s, when jobs, heating, electricity, and food were crucial questions, made it much more difficult to mobilize people for anti-nuclear and ecological causes, as they were preoccupied with daily survival.

In this context the radical change in the authorities' position towards nuclear power attracted little public scrutiny. Nuclear promoters, with the support of their foreign colleagues,[8] regained some influence on the policy-makers and advanced a new post-Chernobyl public discourse on nuclear power. They insisted on the safety of the VVER reactors as opposed to the Chernobyl type RBMK reactors, emphasizing very important differences between the two types, notably the latter's positive void coefficient and absence of containment. They reminded the public of the economic importance and viability of nuclear power and the need to overturn the moratorium on the construction of new reactors in Ukraine.

Such anti-nuclear activist groups as Greenpeace Ukraine, Zelenyi Svit and Green Party strived to give as much publicity as possible to what they saw as unacceptable return of the Ukrainian officials to pro-nuclear positions. They considered information and outreach activities involving the general public, elected officials and expert community as one of the instruments of resistance to the looming "nuclear renaissance". They reminded the public that Chernobyl accident and its continuing public health and environmental impacts were the tragic proofs of the inherent danger of the nuclear enterprise. They illustrated the lack of safety of Ukrainian nuclear installations by putting out constant press-releases on various incidents that could one day become another Chernobyl. Environmental activists also pointed out that new reactors would mean additional large amounts of spent nuclear fuel and radioactive waste, and that the problem of their safe storage and disposal was still unsolved around the world, and completely ignored in Ukraine (Tsvetkova, 2016).

The local protesters in Zaporizhzhya region were primarily preoccupied by the fact that the further expansion of already vast nuclear facilities would have significant negative impacts on the local environment and people. For instance, they feared that the NPP cooling waters when allowed to flow to the Kakhovka reservoir on the Dnipro River would contaminate them with tritium and other dangerous elements. Local activists also insisted that the inhabitants of the areas surrounding the

[8] It seems, for example, that during this period IAEA representatives organized several training seminars for nuclear specialists on the appropriate ways to communicate with public on nuclear energy (Tsvetkova 2016).

plant were poorly, if at all, compensated for the ever-growing risk from the nuclear site (Soiuz “Grazhdanskii dozor” 2012).

In spite of the successful referendum against the Zaporizhzhya NPP, the protesters failed to mobilize large groups of population against the return of the pro-nuclear policies and they had little if any impact on decisions with regard to new construction projects. If only a small part of these projects were completed in the following decade, this was due not to public opposition but to economic difficulties.

Public engagement

Event 3:	**Vote on the repeal of the moratorium and relatively weak anti-nuclear protests (1993-1994)**
Who was involved (refer to table of potential actors, above)	The Ukrainian President, government and Verkhovna Rada (Ukrainian parliament) Goskomatom and Derzhatomnadzor Environmental and anti-nuclear NGOs cooperating within an anti-nuclear campaign coordinated by Greenpeace Ukraine, *Zelenyi Svit* and its Nikopol branch. Groups of people residing in the proximity of Zaporizhzhya Nuclear Power Station
When and where did it take place?	Protests took place in Kyiv and in towns situated near Zaporizhzhya Nuclear Power Station, first of all Nikopol and at the NPP site.
What type of process was it (communication, consultation or participation)? How did this change over time? Please state process type, then describe in detail.	Public protests. No public consultation or participation procedures were implemented by the state or nuclear authorities prior to the decision to overturn the moratorium. A referendum was organized by NGO *Zelenyi Svit* and its Nikopol branch.
What rationale was given by the party that implemented the engagement (if any)?	N/A

3.4. Event 4: Controversial negotiations on the closure of the Chernobyl NPP and public hearings on the completion of the Khmelnytska 2 and Rivne 4 nuclear reactors in exchange (1994-2000)

Summary

In 1995 Ukraine and the G7 countries signed a Memorandum of Understanding in which Ukrainian authorities agreed to close the Chernobyl NPP in exchange for significant compensation. However, the forms and conditions of this compensation became a subject of long and controversial negotiations. Ukrainian authorities insisted on the necessity of Western funding for the completion of two reactors at Khmelnytska and Rivne nuclear power plants (K2-R4). The European Bank for Reconstruction and Development (EBRD) which was to manage the funds implemented public participation and consultation procedures to determine whether the reactors' construction was the most efficient way to compensate for the closure of Chernobyl, and this led to significantly lower funding than the Ukrainian government had counted upon. This outcome was partially due to the sustained pressure from Ukrainian and International NGO's (*NECU, Bankwatch, Ekoclub-Rivne* among others) which used public hearings, lobbying and protest rallies to oppose the EBRD financing of the K2-R4 construction. Ukraine finally acceded to demands to close Chernobyl in 2000, and with local financing and bond issues – not EBRD funds – Energoatom completed the Khmelnytska 2 and Rivne 4 units which came on line in October 2004.

Type of event: Public consultation, public participation

General description

After the explosion at reactor no. 4, and during the on-going clean-up, the remaining three reactors at the power plant were brought back on line to meet projected energy shortfalls. In 1991, unit 2 was damaged by a major fire and was shut down. In November 1996, unit 1 was shut down, followed by unit 3 in 2000 after pressure from the European Union over questions of safety; for Ukraine the prospect of future admission to the EU played a role here.

The decommissioning of Chernobyl's NPP units 1-3 and the construction of a new shelter over the destroyed unit 4 and its Sarcophagus became a prolonged battle among dozens of different countries and international organizations over political and financial issues. In July 1994, the G7 nations initiated negotiations with Ukraine over the complete shutdown of Chernobyl. Ukrainian and Western experts proposed different solutions for replacing Chernobyl's contributions to the grid: building of a gas-fired power plant, modernizing coal and oil plants, completion of unfinished units at Khmelnytska, Zaporizhzhya and Rivne or even construction of two new nuclear reactors in the town of Slavutych, built near Chernobyl to house station workers and their families after the disaster (Launer and Young 1997: 66-67; Nuclear Treaty Initiative 2016). The December 1995 Ukraine-G7 Memorandum of Understanding provided for closing Chernobyl in exchange for the possibility of western funding to complete Khmelnytska 2 and Rivne 4 (K2-R4) that were 80% complete when the Ukrainian Parliament adopted a moratorium on construction in 1990. The memorandum also declared the prospects of financial aid to help Ukraine restructure its power sector, build a pumped storage plant, rehabilitate and update hydro- and thermal plants, and develop energy efficiency projects (Memorandum of Understanding 1995). However, proposed support from such institutions as the EBRD and European Commission was much lower than the Ukrainian government had hoped. Some of the loans were deferred because European institutions considered that Ukraine had not fulfilled conditions required in exchange, in particular those related to the reforms in the energy sector.

As for the completion of the K2-R4 reactors, according to the EBRD rules regulating investment projects, a series of public consultation and public participation procedures were implemented. EBRD representatives organized a number of round-tables and consultations with different stakeholders: government officials, representatives of different nuclear organizations as well as NGOs. Several public hearings were organized as part of the environmental impact assessment of K2-R4 in cities and villages situated in the vicinity of the plants. Ukrainian environmental and anti-nuclear NGOs actively participated in these hearings. They criticized the hearings as events organized as a “mere formality” as opposed to attempts really to take the opinion of the local population into account (Pasyuk 2016). Several local NGOs organized alternative hearings that, according to activists, showed very critical attitudes of the local population towards the construction project (Fedorynchyk 2000). A great number of the NGOs joined the campaign from abroad: 338 NGOs from 58 countries signed a joint letter against the EBRD financing the completion of K2-R4. With the help of foreign NGOs Ukrainian activists participated in several lobbying trips, for example to Germany and The Netherlands (Pasyuk 2016). Ukraine succeeded in closing all units at the

Chernobyl NPP by 2000 as was stipulated in the Memorandum with generous support of the western partners. Ukraine also completed K2-R4, although all with its own funds, in 2004.

Arguments and behaviours

Ukrainian officials were disappointed by Western partners who, according to the Ukrainian side, failed to fulfil their 1995 commitment of assistance to support Ukraine's energy sector in exchange for closing the Chernobyl plant. In particular, the West failed to provide the funds necessary to complete K2-R4. In a speech at the meeting on the opening of the Khmelnytska NPP in 2004 Ukrainian President Leonid Kuchma blamed the Western governments: "We have waited for five years, but the West evaded its obligations under various pretexts, laying down new requirements to Ukraine in return. And after obtaining the closure of Chernobyl it forgot about its promises for good" (Podrobnosti 2004).

The NGOs protesting against the project insisted that completion of the two reactors was not economically the most efficient way to compensate Ukrainian energy system for the closure of Chernobyl. On top of this, they noted that the country had sufficient generating capacities which were underused and insisted that the Ukrainian government instead implement long-term energy efficiency programs. Activists pointed out that Soviet-designed reactors at K2-R4 were far below Western safety standards. Finally, referring to the results of the alternative public hearings organized by NGOs, as well as a public opinion poll done by SOCIS – Gallup International in April 2000, they emphasized the lack of people who supported the project (only 14% of the respondents supported the project according to the poll) (Fedorynchyk 2000; Pasyuk 2016).

Public engagement

Event 4:	**Post-Chernobyl anti-nuclear protests and vote on the moratorium on the construction of the new nuclear reactors as a result of (1989-1991)**
Who was involved (refer to table of potential actors, above)	The Ukrainian President, government (Ministry of Energy), local authorities in Rivne and Khmelnytska regions Nuclear operator Energoatom and management of Rivne and Khmelnytska NPPs Media International, national and regional antinuclear NGOs: Greenpeace, Bankwatch, NECU, Ekoclub-Rivne European Bank for Reconstruction and Development (EBRD)

	Local population in Rivne and Khmelnytska regions
When and where did it take place?	In Kyiv, in Rivne and Khmelnytska regions
What type of process was it (communication, consultation or participation)? How did this change over time? Please state process type, then describe in detail.	Public consultation between EBRD and stakeholders, including anti-nuclear NGOs, public participation process including public hearings, alternative public hearings organized by NGOs, protests organized in some EBRD countries to put pressure on the decision-makers
What rationale was given by the party that implemented the engagement (if any)?	Public consultation and hearings were organized according to the “due procedures” that every EBRD investment project must follow

3.5. Event 5: Start-up of the Khmelnytska 2 - Rivne 4 nuclear reactors (2004) as part of strategy aiming at "nuclear revival" and a new public information effort

Summary

In the effort to rely more heavily on nuclear power to meet energy demands and promote energy independence, Ukraine finished two long-delayed and long-disputed reactor projects, unit 4 at the Rivne NPP and unit 2 at the Khmelnytska NPP. Industry accomplished this against the backdrop of an effort to engage the public about the safety and efficacy of nuclear power. NPPs throughout the country renovated and expanded information centres with new or enlarged news services, newspapers, and TV studios. This openness was a distinct break with the Soviet past. The information centres, located near to reactor sites, enabled extensive public access. The centres built exhibitions and museums. Centre information facilities made outreach to children a special function. They have organized festivals and drawing contests for the children. The drawings reveal, generally, the success of outreach, for most of the drawings play on themes of the domesticated atom in Eden-like scenes.

Type of event: Public communication

General description

In the 1990s the Russian and Ukrainian economies struggled with crisis after crisis, astronomical inflation, and then deep recessions. The nuclear enterprise fell on very difficult times, and also had to deal with public fear and anger over Chernobyl. But at the turn of the century, the industry began to revitalize. The Ukrainian government strived with great difficulty to turn nuclear power into a crucial component of its drive for economic self-sufficiency and independence from Russia. The year 2004 was an important benchmark for the post-Soviet nuclear industry because two long-delayed and long-disputed construction projects were finally completed, unit 4 at the Rivne NPP and unit 2 at the Khmelnytska NPP whose construction began in the 1980s.

The renovation and enlargement of existing information centres and the expansion of their activities was the first and most visible sign of an attempt at nuclear revival in the public communication domain. Thus, the long awaited completion of the unit 4 at the Rivne power plant was celebrated with an inauguration of a new information centre that occupied a renovated former local movie theatre in Kuznetsovsk. This new centre hosted a large screening room, an exhibition dedicated to the station's describing its history and featuring two models of the reactors, and a small museum of local history and culture.[9]

More generally, the information centres grew in numbers of staff and departments (although later on some centres had to cut their staff due to limited budgets). A number of them added or enlarged news services, newspapers, and TV studios. They created webpages with news about the station; current operating and safety data; visits of delegations; photo galleries; and station publications. They now usually sponsor a weekly newspaper typically published in 2,000 to 3,000 copies. Some of these newspapers existed already in Soviet times, for example, the newspaper *Energia*, published by the Rivne Nuclear Power station since 1978. An even more important development was that the information centres became more autonomous from the administration of the power stations and moved off closed power station sites to become accessible to the public who no longer needed specific authorization in order to visit the centres. They sponsored competitions for children including drawing contests; screened documentaries and cartoons; arranged visits to nuclear technology exhibitions and museums; and organized games, lectures and even festivals and plays. While these activities in the post-Soviet nuclear domain may appear quite rudimentary to people at European power stations, the openness of these new information centres was symbolically important as they aimed to break away from the Soviet tradition of secrecy.

However, constant changes in the direction of the industry, new appointments at the head of Energoatom, and different communication teams coming to power has meant the absence of common methods or approaches in the effort at public outreach. Thus, for example, Ilona Zaets, the chief of the PR and communication in 2016, came into the office with the new President of Energoatom, Iurii Nedashkovskii, who was appointed in the early 2014 after the political crises in Ukraine in 2013 and 2014 and the flight of former Ukrainian President Yanukovich from office in February 2014 (Zaets 2014, 2016). A persistent lack of financing has also hindered efforts significantly. While the information centres expanded and acquired new buildings and exhibitions,

[9] I visited this information center in October 2014 and April 2016. See also the webpage of the center: Rivnens'ka Atomna Stantsiia 2016.

much of this came from local initiatives and often without common communication strategies directed to the outside communities.

Children drawing contests on nuclear themes are a good example of the contemporary nuclear communication effort as well as of cultural representations of the nuclear energy in Ukraine. Already in the early 1990s nuclear specialists in professional societies in Ukraine advanced the idea of working with children's drawings to engage both younger and older audiences, and the information centres have embraced them fully. They see children as potential future young cadres for the nuclear industry and as easier to engage than adults. It is also possible to reach adults through children (Barbashev 2015).

Drawing competitions on nuclear themes were introduced through local initiative at some plants early on. They became particularly popular in the late 2000s and are now coordinated by the nuclear operator Energoatom. The information centres of each of the 4 operating Ukrainian power stations announce artistic competition every year. Children living within 30- and up to 100 kilometres diameter zones are encouraged to send their works to the information centres of the plants, which then select several of them to participate in the second round at the national level. Children submit drawings and sometimes handicrafts or animation movies. The number of participants may vary but often reach one hundred or more in these contests. The best works are usually rewarded with material prizes.

The contests are very much local initiatives and rely on the enthusiasm of local teachers and information centre workers who are also very often former teachers or have worked in secondary education. They are also local as a celebration of local communities whose lives revolve around power stations.

At the same time the drawings seem to circulate quite widely: present on the walls of information centres, on official web-pages and social media and in printed publications of nuclear organizations. They are even offered as presents to some foreign guests of the nuclear operator Energoatom. As a consequence they also contribute to standardized visual representations of nuclear power. From year to year drawings repeat some of the same themes or even copy the drawings from previous years the children can find on the internet or displayed in the information centres.

Arguments and behaviours

The renewed public relations effort has aimed at promoting the atomic industry as safe and open to the public, economically beneficial for local communities and the whole nation, and different from "Soviet" nuclear technology with its secrecy and such accidents as Chernobyl. Public communication also emphasized the way nuclear technology is important for national prosperity and independence and that nuclear installations operate in harmony with human activity and natural environment.

These aspects are obvious in the children drawings sent to the competitions organized by the nuclear operator Energoatom and local information centres on nuclear energy at each Ukrainian station every year. The drawings often present images that "domesticate" the atom by showing power stations situated in Eden-like settings. They stage openness, accessibility, and the friendliness of nuclear places and installations as parts of everyday life, pictures of smiling cooling towers are common illustrations as are numerous pictures involving children playing peacefully against the backdrop of nuclear plants.

Another striking feature of nuclear imaginaries as they appear in the drawings is their attempt to reconcile nuclear modernity with tradition, especially national tradition, most visible in abundant national and religious iconography (women and children, and men sometimes in national costumes, angels and churches).[10] The "nationalization" of the atom appears here on two different levels. First of all, these pictures reflect a widely promoted idea in Ukraine that nuclear power is an important condition for the country's national prosperity and independence. Here we should remember that Ukraine has been very energy dependent on imports of Russian gas and oil since the Soviet period and at the same time that nuclear plants produce more than half of country's electricity. Nuclear officials thus promote nuclear energy as an instrument of emancipation from Russia even if Ukraine relies heavily on Russia for nuclear fuel, its reprocessing and other nuclear technologies.

[10] I refer here to the pictures seen on display at the Information Centers of the Rivne NPP in Varash (formerly Kuznetsovsk) and Khmelnytska NPP in Netyshin that I visited in October 2014 and in April 2016. Such pictures can also be found at the nuclear stations official websites. See, for example: Rivne NPP 2016b; South Ukraine NPP 2016.

Another level of nationalization that appears in the drawings in a striking manner is a very strong attachment to local community as part of the Ukrainian nation. This attachment acquired dramatic overtones since Russia annexed Crimea and started a “hybrid war” in the East of Ukraine in 2014. In spring 2015 Energoatom organized an artistic competition and a teenager from Varash (formerly Kuznetsovsk), the town near the Rivne NPP, won the first prize telling the story of a boy, whose father leaves home to go to war and defend his Motherland.

These depictions of nuclear power convey the message that Ukraine accepts this technology, is strengthened by it and protected from its negative impact. Even if the negative consequences of Chernobyl continue to haunt Ukraine, the nation, those pictures show, cannot do without nuclear energy: nuclear energy is a predicate for national survival.

Public engagement

Event 5 :	**Start-up of the Khmelnytska 2-Rivne 4 nuclear reactors (2004) as part of strategy aiming at “nuclear revival” and new public information effort**
Who was involved (refer to table of potential actors, above)	Local authorities and public culture and education institutions and facilities in regions hosting NPPs Nuclear operator Energoatom, nuclear stations and their local information centres Local population in the regions hosting NPPs, local elected officials, visitors from different parts of Ukraine and foreign delegations
When and where did it take place?	In the cities hosting nuclear power plants
What type of process was it (communication, consultation or participation)? How did this change over time? Please state process type, then describe in detail.	Public communication
What rationale was given by the party that implemented the engagement (if any)?	To inform local residents about the operation of nuclear reactors, to explain why the atomic industry is safe, open, economically beneficial and important to insure national sovereignty and prosperity

4. Facts and figures

The purpose of this section is to give an overview of nuclear power in Ukraine. This section contains such data as number of reactors, reactors' locations, technical and chronological details of reactors' construction as well as statistics on electricity production, periodization and social connections to nuclear constructions. This data can be used as a supportive material to the following sections of the country report and in order to understand the overall country's situation. Key dates and abbreviations used in this report are presented in the beginning of this section.

4.1. Data summary

- There are 15 operational reactors in Ukraine, 4 reactors are shutdown permanently and 2 reactors are under construction.
- Ukraine is highly dependent on nuclear power – operating reactors generate almost 50% of country's electricity.
- In 2004 two reactors came online: Khmelnytska -2 and Rivne-4, the construction of both started in 1980s.
- Chernobyl accident in 1986 changed the perception of nuclear power worldwide and questioned the safety standards of Soviet reactors.

4.2. Key dates and abbreviations

Key dates:

1931	Founding of Ukrainian Physical Technical Institute in Kharkiv
1931-32	Millions of Ukrainians die in famine caused by Stalin's collectivization campaign
1941	Invasion of Ukraine by Nazi Germany, loss of one-fifth of population
1944	Establishment of Institute of Physics in Kyiv
1950s-60s	Expansion of experimental nuclear physics in Kharkiv and at Institute of Physics with acquisition of such apparatuses as cyclotrons, electrostatic generators, and a VVR-M experimental reactors
1970	Foundation of Institute of Physics and Institute of Nuclear Research
1970s	Construction of a series of PWRs and 4 RBMKs begins
1970s-	Between 1980 and 1989, 12 PWRs enter into operation, between 1977 and 1983, 4

1980s	RBMKs enter into operation
1986	Chernobyl Disaster, April 26
1989	Ukrainian government abandons Chigirin and Crimean stations
1990	Parliament adopts a moratorium against new nuclear units and suspends construction of Khmelnitsky, Zaporizhzhya, and Rivne units
1991	Break-up of the USSR and formation of independent State of Ukraine
1993	Parliament votes to repeal the moratorium, construction resumes at construction of Khmelnitsky, Zaporizhzhya, and Rivne units
1995	Unit 6 at Zaporizhzhya NPP enters into operation
2004	Unit 2 at Khmelnitsky NPP and unit 4 at Rivne NPP enter into operation
2010	Government begins process of extension of operating licenses at several stations
2014	Annexation of Crimea by Russia and beginning of separatist war in Eastern Ukraine

Abbreviations:

ChAES	Chernobyl NPP
Energoatom	Ukrainian nuclear utility
EBRD	European Bank for Reconstruction and Development
EU	European Union
Goskomatom	State Committee of Ukraine for Utilization of Nuclear Energy
IAEA	International Atomic Energy Agency
KhAES	Khmelnytska NPP
Mintopenergo	Ministry of Fuel and Energy
NECU	National Ecology Centre of Ukraine
NPP	Nuclear Power Station
PWR	Pressurized water reactor
RAES	Rivne (or Rivenns'ka) NPP
RBMK	Channel-graphite reactor (Chernobyl type)
SNF	Spent nuclear fuel
SUAES	South Ukraine (or Iuzhno-Ukrain'ska) NPP

Turboatom	Ukraine firm that builds turbines in Kharkiv, Ukraine
TVEL	Russian nuclear fuel company
UAH	Hryvna (Ukrainian currency)
UFTI	Ukrainian Physical Technical Institute
UkrEnergy	Ukraine National Power Company
UkrIaO	Ukrainian Nuclear Society
VVER	Water-water Reactor (Soviet-era PWR)
ZAES	Zaporizhzhya NPP
WNA	World Nuclear Association

4.3. Map of nuclear power plants

Figure 1 represents a map of currently operating nuclear power sites in Ukraine.

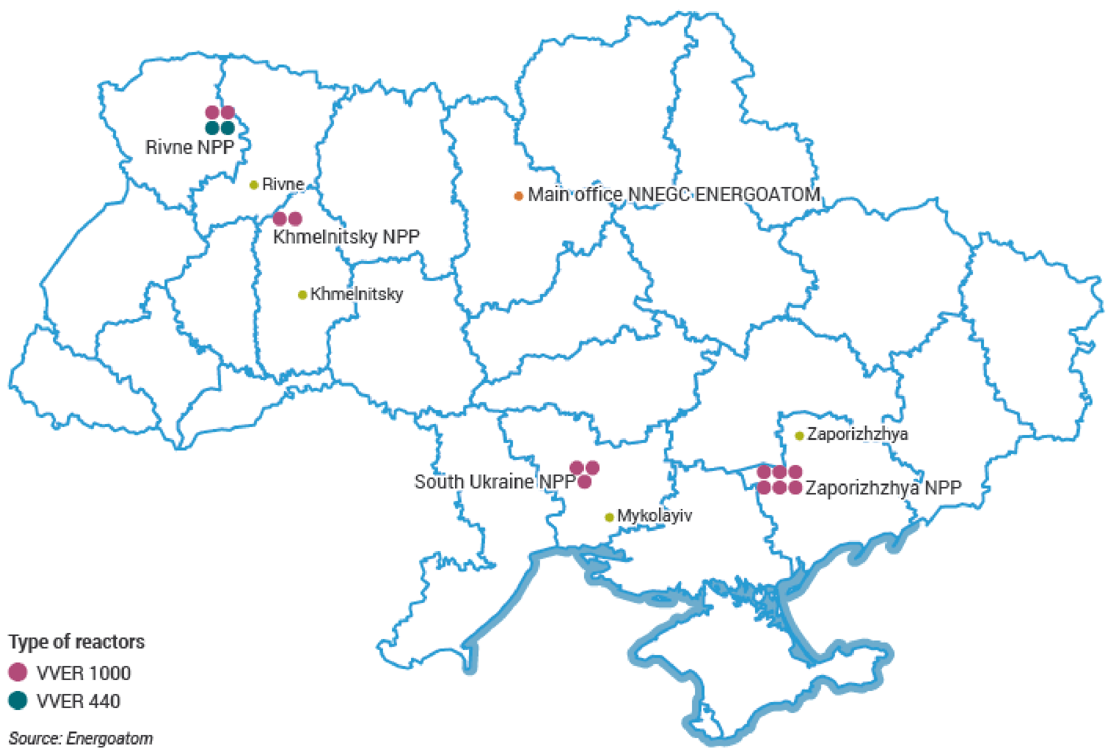


Figure 1 - Nuclear power plants in Ukraine. Source: WNA 2016, Energoatom Ukraine.

4.4. List of reactors and technical, chronological details

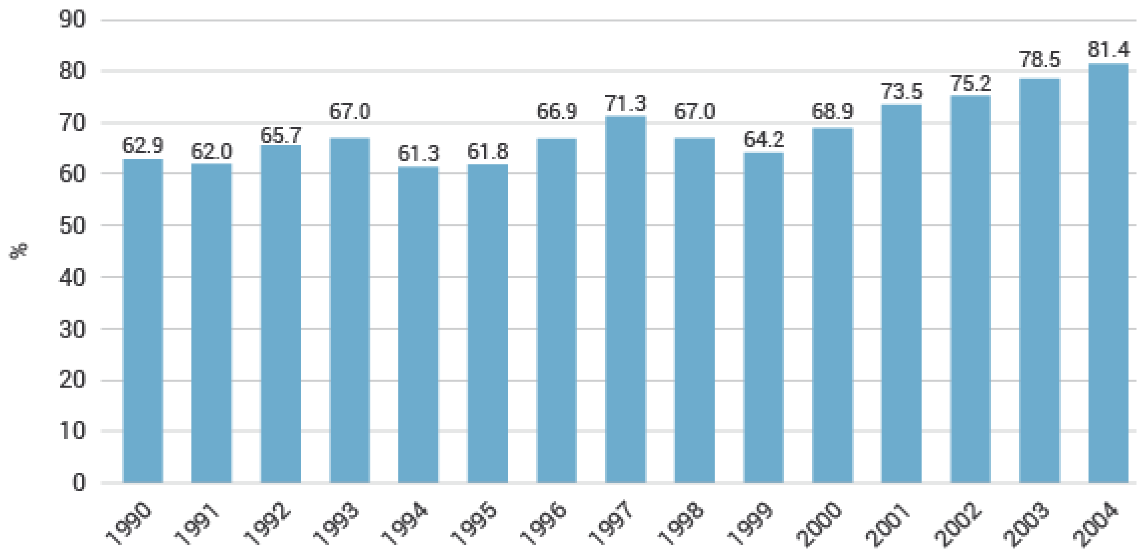
Tables below show the list of reactors, suppliers, operators as well as date details.

Table 1 - Operational nuclear power reactors. Sources: IAEA 2016; WNA 2016

No	Name	Operator	Supplier	Type	MWe net	Construction began	Grid power	Shutdown
5	**Khmelnytska-1**	Energoatom	USSR	PWR	950	1981	22.12.1987	2018, 2032
6	**Khmelnytska-2**	Energoatom	USSR	PWR	950	1985	8.8.2004	2035, 2050
9	**Rivne-1**	Energoatom	USSR	PWR	381	1973	22.12.1980	2030
10	**Rivne-2**	Energoatom	USSR	PWR	376	1973	22.12.1981	2031
11	**Rivne-3**	Energoatom	USSR	PWR	950	1980	21.12.1986	2017, 2032
12	**Rivne-4**	Energoatom	USSR	PWR	950	1986	16.10.2004	2035, 2050
13	**South ukraine-1**	Energoatom	USSR	PWR	950	1976	31.12.1982	2012*, 2033
14	**South ukraine-2**	Energoatom	USSR	PWR	950	1981	6.1.1985	2015, 2030
15	**South ukraine-3**	Energoatom	USSR	PWR	950	1984	20.9.1989	2019, 2034
17	**Zaporizhzhya-1**	Energoatom	USSR	PWR	950	1980	10.12.1984	2015, 2030
18	**Zaporizhzhya-2**	Energoatom	USSR	PWR	950	1981	22.7.1984	2016, 2031
19	**Zaporizhzhya - 3**	Energoatom	USSR	PWR	950	1982	10.12.1986	2017, 2032
20	**Zaporizhzhya-4**	Energoatom	USSR	PWR	950	1983	18.12.1987	2018, 2033
21	**Zaporizhzhya - 5**	Energoatom	USSR	PWR	950	1985	14.8.1989	2019, 2034
22	**Zaporizhzhya - 6**	Energoatom	USSR	PWR	950	1986	19.10.1995	2026, 2041

Table 2 – Shutdown nuclear power reactors Sources: IAEA 2016; WNA 2016

No	Name	Operator	Supplier	Type	MWe net	Construction began	Grid power	Shutdown
1	**Chernobyl -1**	Energoatom	USSR	LWGR	740	1970	1977	1996
2	**Chernobyl -2**	Energoatom	USSR	LWGR	925	1973	1978	1991
3	**Chernobyl -3**	Energoatom	USSR	LWGR	925	1976	1981	2000
4	**Chernobyl -4**	Energoatom	USSR	LWGR	925	1979	1983	1986



Source: World Nuclear Association

Figure 2 – Nuclear plant load factors.

Table 3 – Planned and proposed nuclear reactors in Ukraine. Source: WNA 2016.

Reactor	Type, V=PWR	MWe gross	Start construction	Start operation	Construction began
Khmelnytska 3	V-392	1000	9/85, 2015?	2019?	1986
Khmelnytska 4	V-392	1000	6/86, 2015?	2019?	1987
South Ukraine 4	?	1200	?	2020	
New unit		1200	?	2020	
Replacement 1		1000	2021	2026	
Replacement 2		1000	2022	2027	
Replacement 3		1200	2024	2030	
Replacement 4		1000	2027	2033	
Replacement 5		1000	2027	2033	
Replacement 6		1000	2028	2034	
Replacement 7		1200	2027	2033	
Replacement 8		1200	2028	2034	
Replacement 9		1000	2029	2035	

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NOTE: In this bibliography and throughout the text we use a simplified version of the US Library of Congress system of transliteration for Ukrainian and Russian sources into English.

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United States

Short Country Report

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Executive summary

This report belongs to a collection of 20 short country reports on the History of Nuclear Energy and Society (HoNESt, project Ref.662268). The reports tackle the complex sociotechnical system around nuclear energy. Nuclear developments, notably nuclear energy, are closely intertwined with social, economic, environmental, political and cultural spheres. Nuclear energy is also a globalized system involving transnational transfers of knowledge, materials, technologies, people and products including electrical power, medical elements, toxic wastes and other environmental hazards, materials, capacities and knowledge that must be carefully safeguarded. Nuclear energy is a complex social and technological phenomenon that influences societies but is also shaped by societies.

The short country reports are designed to assemble information and research results on the history of the relations between nuclear energy and society about all the different country cases in an accessible manner, and to document the findings with references.

The purpose of the country reports is threefold, addressing three different audiences:

1. to provide basic elements of narrative and analysis for further historical research by HoNESt researchers;
2. to provide information, context and background for further analysis for HoNESt's social science researchers;
3. to provide accessible information on nuclear-societal relations in the various countries for the purposes of outreach and communication with stakeholders (civil society, industry, associations, policy makers, journalists).

This report focuses on the history of the relations between nuclear energy and society in the United States. The US experience is crucial in the worldwide and European contexts for understanding public-industry interactions with nuclear power over time, and also how such issues as risk, safety, regulation, and others have evolved. As a leader in nuclear power, US developments are relevant for technology transfer, regulatory approaches, and safety-risk issues – even when it follows rather than leads in these areas. The United States, along with Russia, the United Kingdom, and others, was among the first nations to commercialize nuclear power,

beginning in the 1950s. Roughly one-quarter to one-fifth of all power reactors in the world were operated or are still operating in the US – currently 99 of them. Such US manufacturers as Westinghouse/Toshiba, General Electric, and Combustion Engineering have built or plan to build a large number of reactors in Belgium, Spain, and Brazil, China, South Korea, India, and elsewhere, with orders secured for the next ten years or so.

The US nuclear power program took off in an atmosphere of competition with the USSR. At first, reactor development unfolded in a number of national laboratories and remained largely secret to the public until the birth of the international "Atoms for Peace," an effort to share nuclear knowledge for medical, industrial, power production and other purposes to defuse growing Cold War tensions. In this environment the US government and its Atomic Energy Commission (AEC) pushed for rapid commercialization. The AEC moved ahead with certainty that it could manage the new technology. Yet the AEC kept a number of findings and reports including reactor safety studies out of public view, and later ones faced criticism for methodological and other shortcomings in these reports. (Gomberg, 1957; US AEC, 1957; US AEC. 1973; US NRC, 1975). Even recognizing the nascent stage of the industry and technology, the AEC engaged a series of *ad hoc* procedures when it initially considered construction and operating licenses. Its staff was small, often lacking specialists in important areas of nuclear physics, material science, hydrology, geophysics and so on. It often relied on industry for expertise. The result was the acceptance of designs that many in the public believed were not safe enough, and the siting of stations in unsafe areas or areas too close to population centers: a breeder reactor in Detroit, MI (Enrico Fermi), close to earthquake faults (Bodega Bay and Diablo Canyon, CA), and close to cities (Ravenswood in the Bronx, NY, and Indian Point, 65 km north of New York City, and many others). Ultimately, the AEC suffered from "agency capture"; it was beholden to the industry it was designated to regulate.

Anti-nuclear sentiment grew during the anti-war, environmental, civil rights and women's rights movements of the 1960s, triggered in part by the horrors of Vietnam and exposes on environmental degradation, especially the publication of Rachel Carson's *Silent Spring*. The passage of the National Environmental Protection Act (1969) contributed to this questioning, while the Freedom of Information Act (1966) enabled greater scrutiny of government action, including regulation of nuclear power. The publication of AEC documents, studies and deliberations led to a new, critical, and even untrusting relationship between the public and the nuclear industry.

To rebuild trust and ensure safety of the public, the government established the NRC in 1974 “as an independent agency” to ensure “safe use of radioactive materials” while “protecting people and the environment.” (US NRC. 2016a.) Yet ongoing mass protests over the licensing of the Diablo Canyon and Seabrook stations in New Hampshire suggested that oversight did not mean an end to public concerns. Costs increased rapidly as did time for licensing and construction, with two major bankruptcies (PSNH and WPPSS in Washington state known by some as “WHOOPS”), and power generation costs were much higher than predicted. (Mooz, 1979; Pope, 2008)

A partial meltdown at Three Mile Island (TMI) near Harrisburg, Pennsylvania, in 1979, persistent problems at the Davis-Besse NPP in Ohio, and other accidents and events have indicated that industry safety culture was too passive and that NRC supervisory functions have improved but were lacking in many ways. These conclusions come from the NRC itself and the GAO, not from outside public interrogators alone, and have unsettled the industry. (e. g., US GAO, 2006)

Yet public oversight and protest – so crucial in the 1970s, 1980s, and 1990s – waned as industry ceased building new reactors after TMI. The question is whether the public will become active again as the NRC begins to review licenses to prolong the operation of existing stations and as new applications to construct and operate are submitted to NRC offices in response to federal incentives to invest in nuclear power in the 2005 Energy Act. Industry is prepared for nuclear renewal with extensive research, PR, and other groups to educate the public about the benefits of nuclear power.

Public opinion about nuclear power has evolved over several periods, and even against a backdrop of concern, at times mistrust, and such accidents as TMI and Chernobyl, a majority of Americans until quite recently in the twenty-first century seem to have positive attitudes toward it.

1. Historical Context (Narrative)

1.1. Contextual narrative: Experts and the Public in the US in the Years of Nuclear Power

At the end of World War II, after the design and production of nuclear bombs at Los Alamos, NM, and the destruction of Hiroshima and Nagasaki in August 1945 with nuclear bombs, a debate broke out about how to control and manage nuclear technology. In the end, with the passage of the Atomic Energy Act of 1946 (the McMahon Act), the US government created the Atomic Energy Commission (AEC) to establish civilian control – not military – over this nuclear knowhow and technology. By the late 1940s and 1950s, a series of research programs using experimental reactors, isotopes, and the like established the likelihood of applications from power generation to medicine, industry, and agriculture, and to transportation that developed largely in AEC-controlled national laboratories. Yet from the start the AEC suffered from two weaknesses in the effort to promote nuclear power. One was that, at least initially, the AEC commissioners were fully beholden to military interests; the unfolding Cold War and fear of communism led to a headlong rush into designing and testing better nuclear weapons. The second is that the AEC was ultimately "captured" by the industry it was meant to regulate, and when it embarked on civilian power production this was reflected in a closed managerial style that was handicapped by the absence of sufficient internal expertise to ensure that reactor design and siting erred on the side of civilian safety. Procedures to enable public scrutiny toward the ends of safety and efficacy were absent. The AEC developed *ad hoc* procedures for dealing with new challenges and uncertainties (seismic concerns, LOCAs, and so on).

On December 8, 1953, President Dwight D. Eisenhower delivered his "Atoms For Peace" speech at the United Nations to balance fears of nuclear arms race with the hope of renewed interest in peaceful uses of nuclear power through the sharing of nuclear knowledge, knowhow and materials throughout the world. This led the House and Senate to pass the 1954 Atomic Energy Act to promote private development of nuclear energy, with the AEC providing a variety of incentives and, in the eyes of many critics, paying inadequate attention to various safety issues in the effort to promote nuclear power. As Mazuzan points out, the 1954 AE Act gave the private sector the right to own nuclear materials and operate its own nuclear facilities:

> Under the broad authority of the 1954 Atomic Energy Act, the AEC pursued a policy based on the premise that private industry could bring about economically competitive atomic power faster than a government-run program. This policy reflected the pro-business orientation of the Eisenhower administration. Success rested in large measure with AEC chairman Lewis L. Strauss, a strong-willed man with a remarkable talent for being constantly at the center of stormy controversy.(Mazuzan, 1980: 342)

Granted, safety problems became increasingly clear as reactor technology developed – and more complex as reactors grew larger in size, to 1,000 MW units and larger. Supervising the activities of the AEC was Congress's Joint Committee on Atomic Energy (JCAE) which was abolished in 1977 after the creation of the Nuclear Regulatory Commission in 1974.

A US post office stamp indicating the national message of "atoms for peace" (l); President Eisenhower speaking at the United Nations, December 1953 (r)

In January 1955 the AEC announced a Power Demonstration Reactor Program, "designed to open the way for American industry to develop, fabricate, construct, and operate experimental reactors." There were a number of promising reactor designs from Pressurized Water Reactors (PWRs) to Boiling Water Reactors (BWRs), to Liquid Metal Fast Breeder Reactors (LMFBRs), and different fuels including natural uranium, enriched uranium and plutonium. It was not clear that the PWR and BWR would become the mainstays of the industry. Throughout the demonstration program, from 1955 to 1963, the AEC offered funding to private companies for conducting research and development on proposed reactor designs; waived charges for the loan of source and special nuclear fuels for up to seven years; and provided free research and development in government laboratories for certain mutually agreeable projects.(Mazuzan, 1980: 343) This established a tradition of direct and indirect subsidies to the private sector industry that persists into the 2010s, for example through insurance.

The utilities, engineering firms and manufacturers in the US essentially decided upon two reactor types, PWRs (largely Westinghouse models) and BWRs (largely General Electric models). Both PWRs and BWRs use enriched uranium as fuel and water as both coolant and moderator, to slow down neutrons. The major difference between these two types of reactors is that the PWR has water at over 300°C under pressure in its primary cooling/heat transfer circuit, and generates steam in a secondary circuit while BWR makes steam in the primary circuit above the reactor core" (CLP, 2013)

Insurance and Indemnity

To encourage industry to join in on the AEC reactor push, the US Congress passed the Price-Anderson Act (1957) with a limit on liability of $560 million. The industry was required to obtain as much insurance as the private insurance pool would provide and the federal government would provide the rest of the insurance up to a maximum amount of $500 million. Since the private insurance companies were willing to put up only $65 million, a tiny sum compared to the damages that might result from a meltdown, the federal government determined to pick up the rest. Critics of the proposal pointed out that, not only would the public taxpayer be paying for private industry's insurance, but that the limit might leave thousands of victims unindemnified in case of a catastrophic accident (see Reactor Accident Safety Studies, Appendix 5 below), and the public (through the US government) would be responsible for any further cleanup and other costs.[1]

In simple terms, Price-Anderson covered a 10-year term. All stakeholders hoped that during that ten-year period the industry would gain experience, that the problems of reactor safety would be

[1] A legal specialist on nuclear energy noted approvingly that "considerable talent and time were spent in drafting the Price-Anderson Act, and it seems to have accomplished its primary purpose of encouraging private enterprise in the field of atomic energy by providing protection from the danger of financial ruin."(Bangs, 1961: 1180-81)

to a great extent solved, and also that the insurance industry would develop experience on which to base a strong program of their own. Since 1957 the Act has been extended several times, most recently in the Energy Policy Act of 2005 that extended it through December 31, 2025, and offers the nuclear power industry roughly $12 billion in liability insurance protection to compensate the public in the event of a nuclear accident.

As an anti-nuclear specialist pointed out in 1965, Price-Anderson enabled a significant and direct government subsidy to the industry. He suggested that the AEC suppressed a study it commissioned by Brookhaven National Laboratory specialists to complete on reactor accidents and insurance. This report, called WASH-740, considered the effects of a "maximum credible accident," at 3.400 fatalities, 43,000 radiation injuries, and $7 billion property damage spread over an area of 150,000 square miles (perhaps $55 billion in 2016 dollars). (Pesonen, 1965: 242-244)

Financial Challenges to the Nuclear Industry and Growing Costs

Subsidies to the industry through Price-Anderson, rate hikes awarded before power generation, and other considerations have helped the nuclear industry. Yet cost overruns have plagued it. There is a lot of debate about the true costs of nuclear power (capital costs, fuel costs, operating costs, waste management costs) compared to other forms of energy production. But the fact remains that nuclear reactors cost on the average in the 2010s $6 billion per 1,000 MW installed, and since the first station was built not one has come in under its initial cost estimates, although the Russian company, Rosatom (see Russian country report) intends construction at significantly lower costs for current projects. The efforts of industry and regulatory agencies to speed the introduction of nuclear power and fulfill the promise of low costs failed. In 1969, nuclear plants projected for completion in 9 years were expected to cost about $226 per kilowatt hour. In 1978, with an anticipated 12-year construction period, estimates increased to $1,648 per kilowatt hour. (Nelkin, 1981: 132; Mooz, 1979)

One of the greatest failures in this environment of growing costs – and skyrocketing cost uncertainties – involved the Washington Public Power Supply System (now Energy Northwest), a public power joint operating agency formed in 1957 to produce at-cost power for northwest utilities. WPPSS became commonly known as "Whoops" due to its over-commitment to build five large nuclear power stations in the 1970s which brought about its financial collapse and the second largest municipal bond default in U.S. history. (Pope, 2008)

The Energy Policy Act of 2005 offered extensive subsidies for nuclear power and other alternatives to fossil fuels. It offered billions of dollars in tax credits, and loan guarantees for advanced nuclear reactors or other emission-free technologies up to 80% of the project cost, $2 billion in insurance to cover licensing delays to the industry, extension for 20 years of the Price Anderson Act for nuclear liability protection, and support for advanced nuclear technology. Opponents of these costs question subsidization of such an industry in a free market economy. Yet there appears to be great support in Congress for the industry in spite of the history of cost overruns. (Alexander, Whitehouse, 2016)

Experts, the Public and Decision Making in Nuclear Power

How did the nuclear energy industry acquire such great strength and the ability to construct over 100 reactors given these cost and other considerations? Granted, nuclear power stations generally operate within accepted parameters, although there have been significant dangerous incidents and accidents at Fermi NPP, TMI, Browns Ferry, and Davis-Besse as described in this report. One explanation for the strength of the industry is the special prestige of scientists owing to their success in the Manhattan Project and their role in the unfolding Cold War military-industrial struggle with the USSR. Scientists generally played a major role with little public concern about their power and influence in federal agencies in technology assessment until the 1970s. Then, scientific and technological debates widely entered the public sphere and scientists themselves were subjected to great scrutiny for their views. A variety of industries introduced their own experts to influence debates over technology and safety at this time, and as has been demonstrated in some cases used their experts to subterfuge the truth and mislead the public about climate, sweeteners, and tobacco. (Conway, Oreskes, 2010)

As Balogh shows for nuclear power, at first civilian officials and experts in the AEC and JCAE in Congress successfully pushed the nuclear agenda without public intercession. Government officials and scientific experts desired nuclear power, if consumers did not and private companies were not interested in building expensive reactors against financial and scientific uncertainties. This required government officials to be salespeople who advanced arguments about national security and who convinced Congress to provide a variety of expensive direct and indirect subsidies. Further, in the 1970s, as more and more experts and groups entered controversies over nuclear power, citing, safety and so on, the public grew restive and confused, and this contributed to the decline of nuclear power by effectively tarnishing the reputation of experts. (Balogh, 1991) Balogh concludes that government officials must open the policy-making process fully in the early stages and "test for demand rather than seek to create it artificially"(Balogh, 1991: 326).

In his analysis, similarly, Stever called for greater openness and for the involvement of the public early on in technology assessment. He argued, for example, in nuclear power that station siting issues should be made publicly and early on, not after a utility has invested a great deal of time and money to justify a site. He demonstrated clearly that the NRC routinely licenses plants on extremely thin financial, safety, and environmental evidence. For Seabrook NPP neither state nor federal environmental review had a significant impact on the choice of sites or the range of alternates considered. As others have noted, the NRC all too often and in this case accepted the utility's safety information on faith since it lacked capability to make independent evaluations. Stever concluded that time-consuming licensing processes were more the result of the NRC's inefficient way of doing business, not the product of environmentalist delay tactics. All of this called for a more independent and objective NRC. (Stever, 1980: 168).

In a study of opposition to Diablo Canyon, Wills argues that antinuclear activism in California reflected more concerns about "about human ties with nature" than East-West competition (Wills, 2006: 9). This antinuclear activism was splintered, not hegemonic, for example, with disputes over the Sierra Club executive board's initial decision to endorse PG&E's selection of the Diablo site as a way to protect other pristine nature. (Later, worries about seismic faults and TMI turned the Sierra Club away from nuclear power; in 2018 the Sierra Club remains strongly opposed to nuclear power.) Wills illuminates the mass demonstrations of two groups, the Mothers for Peace and the Abalone Alliance, who were certainly motivated by pacifism and counterculturalism, but whose environmentalism was crucial to their mobilization against nuclear power. Wills also demonstrates how not only inept regulation, corporate mismanagement, and rising construction costs led to the decline of nuclear power in California, but also how these groups and other citizens used local and state agencies to block projects. Ultimately, their activities contributed to the creation of the antinuclear California Energy Commission in 1974 and to the passage of antinuclear state level legislation in 1976. The struggle for a clean, healthy environment was most important among the middle-class and well-educated members of the struggle. (Wills, 2006)

1.2. Presentation of Main Actors: US Nuclear Industry and Society Actors

Government

AEC (Atomic Energy Commission) → NRC (Nuclear Regulatory Commission w/ large staff and 5 commissioners). See Appendix 4, country report, for NRC Organizational Structure

- Atomic Energy Acts of 1946 and 1954
- 1955 Power Demonstration Reactor Program
- AEC → NRC in 1973-74

JCAE (Congress's Joint Committee on Atomic Energy)

The JCAE, created by the AE Act of 1946, combined legislative powers with exclusive access to the information, much of it secret, upon which its own often secretive deliberations were based. The JCAE was also entitled by statute to be kept "fully and currently informed" of all AEC activities and vigorously defended its prerogatives. The JCAE was abolished in 1977, three years after the replacement of the AEC by the NRC. In the 1950s the JCAE leadership often came into conflict with the AEC over its own secrecy, for example a new program to push NPPs under AEC chairman Lewis Strauss.

DOE (Department of Energy, grew out of separation of AEC regulatory and promotional responsibilities)

DOE and DOD national laboratories (budget allocations in 2015):

Lawrence Berkeley National Laboratory, Berkeley, California	$570 million
Los Alamos National Laboratory, Los Alamos, New Mexico	nearly $2 billion
Oak Ridge National Laboratory, Oak Ridge, Tennessee	about $1.1 billion

Sandia National Laboratories, Albuquerque, New Mexico	$1.8 billion
Idaho National Laboratory, Arco and Idaho Falls, Idaho	$950 million
Lawrence Livermore National Laboratory, Livermore, California	$1.2 billion
Savannah River National Laboratory, Aiken, South Carolina	$1.4 billion
Pacific Northwest National Laboratory, Richland, Washington	$500 million

(DOD) Department of Defense

The US maintains roughly 1,500 nuclear weapons. According to its The 2010 Nuclear Posture Review (NPR, April 6, 2010), its goals are to prevent nuclear proliferation and terrorism; reduce the role of nuclear weapons; Maintaining strategic deterrence and stability at reduced nuclear force levels of its nuclear triad of bombers, submarines and missiles; strengthening regional deterrence and reassurance of U.S. allies and partners; and sustaining a safe, secure, and effective nuclear arsenal.

The US has spent almost $9 trillion on nuclear weapons, a figure makes the stated goal of "non-proliferation" unfathomable.

EPA (Environmental Protection Agency). Regulators.

GAO (General Accounting Office). Investigations of government bodies and their compliance with their statutory responsibilities.

Industry Actors

The US nuclear industry consists of major manufacturers of reactors, operators and owners, and the NPPs. See appendix 4 (p. 49) for a list of these operators, owners, and holding companies of NPPs.

Major US Reactor Manufacturers

General Electric/Hitachi

Westinghouse

Babcock and Wilcox

Fuel Suppliers

Urenco USA

USEC (Centrus)

GLE (Global Laser Enrichment)

Current Major US Nuclear Operators and Owners

Entergy Operations Inc.

FirstEnergy Nuclear Operating Company

Exelon Generation Company

Luminant

PG&E

WPPSS

TVA

Duke Energy Progress

NRG Energy

NextEra Energy

The Public

NGOs

Sierra Club

NRDC

UCS

Unions (laborers)

Protest Organizations and Anti-nuclear Groups. See Appendix 2 for a partial list of these groups.

Individuals

The Media

Newspapers

Radio

TV

Press centers, public information offices

PR offices

Independent journalists

Documentary makers

Academics

NGOs

Filmmakers

“Webpages” from a variety of different sources

1.3. Actors: Narrative Discussion

The main supporters of nuclear energy in the United States are government bureaucracies including the Department of Energy and the Nuclear Regulatory Committee, the latter which, however, is responsible for oversight and regulation, not promotion, and such government laboratories long connected with military as well as civilian tasks as the Oak Ridge, Los Alamos, Livermore, Hanford, and Idaho; private companies including reactor manufacturers, utilities, operators, and owners; and trade associations representing the industry including the National Energy Institute.

The DOE has several offices and programs connected with nuclear issues (military, security, proliferation, energy, fission and fusion). “The Office of Nuclear Energy’s (NE) primary mission is to advance nuclear power as a resource capable of making major contributions in meeting our Nation’s energy supply, environmental, and energy security needs. We seek to resolve technical, cost, safety, security and regulatory issues through research, development and demonstration. By focusing on the development of advanced nuclear technologies, NE supports the Administration’s goals of providing domestic sources of secure energy, reducing greenhouse gases, and enhancing national security.” The NE budget in 2015 was $914 million. In addition, some twenty laboratory and technical centers are connected significantly with nuclear energy and/or with nuclear weapons. The DOE budget for various US laboratories, some of which are run by private corporations, others by universities, and still others are federal, was roughly $30 billion in 2014. (Some of these laboratories and programs are quite small, others very large. See US DOE 2016a.)

The Nuclear Energy Institute has roots to several groups from the 1950s, but was founded in 1994 from the merger of the Nuclear Utility Management and Resources Council (NUMARC), the U.S. Council for Energy Awareness (USCEA), which conducted a national communications program, the American Nuclear Energy Council (ANEC), which handled governmental affairs, and the nuclear division of the Edison Electric Institute which handled issues involving used nuclear fuel management, nuclear fuel supply and the economics of nuclear energy.

Proponents and Opponents

Generally speaking, supporters of nuclear energy emphasize the facts that nuclear power will help secure US energy independence; does not produce greenhouse gases that contribute to global warming; is a proven technology whose next generation of reactors are, or will be almost inherently safe; and is crucial to provide base load for energy demand into the 21st century. They argue that NPPs operate as intended. Those who support nuclear power include such groups and individuals as utilities, manufacturers, trade associations, state and national representatives, and members of the public.

Those who oppose nuclear power, or at least call for greater circumspection concerning its further development, include such scientific organizations as the Union of Concerned Scientists (UCS), and a wide range of citizen-led ad hoc and formal groups. Opponents note that nuclear power is more costly than supporters contend, indeed has a history of cost overruns; may be risky, certainly more risky than supporters admit; they note that in the case of a catastrophic accident, people and property may be damaged, and timely evacuation will be nearly impossible; and they point out that no long-term solution for the large quantities of high level radioactive waste and spent fuel that occupy the nation's NPPs has been found. They also note the practice of siting stations near population centers may save costs for infrastructure and transmission of electricity but opens millions of consumers precisely to the risk of accidents. Finally, they observe the industry has a less stellar record of operation than industry contends.

According to one analysis, several images frame attitudes toward nuclear power. A prevailing view among proponents suggests that nuclear energy represents progress with its promise of clean energy, efficiency and "technofixes" with their implicit rejection of Luddism. An opposing position finds that nuclear technology leads to the destruction or disruption of nature. This framing plays out in media which are crucial in the construction of public understandings with their images, meanings and messages set forth in TV, newspapers and journals, cartoons, and opinion columns. (Gamson, Modigliani. 1989) The framing is directed toward a potentially confused or uneducated public, perhaps even towards those with dangerously anti-American sentiments. For example, protestors against construction of a reactor at Bodega Bay were equated by the utility PG&E with communists. (Walker, 1990). In his study of opposition to Diablo Canyon, Wills argues that antinuclear activism reflected more concerns about "about human ties with nature" than East-West competition or anger over big government. (Wills, 2006: 9).

Spencer Weart points out that in the mid-1960s American agencies and corporations made twice as many films about reactors and three times as many about safety and environment as in the preceding five years. In the 1960s roughly 40 million people attended AEC film screenings and many times more watched at home on TV. Weart writes, "The result was less to excite the public about AE than calm them. The films toned down the utopian promises of 1950s films," focusing on electrical energy rather than on "medical and agricultural fantasies." (Weart, 1988: 299) Among the AEC films of the 1950s included "Power and Promise: The Story Of Shippingport Nuclear Power Plant,"[1] "Nuclear Energy Goes Rural," "Atomic Venture," "Atomic Power Today: Service with Safety."

A shaded dualism with images of instantaneous, enormous destruction, and Frankensteinean futures vying with those of the peaceful, powerful atom as protector and as benevolent (utopian) servant characterize the period from Hiroshima to the 1960s. The rise of anti-nuclear discourse characterizes the period from the 1970s to TMI, with the hegemony of the vision of progress destroyed. While nuclear was connected to energy independence from OPEC oil, fear of proliferation led to attacks on nuclear power, notably in President Jimmy Carter's rejection of the US LMFBR. Such anti-nuclear groups raised public awareness of safety issues at the time: Friends of the Earth, Critical Mass, and the UCS. (Gamson, Modigliani. 1989)

The relatively litigious American legal and administrative system permits interveners to exert influence on the technology assessment process. Building on the anti-war and environmental movements of the 1960s, and especially since the 1970s, the establishment of the Environmental Protection Agency, the Occupational Safety and Health Administration, and other regulatory and safety bodies, many American citizens have sought to participate in the regulatory process directly through petitions and lawsuits. They have also turned to protest and the organization of NGOs to pursue their goals (see case studies on Diablo Canyon and Seabrook). At first the public enunciated little concern about atomic energy. But when the atom was tied to concerns about weapons testing and fallout, then worries grew. One poll published before 1962 (in 1956) showed 69% of Americans had no fear of having a plant located in their community. (Erskine, 1963)

The picture changed with TMI and Chernobyl, with ubiquitous visions, especially for the Chernobyl accident, revealing great and persistent dangers. The authors conclude that media discourse provides

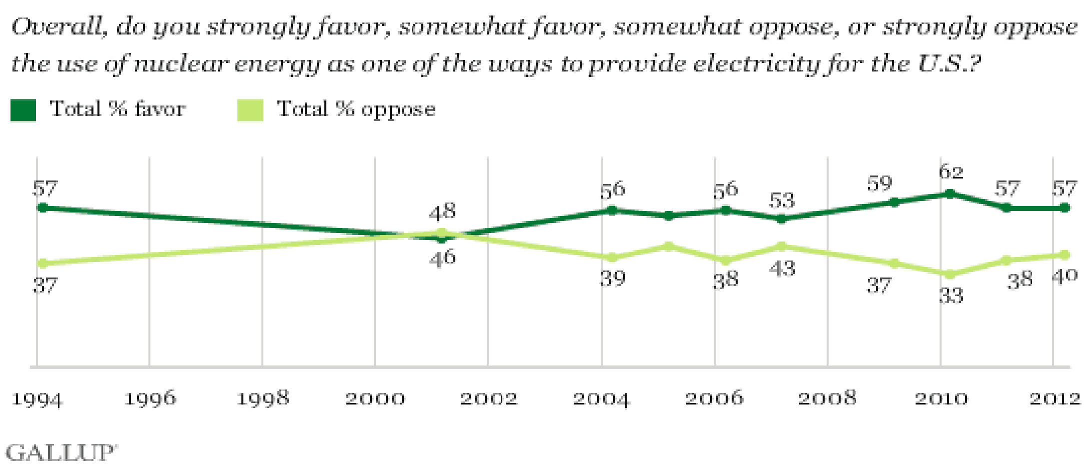
> …an essential context for understanding the formation of public opinion on nuclear power. More specifically, it helps to account for such survey results as the decline in support for nuclear power before Three Mile Island, a rebound after a burst of media publicity has died out, the gap between general support for nuclear power and support for a plant in one's own community, and the changed relationship of age to support for nuclear power from 1950 to the present. (p. 1)

A number of NGOs have engaged in protest against nuclear power, many of which have multiple concerns and foci: the Sierra Club, the Riverkeeper, the Union of Concerned Scientists (UCS), the latter “founded in 1969 by scientists and students at the Massachusetts Institute of Technology.” According to UCS, “That year, the Vietnam War was at its height and Cleveland’s heavily polluted Cuyahoga River had caught fire. Appalled at how the U.S. government was misusing science, the UCS founders drafted a statement calling for scientific research to be directed away from military technologies and toward solving pressing environmental and social problems.”(UCS, n. d.) For their part, the nuclear industry and US government bodies have sought to engage the public over the benefits and safety of nuclear.

The investigative arm of the Congress, the Office of Technology Assessment (OTA) that might have provided Congress with important, unbiased input on energy policy generally and nuclear power and climate change specifically, was destroyed by Speaker Newt Gingrich in part because of its independence and objectivity. During its years of operation (1972 – 1995) OTA studied over 750 studies that begged for objective, non-partisan critical understanding, many in the nuclear area. In 1984 OTA published *Nuclear Power in an Age of Uncertainty* that considered “Public Attitudes Toward Nuclear Power.” The study noted that “public attitudes toward nuclear power have become increasingly negative over the past two decades, with the most recent polls indicating that a slight majority of Americans opposes further construction of reactors.” In the 1950s pollsters hardly studied the issue, while in the 1960s several opinion polls noted that less than a quarter of the public opposed nuclear power. In the 1970s substantial majorities of the public still favored nuclear power, even as anti-nuclear referenda appeared on ballots in eight States. The accident at TMI led to a sudden decease in the percentage of people who had been in favor of or uncertain about continued construction of reactors, with the percentage opposed increasing. Polls since mid-1982 indicated a slow erosion in support for nuclear power with over 50 percent opposed, and a large majority opposed to the construction of new plants in or near their communities. Nuclear was even less appealing than offshore oil drilling and coal plants, nuclear is now the least favored alternative. In spite of a majority finding nuclear power as potentially unsafe, many people saw it as a solution to the country's long-term energy problems, and the majority rejected a halt to new construction or a permanent shutdown of all operating reactors. (OTA, 1984: chapter 8)

According to the Gallup polling organization, nuclear power seemed fully to recover its standing among citizens in the 1990s and 2000s, with those in support of maintaining nuclear energy in a strong majority, even after the Fukushima disaster until 2016. (Newport, 2012, Reffkin, 2016). See table 1.

Table 1. Support for Nuclear Power Among US Citizens, 1994-2012



Source: (Newport. 2012.)

Media actors – those people who work for or direct newspapers, radio and television, press centers and public information offices, films and documentaries – have an important presence in the history of nuclear power in the US. They have been central in informing the public and shaping attitudes at the early stages of the "peaceful atom" (Boyer, 1985; Weart, 1988); in reporting on the history of the industry, licensing, and regulation; and in presenting particular messages from industry, government, and NGOs. One could argue that the ultimate “openness” of the US system enables a high degree of public participation in the technology assessment process and enables usually better outcomes in the technologies promoted and defused, including nuclear technologies.

2. Showcase: Early Demonstration Projects: From Nuclear Utopianism to Public Concern

Against this regulatory and financial backdrop, the construction of nuclear power stations moved forward in the United States. Given its mandate, the AEC worked to promote a number of demonstration plants that indicated the promise of nuclear power. Along with successes at Shippingport, there were great failures at Fermi, Bodega Bay, and Ravenswood.

The first commercial NPP in the United States to use nuclear energy was the Shippingport Atomic Power Station of the Department of Energy and the Duquesne Light Company, not far from Pittsburgh on the Ohio River. In a dramatic high-tech display, ground was broken in 1954 during dedication ceremonies by President Dwight D. Eisenhower, who also opened it on May 26, 1958, as part of his “Atoms for Peace” program. The reactor plant was designed by the Westinghouse Electric Corporation in cooperation with the Division of Naval Reactors of the Atomic Energy Commission, as a large-scale light water reactor for a proposed aircraft carrier (Hewlett, Duncan, 1974); Westinghouse rapidly became a world leader in nuclear power.

The first power at Shippingport was produced on December 18, 1957, and was fed into the grid for the Pittsburgh area; it was 68,000 kW – or one-sixteenth the size of today’s reactors. The design of the power plant was again altered in 1977, when the core was changed to a light water breeder reactor (LWBR). A breeder reactor uses both thorium and uranium as a fuel source. As the reactor consumes uranium, it produces more uranium from thorium as a by-product. The reactor is designed to produce more uranium than it uses, allowing the plant to use thorium, which is a cheaper and more abundant fuel source. (ASME, n. d.)

Another early project, Dresden 1, the first privately-financed NPP, was activated in 1960 and retired in 1978. It is a GE BWR (like those at Fukushima), and it was fraught with operating problems. Operating since 1970 are Dresden units 2 and 3 with GE BWRs. Its licenses were extended in 2004 from 40 to 60 years. Tritium leaks into surrounding groundwater plague the NPP.(US NRC, c.2004) Between the 1970s and 1996, Dresden was fined $1.6 million for 25 incidents.

Ravenswood, Queens, NY, 1962

In the early years of nuclear power, utilities and regulators rarely gave a second thought to the possibility of siting an NPP in an urban area. The goal was to build close to demand and keep transmission and infrastructure costs down. Yet "organized resistance" to nuclear power plants emerged in New York, California and elsewhere over plans for such NPPs. One of the first controversies concerned the application of the Consolidated Edison (ConEd), Inc. – one of the largest investor-owned electrical companies in the US that provides electricity to New York City, to build a 1,000 MW NPP in Ravenswood, Queens, only two miles from the UN. A former chairman of the AEC, David Lilienthal, said, "I would not dream of living in the borough of Queens if there were a large atomic power plant in that region, because there is an alternative — a conventional thermal power plant as to which there are no risks." The group "CANPOP" -- Committee Against Nuclear Power Plants -- formed to protest. ConEd's Ravenswood application made the AEC consider more systematically whether to permit the construction of nuclear power plants in large cities. Eventually ConEd withdrew its application for a construction permit. (Mazuzan, 1986)

(l) ConEd's proposed Ravenswood NPP on the Queens waterfront; (r) the Ravenswood application to the AEC drew significant protest.

Bodega Bay

Another early project that triggered anti-nuclear protest – and demonstrated the AEC's weaknesses in assessing risk and safety without internal experts – was the request of Pacific Gas and Electric Company (PG&E) in 1963 for a permit to build a 340 MW nuclear plant at Bodega Head, about 50 miles north of San Francisco. PG&E originally thought of a thermal station but jumped on the nuclear wagon to meet regional rapid growth in population and energy demand that required new capacity of some sort. Opponents initially opposed the plan to preserve the natural beauty of the oceanfront site for parkland. They uncovered a more serious issue that ought to have disqualified the site: the discovery of a geological fault not far from the station. PG&E for its part had already begun excavation of the site. The Bodega Bay NPP proposal, therefore, was crucially important in placing before the AEC the issue of earthquakes and reactor safety. Eventually, since the AEC could not approve the site as seismically stable with certainty, PG&E withdrew its application.

Public involvement was crucial here. By December 1963 the Northern California Association to Preserve Bodega Head and Harbor had grown to about 800 members who opposed the station. Many people believe its success had much to do with the efforts of its executive secretary, David Pesonen, a man who wrote extensively, including an editorial critical of Price-Anderson in *New Republic* in 1965. Pesonen worked at the Sierra Club and represented it at hearings on Bodega Bay at the California Public Utilities Commission. Personen noted that the reactor would be only a few hundred feet of the San Andreas fault, and even PG&E experts admitted that a major earthquake like the 1906 San Francisco earthquake was possible within a century. Yet those experts believed that they could build an NPP to withstand an earthquake of major proportions and insisted on the "absence of active faults." (Walker, 1990) As protests grew, PG&E played hardball accusing the association of being a communist front organization.

PG&E developed a reactor design "on a base of special sand and allowed three feet of clearance between the reactor's walls and the side of the hole it would sit in." Shockingly, until this time the AEC had no seismologists on staff. The March 1964 Alaska earthquake, at 8.6 the largest in North America ever recorded, created more discussion and concern about the design. Finally, in October 1964, the AEC released its findings that PG&E had tried to engineer suitable protection in reactor containment structure in the event of an earthquake, but that the designs were unproved and untested, and PG&E withdrew its application and canceled plans for the plant, turning instead to a site closer to Los Angeles for its Diablo Canyon NPP.(Walker, 1990; Pesonen, 2013)

Indian Point NPP

Once the AEC turned down ConEd's request to build an NPP in Queens, NYC, ConEd proceed with plans to build at Indian Point, on the Hudson River, only 65 kilometers by car from Manhattan and the largest metropolitan area in the US – and 50 kilometers as the crow flies. After the Fukushima disaster, the US Embassy recommended that all Americans within 50 miles leave the area. If the same parameters were used in a meltdown accident at Indian Point, 20 million people might have to leave – an impossibility. The population density around the station is 2,100/square mile, the highest for any US NPP.

Indian Point is probably the most poorly operated and dangerous NPP in the US as has been documented extensively in the *New York Times* (New York Times, 1983). From initial planning in the early 1950s to construction in the 1960s, to the shut down of unit one, to cost overruns even before construction, to the ongoing farcically and tragically unsafe operation of units 2 and 3 – two 1,000 MW Westinghouse PWRs – that Entergy, which bought the plant from ConEd, has petitioned to keep open to 2029 for one unit and 2031 for the other, Indian Point is miserable way to run a business, let alone an NPP. Governor Andrew Cuomo wants to close Indian Point.

Recent accidents – some of which appear to be caused by malfeasance – give a sense of the serious problems that continue to plague the Indian Point NPP. (UCS, c.2015) In May 2015, an electrical transformer at Unit 3 exploded, causing water to flood a room where electrical distribution panels are housed, and pouring 3,000 gallons of oil into the Hudson River; threatening a station blackout. In February 2016 radiation levels at three monitoring wells around the plant spiked by 65,000%, although the power company claimed there was no danger to the public. In March 2016, during refueling, a breaker tripped and cut power in one of the reactors; when the diesel generators kicked in, they died while trying to restart the first electrical system. Fortunately a second backup worked. Also in March, a special inspection of unit 2 found that 27.5% of the stainless steel bolts needed to channel cooling water through active nuclear fuel rods were broken, distorted or "missing" entirely! A series of unplanned shutdowns plague the station. Finally, the heated effluent water – up to 2.5 billion gallons a day – kills about 1 billion fish and other aquatic organisms a year. (Thielman, 2016)

Reactors 2 and 3 remain open in part because of a regulatory failing: so many complaints called "contentions" have been filed with the NRC that the station is allowed to operate until it can respond to all the grievances as part of its relicensing process. Thus, three weeks after the water leak, the NRC approved Entergy's request, made several years prior, that it be allowed to perform a comprehensive leak test every 15 years, rather than every 10. According to Edwin Lyman, a senior scientist with the Union of Concerned Scientists, the license-renewal process itself risks public safety in that it "was designed to limit the scope that could be considered, specifically the ability of the public to intervene" by requiring stations to address "contentions" by showing the operator has a plan to correct a specific problem. (Thielman, 2016)

The significant number of serious accidents and "contentions" led an NGO dedicated to the health and safety of the Hudson River, Riverkeeper, to push to shut down Indian Point NPP. Riverkeeper offered ten reasons to close Indian Point including seismic risks, exemptions for safety rules, a weak evacuation plan, a threat to NYC's water supply. A series of incidents – and major accidents – which indicates the challenges faced in mastering nuclear technology, assuring the public about safety, and the risks that are revealed in station operation that may begin from the mundane and move quickly to a near catastrophe.

Brown's Ferry, Alabama (1975)

An accident at Brown's Ferry in 1975 indicated the precarious nature of public safety in such a regulatory environment. A fire at Brown's Ferry took hours to put out, showed fire hazards everywhere, but no fire suppression equipment, and even malfunctioning emergency telephones, all of which came close to creating a LOCA.

At noon on March 22, 1975, both Browns Ferry Units 1 and 2 at the NPP were operating at full power (1,100 MWe each) to the Tennessee Valley Authority. (Comey, 1976) Two electricians were trying to seal air leaks in the cable spreading room below the control room, through which the electrical cables that control the two reactors run, and the reactor building. They used spongy foam rubber to seal the leaks. They used candles to determine whether or not the leaks had been successfully plugged -- by observing how the flame was fluttered by escaping air. The electrical engineer put the candle too close to the foam rubber, and it burst into flame. He tried "to extinguish the fire by beating out the flames with a flashlight and by smothering [it] with rags." The other worker returned with a fire extinguisher, and it failed to stop the flame, too. They went to the reactor

More Detail on the Tragedy of Mistakes

At Brown's Ferry Unit 1, a March 22, 1975, fire disabled a large number of engineered safety systems at the plant, including the entire emergency core cooling system (ECCS) on Unit 1, and almost resulted in a meltdown accident. Beginning at 12:55, the electrical supply was lost both to control and power the ECCS core spray system was lost; the low-pressure ECCS was lost; the reactor core isolation cooling system was lost; and most of the instrumentation which tells the control room what is going on in the reactor was lost. Some of the shutdown equipment began failing on Unit 2, and the high-pressure ECCS was lost at 1:45 pm. Control over the reactor relief valves was lost at 1:20 pm and not restored until 2:15 pm, at which time the reactor was depressurized by using the relief valves and brought under control.

With all ECCS systems lost, decay heat in the reactor core forced water temperature to rise and core pressure rose to the relief valve set points. In its report on the cause of the fire, the TVA stated: "The material ignited by the candle flame was resilient polyurethane foam. Once the foam was ignited, the flame spread very rapidly. After the first application of the CO_2, the fire had spread through to the reactor building side of the penetration. Once ignited, the resilient polyurethane foam splattered as it burned. After the second extinguisher was applied, there was a roaring sound from the fire and a blowtorch effect due to the airflow through the penetration." The report continued, "The airflow through the penetration pulled the material from discharging fire extinguishers through the penetration into the reactor building. Dry chemicals would extinguish the flames, but the flame would start back up." (Tennessee Valley Authority, 1975: 14-15)

building to use extinguishers from the opposite side. They notified the shift engineer only 19 minutes later, by which time thick, dense smoke hindered efforts. The control panel began to malfunction as did Unit 1 pumps. After the power level on the Unit 1 reactor began to drop inexplicably, the operator started to reduce the flow of the reactor's operating pumps; when the pumps suddenly quit at 12:51, he finally shut the reactor down by inserting the control rods. That is, Unit 1 was scrammed at 31 minutes and unit 2 at 40 minutes.

The fire department was called only 49 minutes after ignition, it arrived 85 minutes after ignition, but was not given permission to use water, only dry suppression, and it was not admitted to the station for 15 minutes. Almost seven hours after ignition the Athens Fire Department finally received permission to use water but interior hose line and nozzle was inadequate to reach the burning cable trays. About 1,815 kg of PVC burned releasing 645 kg of toxic chloride gases into the reactor building.

As the NRC report on the incident noted,

> The Browns Ferry Nuclear Plant Emergency Procedure lists two different telephone numbers to be used in reporting a fire, one in a table of emergency numbers and the second in a test of the procedure. The appropriate number (299) is the one in the test; dialing this number automatically sounds the fire alarm and rings the Unit 1 operator's telephone. The Emergency Procedure was not followed by those involved when reporting the fire. The construction workers first attempted to extinguish the fire, whereas the procedure specifies that the fire alarm be sounded first. The guard reporting the fire telephoned the shift engineer's office rather than calling either of the numbers listed in the procedure. (Comey, 1976)

The use of polyurethane foams to plug leaks and polyvinyl chloride cable was a mistake in itself because the nature of the material. Also, the “lack of qualified, experienced, fire protection staffing contributed to the conditions which resulted in a direct loss of $10 million and an indirect loss of $30 million related to business interruption.” “Poor design, fire detection and fire suppression provided only on a partial or limited basis; use of polyurethane; no management interest in fire safety” all of which nearly led to a meltdown. (Pryor, 1977)

3. Events

The following five events largely cover the history of commercialized nuclear power in the United States, from nascent efforts of the AEC to push nuclear power in the 1950s, to the efforts of the NRC to regulate and ensure the safety of a mature industry in the twenty-first century. The latter is occurring against the backdrop of aging reactors yet determination of industry and regulators to extend the operating licenses of NPPs. Indeed, in December 2016 two US Senators called for consideration of ways to extend licenses within safety parameters to permit operation to 60 and up to 80 years as a way to slow global warming. (Lamar Alexander, Sheldon Whitehouse, 2016)

The events also permit analysis of the evolution of protest about nuclear power, from concern within the industry about the nature of risks, accident probabilities, and appropriate regulatory framework to ensure safe operation, to public protest over siting, emergency evacuation, and costs. The events similarly permit examination of the role of experts in technology assessment in democratic society, as well as the rights of citizens to intervene in legal and regulatory processes. These events permit fuller comprehension of the evolving attitude of the public toward nuclear power and of the secrecy that sometimes characterized the deliberations of the industry and its regulators. The events include two mass public protests. Finally, the events include the Three Mile Island accident and an effort to understand both the cause of the accident and the nature of the response of local, state and national emergency response personnel and regulators.

3.1. Event 1: Licensing and Operation of Enrico Fermi (Detroit) Breeder Reactor

The Enrico Fermi Atomic Power Plant, Unit 1, located in Monroe County, Michigan, near Detroit, was an LMFBR, designed for 430 MW, although the maximum reactor power with the first core loading was 200 MW. It suffered a meltdown in 1966 that made the reactor inoperable and endangered millions of people. The accident was kept secret at the time.

The Atomic Energy Commission, encouraging at every step the entry of a nascent nuclear power industry, facilitated the licensing of “Enrico Fermi,” although the LMFBR, as an industrial prototype, was untested. In January 1955 the AEC announced a Power Demonstration Reactor Program, “designed to open the way for American industry to develop, fabricate, construct, and operate experimental reactors." (Mazuzan, 1982: 343) Prior to the construction and licensing of "Enrico Fermi" the US Congress passed the 1957 Price-Anderson Act to limit the liability of the nuclear industry to $560 million. (Bangs, 1961; Pesonen, 1965). The result was a rush to bring such NPPs into operation as Shippingport, PA (1958), Dresden (1960), and Fermi (1966).

Detroit Edison formed the Power Reactor Development Company (PRDC) to move Fermi ahead. In the late 1950s the United Auto Workers (UAW) union brought a lawsuit to halt construction because of safety concerns, and lost eventually in the US Supreme Court, with 7 of the 9 judges siding with PRDC. Other public concern was limited by AEC secrecy. (US SC, 1961)

Main Actors	The AEC, through its promotional activities, provision of materials, equipment, knowledge and uranium fuel; industry, through a not-for-profit corporation, the Power Reactor Development Company (PRDC) that sought to build a breeder reactor near Detroit; workers associated with the construction of the reactors and their union representatives; media reporting on the Enrico Fermi reactor; and the courts who evaluated whether the AEC and PRDC had moved from permit to construction according to correct administrative procedures were involved in this event. Through less-than-opaque review procedures and secrecy, the AEC kept its review of safety and other issues out of public scrutiny.
When and where did it take place? Change over time?	1950s (reactor first proposed and construction begins) to operation and meltdown in 1966 to closure in 1973.
What type of process was it? How did this change over time?	In the 1950s and 1960s the regulatory process evolved under the AEC's mandate to promote nuclear power and encourage the private sector to join in. Through less-than-opaque review procedures and secrecy, the AEC kept its review of safety and other issues out of public scrutiny. PRDC officials never lacked confidence in their reactor program.
Transnational concerns?	Transnational concerns played no role in this event except insofar as researchers in national laboratories working on LMFBRs were interested in similar research abroad, notably in Russia.
Regulators, trust, procedures?	The public was belatedly informed about the meltdown that occurred at Fermi in 1966; regulators did not observe their responsibilities to regulate; there were no emergency procedures to speak of.
Public-nuclear interactions?	The Enrico Fermi licensing process with court intervention may be the first time in US history that public individuals began to oppose nuclear power. The head of the UAW Walter Reuther became convinced that the Enrico Fermi NPP would endanger Detroit, the auto industry and

	auto workers, and brought a lawsuit against the station. Leo Goodman, a union activist who had helped to organize nuclear workers, convinced Reuther to oppose the stations's construction.
Outcome	Although the UAW lost the court case concerning Fermi, their legal activities helped establish strategies and procedures for future intervention. The Fermi accident did not change AEC regulatory procedures or increase openness. This would be some time in coming, since AEC commissioners still believed in the technology and were confident in their procedures.

The Enrico Fermi Reactor primary system was filled with sodium in December of 1960 and criticality was achieved in August 1963. Enrico Fermi 1 experienced a meltdown in 1966 due to a problem that no one had detected that dated to 1959 in the reactor core at which time there were only 4 stations operating in US and there was no experience on which to base response of plant, state, or federal personnel, nor any procedures to manage accidents, and no one in the control room had any sense what occurred. That sense developed only years later after dangerous, careful and expensive investigation.

The LMFBR had a long history starting with the research of Walter Zinn and others at EBR-1 at NTL in Arco, Idaho, in 1951 that indicated both the promise and potential safety risks associated with breeder reactors. Detroit Edison directors believed that the private sector should build and run the next breeders, and by 1952 they created a not-for-profit division, the Power Demonstration Reactor Corporation (PDRC) to look into building a reactor and entering the nuclear age. As John Fuller writes,

The developers of the Fermi breeder reactor were very sincere, diligent, and highly qualified individuals to whom the safety of the reactor was paramount. Extreme care was taken to insure against the possibility of a serious accident occurring. The scientists involved were most confident that they had covered all possible problem areas. They had built safeguards on top of safeguards. Yet in spite of the precautions in the design and construction of the Fermi reactor, and in spite of the reassurances by the scientists that a serious accident could not happen, one did occur. (Fuller, 1975: 54). In fact the LMFBRs on which Fermi was based were very small scale and worked poorly, and there had been a series of accidents and incidents with all sorts of reactors in the industry. Theoretical safety in design was clearly different from practical safety in operation.

Incomplete data and uncertainty led the Advisory Committee on Reactor Safety (ACRS) in June 1956 to issue a letter on the Fermi to the AEC: "The Committee as a whole was not satisfied with the evidence presented that no credible supercriticality accident resulting from meltdown could breach the container." The ACRS recommended measures "to insure subcritical distribution of melted fuel and to assure that free fall of core parts cannot reassemble a critical mass suddenly." (ACRS, 1970?: 2) Indeed, the ACRS, "was not satisfied with the evidence presented that no credible supercriticality accident resulting from meltdown could breach the container. It is felt that a more extensive theoretical and experimental program to examine all the possibilities needs to be established and pursued vigorously…"(Fuller: 54) Even with insufficient information and experience, in August the AEC still issued a construction permit to PRDC to build proximate to a major urban center. To preclude controversy, Commission Lewis Strauss marked the ACRS letter "administratively confidential," and went before the US Congress to announce groundbreaking for the construction, not to indicate any circumspection. (Fuller: 56)

In 1959 the AFL-CIO (American Federation of Labor-Council of Industrial Organizations) under Walter Reuther filed a brief that the US Court of Appeals upheld in 1960 that the construction permit for the Enrico Fermi LMFBR plant was illegal and that building would have to stop within fifteen days. But the US Supreme Court quickly overturned that decision, 7-2, declaring that the AEC had been within its rights in permitting the Fermi reactor to be built and that final construction could proceed unhindered. In the majority decision, Justice Brennan stated that the AEC had found "reasonable assurance for present purposes, and that is enough to satisfy the arguments of law," and that a step-by-step process of licensing to operation ensured safety. In the minority opinion Justices Black and Douglas referred to the AEC's own safety committee report in which they wrote, "Plainly these are not findings that the safety standards have been met. They presuppose . . .that safety findings can be made after the construction a finished. But when that point is reached, when millions have been invested, the momentum is on the side of the applicant, not on the side of the public."(US SC, 1961)

The Fermi Reactor went through a series of tests, achieving criticality in 1965. But subsequent testing through 1965 and 1966 reviewed difficulties in controlling power levels in the reactor, temperatures in the sodium coolant flowing through fuel assemblies were higher than normal, and fuel assemblies were exhibiting abnormally high temperatures. Finally, on October 5, 1966, the reactor suffered a meltdown, radiation entered the building triggering alarms, and operators determined only 10 minutes later to scram the reactor manually – the reactor had failed to shut down automatically. Subsequent examination of the fuel assemblies revealed that melting had occurred in two while two others were damaged from overheating. Expensive and dangerous investigation determined that two of the six zirconium pieces added to the core inlet plenum in 1959 had broken free and blocked cooling flow through the fuel assemblies, this had limited flow to about three percent of normal for the two assemblies that experienced melting. (ACRS: 2) However, the PRDC determined that no abnormal releases to the environment occurred. Three years and nine months later, Detroit Edison restarted Fermi 1. The UCS termed the AEC's role following the accident "more like that of a hall monitor" for its passive review, occasional inspections, and no effort to audit the recovery effort, let along learn from the accident. (UCS. c.1970: 4) In November 1972, having failed to operate the unit at any level close to specification, PRCD determined to decommission Fermi 1, the fuel and blanket subassemblies were shipped offsite in 1973, and radioactive sodium was stored on site until 1984.

It should be noted that only Russia has ongoing experience with a commercial LMFBR, the BN-800, at the Belioarsk NPP, in Zarechnyi, Russia. French, Japanese and Chinese industrial breeders have been shelved or lag. See Russian and French country reports.

3.2. Event 2: Licensing and Protest over Diablo Canyon (California) NPP and the Abalone Alliance Protests

In the early 1960s representatives of the California utility PG&E announced plans to construct a nuclear power plant in an undeveloped area on the California coast, apparently seeing a perfect blending of the machine and the pastoral. Not for a minute did they recognize the cognitive disjunction of the "machine in the garden." (Winner, 1986; Meehan, 1984) They settled on Diablo Canyon with a gorgeous view of the Pacific Ocean. The building of this NPP on an active earthquake fault was characterized by substantial cost overruns -- similar to those which have characterized the construction of virtually all reactors throughout the world. Utility spokesmen initially estimated costs at $400 million for two units, but by 1976 the bill had risen to $1.2 billion. When unit 1 opened on May 7, 1985, and unit two on March 18, 1987, the total cost of the plant was $5.52 billion. Construction and licensing provoked mass protest among thousands of activists. These activists, the Abalone Alliance, came in thousands to engage in non-violent actions to halt the station. Diablo Canyon will be closed down by 2025.

Main Actors	AEC, NGOs (Friends of the Earth, Abalone Alliance, other local and state groups), NGOs (Union of Concerned Scientists) utilities (PG&E), media (newspapers), 1,500 NPP staff and workers
When and where did it take place? Change over time?	1960s-2010s Beginning in the 1960s when PG&E applied for permits and began construction, through operation in the Diablo Canyon in the 1980s, this NPP was plagued by stops and starts, legal actions and massive protests, lack of openness about the potential risks of construction at this site, especially concerning earthquake faults, and massive cost overruns.After initially asking to extend the license for 20 years, PG&E has agreed to close Diablo Canyon by 2025.
Communication	Investigation by local journalists and activists reveal that PG&E had obfuscated the true state of affairs regarding seismic safety of the NPP.
Alliances among actors?	Anti-nuclear groups worked together. Eventually roughly 60 anti-nuclear groups and 30,000 people came together in protest.
Transnational concerns?	Transnational concerns played little role here.
Regulators, trust, procedures?	The regulators (AEC → NRC) lost the trust of the people. The NRC seemed to put industry interests ahead of public concerns that were based on accurate evaluation of seismic data and risk, even though at Bodega Bay in the 1960s (NPP rejected by AEC, proposed by PG&E, north of San Francisco, see country report) forced regulators to include seismic data in a standardized licensing process.
Public-nuclear interactions?	At this time (1970s) it became clear through an FOIA request from Friends of the Earth that the AEC had actually suppressed publication of a 1964 update of WASH-740 (1957), a reactor safety study, that estimated a worst-case scenario accident leading to at least 3,400 deaths and $7 billion of property damage, well over the amounts covered by the indemnities of the Price-Anderson Act (1957) with a limit on liability of $560 million. Over time, protests became more widespread. They continued into the twenty-first century, especially as the UCS pushed to have the NRC recognize the danger of further operation.
Resolution	In 2016 PG&E, the State of California and NRC agreed the station should be closed down.
Video	1981 Abalone Coalition Occupation of Diablo Canyon, https://www.youtube.com/watch?v=MPBtwfYcy-M (Irving, 1981)

Diablo Canyon Narrative

Diablo Canyon Nuclear Power Plant is owned and operated by Pacific Gas and Electric (PG&E). The utility applied to the Nuclear Regulatory Commission (NRC) to renew s two current operating licenses for 20 more years, which would have extended operations from 2024 and 2025 to 2044 and 2045. "This facility, next to the Chernobyl disaster is probably the most controversial nuclear facility in the world due to intense public opposition," states the Abalone Alliance in its history of the plant. However, PG&E has agreed to close the station by 2025.

While selecting the site in the early 1960s, only in 1969 did geologists discover the nearby Hosgri earthquake fault. In October 1981 the *San Jose Mercury* revealed the fault was in the ocean only 4 kilometres from the reactors, and that PG&E "knew about the fault for at least a year before telling the public and the Atomic Energy Commission." According to a U. S. Geological Survey report, the station's seismic design could not withstand the maximum potential quake possible, and this led to retrofitting and upgrading. The NRC licensed the facility after redesign. (Sneed)

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The response of public relations representatives at Diablo Canyon to Fukushima was to claim that their reactors were nearly 30 meters above the ocean, with a facility designed to withstand a 7.5 quake in a 6.5 zone, with stored fresh water and diesel generators for emergency operation and cooling. (Sneed, 2014) But what if the non-design 8.0 quake occurred? Will this become a natural disaster? The 1979 movie, "The China Syndrome," released just two weeks before the accident at Three Mile Island NPP, suggests that profit-seeking utilities may not understand the full complexity of reactors and suggests what might happen in a melt-down accident at Diablo Canyon or elsewhere.

Diablo Canyon Units 1 and 2

	Unit 1	Unit 2
PG&E applied for construction permit	Jan. 16, 1967	June 28, 1968
AEC issued construction permit	April 23, 1968	Dec. 9, 1970
NRC issued operating license	Nov. 2, 1984	Aug. 26, 1985

One of the first public protests against nuclear power gelled around the Diablo Canyon station. The Abalone Alliance (1977-1985) took its name from the multitudinous red abalone massacred in Diablo Canyon in 1974 when the utility carried out a hot flush of the reactor unit's plumbing. The Alliance, "a loose coalition of 60 anti-nuke organizations, staged blockades and occupations at the reactor site. Nearly two thousand people were arrested during a two-week blockade in 1981, making this the largest number arrested at an anti-nuclear protest in the United States. Perhaps as many as 30,000 protestors descended on the site. (Rogers, 1981) The Alliance sought not only demonstrations, but resistance to ensure that Diablo Canyon never operated as a nuclear power station. Opposition here –at the Bodega Bay plant north of San Francisco (not built) – and at Seabrook – required that protestors became technologically sophisticated in identifying risk factors and in understanding the law and administrative procedures needed to pursue opposition.

Abalone Alliance members worried about faulty and inflated projections for nuclear power, the economic cost of NPPs, the lack of democratic possibilities surrounding governance of nuclear power, the direct relationship between civilian and military nuclear power, the dangers of theft and sabotage, and the short and long terms dangers of NPP. (Direct Action, 1981) As for the 1981 action:

> In 1981, the Diablo Canyon nuclear power plant — being constructed by PG&E astride an active earthquake fault — was nearing completion. A 1979 protest drew attention to the project and resulted in over 100 arrests. In summer 1981, Abalone Alliance, a statewide network of affinity groups and community organizations, called for a blockade of the site. Hundreds of people responded. An action encampment was set up near the site, and over

> the course of several weeks the protest led to over 2000 arrests. Near the end of the action, whistle-blowers within PG&E alerted the media that earthquake safety plans were seriously flawed. This information delayed the plant's opening by several years. Diablo Canyon was finally licensed in 1984, after hundreds more citizen arrests, which have continued to this day. (Direct Action)

Such other groups as Mothers for Peace, Friends of the Earth, and Redwood Alliance were inspired to derail nuclear power as unsafe, undemocratic, and expensive. (Direct Action, 1981)

The licensing of the Diablo Canyon Nuclear Power Station revealed the ad hoc nature of the AEC and NRC's treatment of seismic characteristics in adjudicating safety concerns and points to why many citizens do not trust either the NRC or the utilities. The rulings and evaluations indicated the difficult effort to balance the accepted need for power generation with public concerns and safety.

In the effort of PG&E to extend its license on Diablo Canyon, the utility

> …informed the Nuclear Regulatory Commission (NRC) about a newly discovered fault offshore from its Diablo Canyon nuclear plant that could cause more ground motion during an earthquake than the plant was designed to withstand. In other words, there was a gap between seismic protection levels of the plant and the seismic threat levels it faced. This seismic shift places Diablo Canyon's two aging reactors literally and figuratively on shaky ground. If an earthquake occurs, it may result in more damage than the nuclear plant can withstand, with dire consequences for tens of thousands of Californians. (UCS, 2013)

The NRC, according to the UCS, put financial concerns ahead of safety ones. In a 2013 study, the UCS described "the federal requirements governing seismic risks at nuclear power plants, the regulatory requirements specifically applied to Diablo Canyon, the identified seismic hazards that may exceed the mandated seismic protection levels, and the precedents at nuclear facilities in California and elsewhere in the United States in which the NRC took steps to protect people from undue risks—in other words, the measures the NRC is now sidestepping at Diablo Canyon." By 2013 the NRC had established clear procedures, standards, and guidelines to follow which the UCS study indicated were not being followed in the case of Diablo Canyon. (UCS, 2013)

PG&E had applied for licenses to extend operating lifetime Diablo Canyon, but in 2016 agreed with the state of California to close the reactors by 2025, in spite of industry claims that the station contributes about $1 billion annually to the local economy and is safe to operate. The utility also agreed to invest in energy efficiency, renewable power and electricity storage to offset the power that will no longer be produced by the nuclear plant. The closure means there will be no more NPPs operating in California.

3.3. Event 3: Three Mile Island, Pennsylvania, 1979

The Three Mile Island (TMI) accident was a partial nuclear meltdown in reactor unit 2 on March 28, 1979, near Harrisburg, Pennsylvania, and the most significant accident in US history. The accident revealed weaknesses in NRC regulatory powers and supervision, the slow response of federal and state agencies to safety issues, and a lack of understanding and trust among the public. After the accident, a commission under Kemmeny, analyzed the cause of the accident and response of station personnel, state and national officials, and the role of the NRC, especially its poor oversight, and the weak safety culture this permitted among industry and operators. The Kemmeny Report led to increased regulatory powers and a renewed safety philosophy among NRC staff and administrators.

Main Actors	Environmental Protection Agency, the Department of Health, Education and Welfare (now Health and Human Services), the Department of Energy, and the Commonwealth of Pennsylvania; the NRC; Metropolitan Edison Company (operator); General Public Utilities (owner); the White; farmers; local Harrisburg residents?
When and where did it take place? Change over time?	March 28, 1979, partial meltdown, government and utility response, and Kemmeny study by the end of 1979.
What type of process was it? How did this change overtime?	Partial reactor meltdown.
Alliances among actors?	State officials, federal officials, the utility and operator came together to ensure public safety, but also whitewashed the accident.
Transnational concerns?	Led to worry among nuclear officials and promoters around the world. Soviets contended “it cannot happen here.”

Regulators, trust, procedures?	The TMI accident revealed inadequate NRC supervision of the nuclear industry and even inadequate understanding among operators how to handle an emergency situation. The accident led to criticism of the NRC, and to it gaining increased regulatory and supervisory powers.
Public-nuclear interactions?	Many people now believe that government's failure to acknowledge the full scope of the disaster continues in the underestimation of risks posed by a new generation of nuclear power plants. Others believe the absence of subsequent significant accidents reveals the safety of NPPs in the US. There have been no continued protests over TMI. For further information on the public response to TMI, see the rich eyewitness accounts in the Dickinson College library archives. (Three Mile Island Archives)
Impact	According to many sources, a “tense, sometimes terrifying week… followed,” marked by official confusion and "surreal" misstatements about the crisis's severity. It did not help that movie theaters nationwide were showing the movie "China Syndrome" about a nuclear plant meltdown. The industry lost credibility. There were no new construction starts for twenty years.
Video	(*New York Times*. 2014). “Nuclear Power's Promise and Peril,” Documentary on TMI at https://www.youtube.com/watch?v=_0P9S4F4KpQ

TMI had two PWRs, one at 800 MWe that began operation in 1974. Industry claims it remains one of the best-performing units in USA. Unit 2 was of 906 MWe and almost “brand new” in 1979, but its meltdown, the worst accident in U.S. commercial nuclear power plant history, led to heightened concerns among opponents of nuclear energy and the public about safety issues, and has first entered the pantheon of nuclear disaster history to be followed by Chernobyl (1986) and Fukushima (2011) with their tens of billions of dollars in expenses and extensive human and social costs. The Kemmeny Commission, which reported to the President of the US, (Kemmeny, 1979) identified human error and operator “culture” as culprits in the meltdown.

The accident began with failures in the non-nuclear secondary system, followed by a stuck-open pilot-operated relief valve in the primary system that allowed large amounts of nuclear reactor coolant to escape. The mechanical failures were compounded by the initial failure of plant operators to recognize the LOCA due to inadequate training and human factors, including those not involving only reactors, for example, human-computer interaction design oversights relating to ambiguous control room indicators. In particular, a hidden indicator light led an operator to manually override the automatic emergency cooling system of the reactor because he mistakenly believed that there was too much coolant water present in the reactor; he caused the pressure release that released radioactive steam. (US NRC, 2014)

Another problem was the formation of a hydrogen bubble.

> When the reactor's core was uncovered, on the morning of 28 March, a high-temperature chemical reaction between water and the zircalloy metal tubes holding the nuclear fuel pellets had created hydrogen gas. In the afternoon of 28 March, a sudden rise in reactor building pressure shown by the control room instruments indicated a hydrogen burn had occurred. Hydrogen gas also gathered at the top of the reactor vessel. From 30 March through 1 April operators removed this hydrogen gas ‘bubble’ by periodically opening the vent valve on the reactor cooling system pressurizer. For a time, regulatory (NRC) officials believed the hydrogen bubble could explode, though such an explosion was never possible since there was not enough oxygen in the system. (World Nuclear Association, 2001)

This event, and the deliberate venting of radioactive gases from the plant on Friday morning produced a reading of 1,200 millirems (12 mSv) directly above the stack of the auxiliary building, that created significant anxiety among the public. (World Nuclear Association, 2001) This led to a spontaneous exodus from around the plant, but not an ordered evacuation. While government and industry officials think this situation was only a sign of confusion and not of danger, it indicates that no one was prepared to handle the situation, and if an evacuation had been required, it would have been too late, or at least disorderly and incomplete – witness the 3-day warning before Hurricane Katrina and the loss of 1,836 human lives. The total costs of cleanup were $1 billion over 12 years. The accident was rated a five on the seven-point International Nuclear Event Scale as an “Accident With Wider Consequences.” (Ibid.)

Kemmeny Report on TMI (1979)

The measured and thoughtful Report of the President’s Commission on the Accident at Three Mile Island (the “Kemmeny” report) focused on the “culture” of operation of nuclear power stations and on operator error without indicting the entire industry. The authors acknowledged,

> We did not examine the entire nuclear industry…We have not dealt with the question of the disposal of radioactive waste or the dangers of the accumulation of waste fuel within nuclear power plants adjacent to the containment buildings. We made no attempt to examine the entire fuel cycle, starting with the mining of uranium. And, of course, we made no examination of the many other sources of radiation, both natural and man-made, that affect all of us. (Kemmeny, 1979)

The authors also did not evaluate the relative risks involved in alternate sources of energy or "reach a conclusion as to whether, as a matter of public policy, the development of commercial nuclear power should be continued or should not be continued." Yet also acknowledging in 1979 that there were 72 operating reactors in the United States with a capacity of 52,000 megawatts of electric energy and that an additional 92 plants received construction permits and were in various stages of construction, they might indeed have paid attention to these crucial data. (Kemmeny et al., 1979: 3-4) The Kemmeny Report indicated the poor oversight and regulatory operations of the NRC:

> To prevent nuclear accidents as serious as Three Mile Island, fundamental changes will be necessary in the organization, procedures, and practices -- and above all -- in the attitudes of the Nuclear Regulatory Commission and, to the extent that the institutions we investigated are typical, of the nuclear industry. This conclusion speaks of necessary fundamental changes. We do not claim that our proposed recommendations are sufficient to assure the safety of nuclear power. (Ibid.: 7)

The study members recognized the need to improve the quality and operation of equipment toward the end of safety. But they concluded that

> …the basic problems are people-related, we do not mean to limit this term to shortcomings of individual human beings -- although those do exist. We mean more generally that our investigation has revealed problems with the 'system' that manufactures, operates, and regulates nuclear power plants. There are structural problems in the various organizations, there are deficiencies in various processes, and there is a lack of communication among key individuals and groups. (Ibid.: 8)

The committee members noted “potentially serious scenarios, such as the break of a huge pipe that carries the water cooling the nuclear reactor,” but concluded that “a preoccupation developed with such large-break accidents as did the attitude that if they could be controlled, we need not worry about the analysis of ‘less important’ accidents.” In part, as a result, “A potentially insignificant incident grew into the TMI accident, with severe damage to the reactor. Since such combinations of minor equipment failures are likely to occur much more often than the huge accidents, they deserve extensive and thorough study. (Ibid.: 9) In reality, operators were poorly prepared for the accident, did not learn from previous ones, did not assimilate warnings from the reactor manufacturer (Babcock and Wilcox), and could not fathom the huge and confusing control panel (during the first minutes over 100 alarms were sounded). The committee, however, shockingly concluded that an accident was bound to occur:

> While the major factor that turned this incident into a serious accident was inappropriate operator action, many factors contributed to the action of the operators, such as deficiencies in their training, lack of clarity in their operating procedures, failure of organizations to learn the proper lessons from previous incidents, and deficiencies in the design of the control room. These shortcomings are attributable to the utility, to suppliers of equipment, and to the federal commission that regulates nuclear power. Therefore – whether or not operator error "explains" this particular case -- given all the above deficiencies, we are convinced that an accident like Three Mile Island was eventually inevitable.” (Ibid., 11)

The Kemmeny Report also recommended greater rights to states to regulate siting and regulation. This would have given them the ability to derail or significantly slow licensing by refusing to permit certain sites from being selected or claiming that stations could not operate because no feasible evacuation plan was possible in case of an accident. But the federal government, the courts, and the NRC have not permitted any turn toward state rights as recommended. This would have created havoc for the industry, for example, by permitting Massachusetts to reject the Seabrook station evacuation plan and delaying its power production.

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Reforms of NRC after TMI

If reforms of the NRC itself were required, then TMI triggered more debate and considered the precise direction of reforms. Some individuals question whether the agency was slow to respond properly in this and other cases. (See Event 5.) For example, several individuals suggested the appointment of a single, more powerful administrator, rather than the "cumbersome commissioner structure that seemed to interfere with the regulatory behavior of nuclear power." Others worried that a pro-nuclear president would appoint an administrator who might "weaken safety requirements, eliminate intervener rights, and charge ahead with dangerous technologies?" (Ahearne, 1984) According to one review, the functions of the NRC had "little impact on the quality of the NRC's decision making or on the safety of nuclear reactors in general. Moreover, the limited changes that have occurred since Three Mile Island fail[ed] to address several of the larger administrative and political issues concerning the performance of regulatory agencies and how to evaluate it." (Temples, 1982: 355)

Dorothy Nelkin wrote that the NRC responded to the post-TMI criticism with some energy. As a result of the accident and subsequent criticism of the NRC, its staff grew by 14 percent from 2,841 to 3,240 in one year, and its annual budget increased from $325.8 million to $423 million.

Requirements were developed for additional training of reactor operators. Emergency plans include telephone hotlines to a commission emergency response center. The inspection system was improved and the structure of the commission itself reevaluated. But "improved" regulation inevitably increased operating costs and it may also have exacerbated the problems of complexity, compounding the difficulties of management and the risk of systemic effects. (Nelkin, 1981: 138)

Health Effects

According to several studies, the radiation doses of the approximately 2 million people in the affected region were very small and there would be no long term health impacts.

According to the NRC:

> The NRC conducted detailed studies of the accident's radiological consequences, as did the Environmental Protection Agency, the Department of Health, Education and Welfare (now Health and Human Services), the Department of Energy, and the Commonwealth of Pennsylvania. Several independent groups also conducted studies. The approximately 2 million people around TMI-2 during the accident are estimated to have received an average radiation dose of only about 1 millirem above the usual background dose. To put this into context, exposure from a chest X-ray is about 6 millirem and the area's natural radioactive background dose is about 100-125 millirem per year for the area. The accident's maximum dose to a person at the site boundary would have been less than 100 millirem above background.
>
> In the months following the accident, although questions were raised about possible adverse effects from radiation on human, animal, and plant life in the TMI area, none could be directly correlated to the accident. Thousands of environmental samples of air, water, milk, vegetation, soil, and foodstuffs were collected by various government agencies monitoring the area. Very low levels of radionuclides could be attributed to releases from the accident. However, comprehensive investigations and assessments by several well-respected organizations, such as Columbia University and the University of Pittsburgh, have concluded that in spite of serious damage to the reactor, the actual release had negligible effects on the physical health of individuals or the environment. (US NRC, 2014)

3.4. Event 4: Seabrook Nuclear Power Station and Clamshell Alliance Protests

In May 1968 the Public Service Company of New Hampshire (PSNH) announced plans to build a nuclear plant in Newington, NH, on the Great Bay (the site now of multitudinous shopping malls). A year later, in the face of local opposition and higher costs, PSNH gave up this plan. In 1972 the company proposed to build two reactors on the Hampton-Seabrook estuary, of salt marshes and critical habitat for birds and other fauna, along the Atlantic Ocean in Seabrook, NH, the first to come online by 1979, the second in 1981, with a total cost of less than $1 billion. The plans generated extensive public opposition, protest, and occupation of the construction site by the Clamshell Alliance. Protests continued into the 1990s. Construction also drew opposition of the Governor of the Commonwealth of Massachusetts, Mike Dukakis. One reactor was completed at great cost.

Main Actors	PSNH, the State of New Hampshire, the Commonwealth of Massachusetts, the NRC, extensive public protest through Clamshell Alliance, local and state police
When and where did it take place? Change over time?	1968-1990
What type of process was it? How did this change over time?	Protest over the proposed construction of two nuclear power stations in the coastal region of New Hampshire. Protest became large scale. It grew increasingly to reflect concern over the power of local people and their governments against power corporations and the federal government.
Alliances among actors?	The Clamshell Alliance brought together people from a wide range of professions and walks of life in a series of local "clams" or groups. The NRC, the utility and the State of NH worked to head off protest and to see Seabrook Station built. In Massachusetts the Governor's office (Mike Dukakis) opposed the operation of Seabrook because of fears that no evacuation plan was feasible in case of emergency. In 1978 the Clamshell Alliance split after its Coordinating Committee (CC) agreed to call off a large civil disobedience planned at the power plant site in June, instead of obtaining input and consensus from regional Clam groups. The government of New Hampshire had negotiated the opportunity for the Alliance to hold a pro-solar power and music festival at the Seabrook site to avoid bad publicity and the cost of law enforcement. Twenty thousand people attended. In response to a feeling that a

	massive arrest on the site would overwhelm the state, undermine support and finance for the Seabrook nuclear project, and also result in the costs of hiring police from neighboring states, incarcerating thousands of Clams and paying court expenses offered to let Clamshell hold a solar power fair and concert on the site. This proposal was eventually accepted by Clamshell and a highly successful rally of 20,000 people was held on the site with thousands of Clams also camped out on the Seabrook site. But the political consequences within Clamshell led to a split in the Alliance and the eventual formation of the Coalition for Direct Action that called for continued occupation. (Coalition for Direct Action, 1979)
Transnational concerns?	None
Regulators, trust, procedures?	As for state power and the police, the actions led to mass arrests. In later years, New Hampshire authorities minimized the impact of mass civil disobedience at the Seabrook plant by treating activist trespass as a violation and allowing community service in lieu of fines to limit their effectiveness. Clamshell Alliance members attempted to have their actions taken more seriously by the courts and began staging sit-ins of the office of Republican Governor Judd Gregg. The NRC lost a great deal of trust among New Englanders when it accepted an industry-sponsored emergency evacuation plan for a 10-mile radius. Massachusetts Gov. Michael S. Dukakis refused to file plans for the northeastern Massachusetts towns, contending that geographic and demographic characteristics of the seacoast area make it impossible to evacuate safely under any conditions.
Public-nuclear interactions?	The Clamshell Alliance was formed in Rye, NH, at a backyard picnic table in July 1976 by New England activists who nuclear power, leading to a prolonged battle between it, the NRC, the PSNH, one of the smallest utilities in the nation, NH, and MA.
Video	"Seabrook 1977." (Leppzer, 1977). See excerpt at https://www.youtube.com/watch?v=N3rS8hzW2pA

The NRC granted PSNH a construction permit in 1982 for Seabrook, but unit 2 was never built, scrapped when 25 percent complete, and its major components sold to other plants. The cost of one reactor alone ballooned to $4.3 billion by the time it was completed in 1986 (eight times the initial estimate of $1 billion for both units). When the sole reactor came online commercially in August 1990, Seabrook had cost $6.2 billion, and led to the bankruptcy of PSNH. The plant was then sold to several separate utilities who, in 2002, sold their shares to NextEra Energy Resources which owns 88% of the station, with the remainder owned by municipal utilities of Massachusetts. The grotesquely expensive station – and the decision to site it near heavily populated areas (Portsmouth, NH; Boston, MA) with inadequate evacuation plans and concerns about safety generated a massive public response in the Clamshell Alliance Protests. (See Bedford, 1990; Bove, 1978; Coalition for Direct Action, 1979)

The Seabrook experience revealed again that utilities, perhaps inadvertently, but always significantly, underestimated the costs of nuclear power. In the case of Seabrook it was able easily to pass along many of those costs, for example in rate hikes for consumers, even before the reactors generated power. PSNH was permitted several rate hikes, one of 17% or $27 million. A RAND study estimated that construction costs of nuclear power plants would double in real dollars every six years or less because of recurrent design failures and the need to build in redundancies and other safety systems. This was surely the case with Seabrook. (Mooz, 1979; Bove, 1978: 37) The growing costs of Seabrook, and real concerns that rapid and safe evacuation from the densely populated seacoast region of New Hampshire and northern Massachusetts was nearly impossible, led to mass protests against the station and to the formation of the Clamshell Alliance to stop the project. Stever found that lack of openness in the licensing process contributed significantly to cost overruns and ensured heightened conflict over siting. (Stever, 1980)

In 1974, at Wyhl, West Germany, 28,000 people occupied the site of a proposed nuclear station to stop its construction in a nature preserve. People remained on site until the project was abandoned. (See Federal Republic of Germany Country Report) Seeking similar results, The Clamshell Alliance, an umbrella organization of 15 anti-nuclear groups, was formed at a July 1976 meeting of 50 people, almost all of whom were NH residents. The goal of the Alliance was to halt Seabrook construction and to force cancelation of the project by any means necessary within the context of “non-violent, direct action.” (Coalition for Direct Action, 1979)

As soon as the NRC issued a construction license in summer 1976, 200 New England residents rallied at the edge of the future power plant site, on the seacoast saltmarsh as the Clamshell Alliance, 18 of whom were arrested for “criminal trespass” and sentenced to time in jail. A week later, 188 other New England citizens returned to the Seabrook site; they too were arrested. As one of the founders wrote, “By the early spring of April 1977, two thousand ‘Clams,’ as they came to be known, had returned to the site to non-violently reclaim the land and declare the ocean front 'nuclear free." Over the years dozens of Clams were arrested for nonviolent civil disobedience at Seabrook in the effort to stop nuclear power, including two state legislators, one from Massachusetts and one from New Hampshire. (US NRC, 1979; Gunter, 1990)

Hundreds of demonstrators descended on the plant when PSNH began the first power tests in June 1985, with 627 arrested for trespassing. The protesters included children and handicapped people. The protestors chanted, "Shame on us" and carried signs that read "In Mourning for the Late, Great State of New Hampshire" and "Remember Chernobyl." Ron Sher, a Seabrook spokesman, dismissed the protestors as failing to recognize "that nuclear energy is a viable energy option." The tests would permit moving through a series of licenses to full power, and to overcome years of delays and cost overruns. (Gold, 1989)

The New England Coalition on Nuclear Pollution had one short-lived victory against Seabrook. They secured an initial favorable ruling by a board of the NRC to postpone Seabrook's construction until waste issues were resolved. But five days later, the order was rescinded and waste issues remained unresolved. (Seabrook Clamshell Alliance, 1976: 15)

The Clamshell allows sought non-violent occupation and "restoration of the construction site by setting up projects demonstrating the potential of alternative, renewable energy sources (e.g., solar and wind energy) in agriculture, aquaculture, and silvaculture (tree products)." All participants had to be trained in non-violent action, "no weapons, no property damage or destruction, no running at any time, no breaking through police lines, no dogs, no drugs or alcohol. In case of confrontation, we will sit down. (Ibid.: 15)

As a leading Cclam, Paul Gunter, recalled, as part of the federal licensing process, the Nuclear Regulatory Commission had required individual state government approval of a nuclear plants' emergency evacuation plans.

> After the Chernobyl nuclear accident, public worries about nuclear plant safety mounted. As a result, Governor Michael Dukakis of Massachusetts withdrew his state's approval of the Seabrook Emergency Response Plan. He cited his grave doubts about the feasibility of effective state evacuation and sheltering capacities in the event of a nuclear accident. Then

> the Nuclear Regulatory Commission reversed its earlier ruling that required state and local approval of emergency response plans. In an effort to keep the Seabrook licensing process alive, the Federal Government decided unilaterally to overrule the concerns of the State of Massachusetts.

Gunter noted, the NRC then recognized a bankrupt company, PSNH, to be competent enough to develop an evacuation plan. (Gunter, 1990)

In November 1987 the Nuclear Regulatory Commission removed a major stumbling block to licensing the Seabrook NPP for low-power testing when its commission voted 4-1 “that a new utility-drafted evacuation plan for the six Massachusetts towns that fall within Seabrook's 10-mile emergency zone could be considered in lieu of a state proposal.” Massachusetts Gov. Michael S. Dukakis refused to file plans for the northeastern Massachusetts towns, contending that geographic and demographic characteristics of the seacoast area make it impossible to evacuate safely under any conditions. That stance has further stalled the oft-delayed $5.1 billion plant. (Journal of Commerce, 1987)

In 2009, NextEra Energy Seabrook noted the intrusion of moisture into sections of walls in certain below-grade structures at the Seabrook nuclear power plant that might cause the degradation of some of the concrete as evidenced by pattern cracking. The NRC put the station under special oversight for 3 years until the problem was resolved. (US NRC, 2016c)

3.5. Event 5: Davis-Besse NPP Operation and Reactor Head Corrosion (2002)

The Davis–Besse Nuclear Power Station near Oak Harbor, Ohio, has a single PWR. On March 5, 2002, maintenance workers discovered that corrosion had eaten a football-sized hole into the reactor vessel head that might have led to a meltdown. The NRC shut down the station for two years to perform the necessary repairs and maintenance for safe operation. It imposed its largest fine ever—more than $5,540,000—against FirstEnergy for the actions that led to the corrosion. (US NRC, 2005) The company paid an additional $28 million in fines under a settlement with the U.S. Department of Justice. The history of Davis-Besse reveals that a power station may be operated, according to regulators, even in the face of persistent, troubling repair, maintenance and other problems.

Main Actors	Original owners: Cleveland Electrical Illuminating and Toledo Edison, then by the FirstEnergy Nuclear Operating Company subsidiary of FirstEnergy Corp, NRC, General Accounting Office (GAO), OhioPIRG, Harvey Wasserman
When and where did it take place? Change over time?	2002 – at the Davis-Besse NPP, one of the most poorly operating stations in the US
What type of process was it? How did this change overtime?	A serious maintenance and repair problem that could have resulted in a major nuclear accident – a meltdown. The NRC required the shutdown of the station for two years until 2004, and with the Justice Department fined Davis-Besse $33,540,000. Problems with the reactor continued to 2016. Industry and the regulator have been aware of these ongoing problems for decades.
Alliances among actors?	Since the late 1990s the NRC – the regulator—has actively engaged its supervisory functions that lead at times to tensions with industry. At the same time the GAO suggests still greater improvements in these functions. The public consists of a loose group of individuals.
Transnational concerns?	General reactor safety.
Regulators, trust, procedures?	Many people in Ohio worry greatly about the safety of the station given the stream of problems that have hampered its operation and the difficulties the regulators have encountered in improving performance – with very little margin for reactor safety. Industry and the regulator have been aware of these ongoing problems for decades.
Public-nuclear interactions?	Demonstrations against the station began in 1979 after Toledo Edison shut down the station to determine if, in the light of TMI, any changes in operating safety needed to be made. Another demonstration involved 200 people in December 1981. In August 2002, more than a hundred area residents and activists from Ohio, Indiana, and Michigan came to Crane Creek State Park to protest repair efforts at the Davis-Besse nuclear plant. In 2004 over 400 activists who sent letters asking state officials to oppose restarting Davis-Besse. In June 2011 over 250 anti-nuclear activists protested the continued operation of the Davis-Besse nuclear power plant. In January 2012 About 20 people participated in a skit in front Davis-Besse Nuclear Power Station before they attended a public meeting about shield building cracks at the plant. “We have nuclear-grade duct tape, nuclear-grade Gorilla Glue and nuclear-grade spackling,” said Kevin Kamps, dressed as C. Montgomery Burns, the owner of the Springfield Nuclear Power Plant in “The Simpsons.”

Video	Myla Reson, (2015). “Davis Besse: Ohio's Costly Nuclear Nightmare,” https://www.youtube.com/watch?v=yefKEDF0uuM

The Davis-Besse NPP has, in comparison with other NPPs, a very poor operating record. (Wasserman, 2015). In 1977 a stuck relief valve was a “precursor accident” to the 1979 Three Mile Island meltdown. In 1985 a LOCA, the worst since Three Mile Island, closed Davis-Besse for a year. In 1998 a tornado caused a total loss of power, destroying the plant's warning, communication and emergency systems, threatening a meltdown. And in 2002, the operator neglected maintenance and upkeep to the extent that leaking borated water was able to eat a 7” hole in the reactor's pressure vessel lid, leaving only a 3/16" liner to contain the coolant and prevent a meltdown. (US NRC, 2008) The plant closed for two years costing ratepayers $600 million and resulting in a $33.5 million fine, the largest in NRC history. In 2010, the utility discovered it had to replace the vessel head again.

The reactor pressure vessel (RPV) heads of PWRs have penetrations for control rod drive mechanisms (CRDMs) and instrumentation systems made from nickel-based alloys and related weld metals. Primary coolant and the operating conditions of PWR plants can cause cracking of these nickel-based alloys and weldments through a process called primary water stress corrosion cracking (PWSCC). In response to the detection of PWSCC at several plants, the NRC issued NRC Bulletin 2001-01, “Circumferential Cracking of Reactor Pressure Vessel Head Penetration Nozzles,” which requested information related to licensees’ programs for inspection of vessel head penetration (VHP) nozzles. (US NRC, 2001) Yet Davis-Besse failed to respond. According to a subsequent report,

> On February 16, 2002, in response to Bulletin 2001-01, the Davis-Besse Nuclear Power Station (DBNPS), located in Oak Harbor, Ohio, began a refueling outage with the intent to perform work that included remotely inspecting the VHP nozzles from underneath the head focusing on the CRDMs. The licensee found that three CRDM nozzles had indications of through-wall axial cracking. Specifically, the licensee found these indications in CRDM nozzles 1, 2, and 3, which are located near the top of the RPV head. (US NRC, 2008: 2)

NRC officials fined Davis-Besse for a variety of reasons. One was the fact that during the early 1990s, the NRC and industry recognized the potential for boric acid corrosion of an RPV head, and urged attention to it. An NRC task force concluded that the DBNPS VHP nozzle leakage and RPV head degradation event was preventable. At the station, such early indications of RPV corrosion were missed as radiation element system filters being clogged by boric acid and corrosion fins, the build up of boric acid deposits on containment air cooler fins and large amounts of boric acid deposits on the RPV head.(US NRC, 2008: 5-6) A task force concluded that the event was not prevented because the NRC, DBNPS, and the nuclear industry failed to adequately review, assess, and follow-up on relevant operating experience, DBNPS failed to assure that plant safety issues received appropriate attention, and the NRC failed to integrate known or available information into its assessments of DBNPS's safety performance.(Ibid.: 6-8)

As in other cases, the NRC blamed "safety culture weaknesses" as one of the root causes of the Davis Besse accident. Officials claimed to take "significant steps within the Reactor Oversight Process to strengthen the ability to detect a weak safety culture in our inspections and performance assessments. In this context, safety culture is defined as 'that assembly of characteristics and attitudes in organizations and individuals which establishes that, as an overriding priority, nuclear plant safety issues receive the attention warranted by their significance.'"(Ibid.: 11) The constant reference to weak safety culture in the industry reveals that this culture is far spread and extensive, not an anomalous situation, as the case of Three Mile Island indicated.

The GAO was critical of the NRC in the early 2000s for its monitoring and supervisory roles, although noted improvement. According to the GAO in 2006, the NRC improved its safety oversight functions. Between 2001 and 2006 it produced over 4,000 inspection findings for failure fully to comply with safe operating procedures, and the NRC subjected 79 of the 103 plants – 80%!! – to increased oversight for some time, and 5 plants to the highest level of oversight – due to the "more systematic nature of performance problems." (US GAO, 2006a: i)

If 80% of NPPs required increased oversight in that five-year period, then perhaps safety remains a significant issue even when the NRC has improved its oversight functions. Indeed, the GAO report notes, the NRC "has been slow to act on needed improvements, particularly in improving the agency's ability to identify and address early indications of declining safety performance." Many stakeholders believe that changes “could enable NRC to better identify safety culture issues and thus provide earlier indications of declining plant safety performance.” Industry has pushed back because it believes that the changes could “introduce undue subjectivity to NRC’s oversight, given the difficulty in measure these often intangible and complex concepts.” The GAO notes, the NRC “was reluctant to incorporate safety culture into the [Reactor Oversight Process] because it considered this type of activity as a management function, and NRC did not believe that it should be directly involved in managing licensees’ plants.” (Ibid.)

The GAO had noted NRC oversight problems already in 1998-99 in its “inconsistent treatment owing to lack of specific criteria, subjective nature of the process, ineffective process to ensure that licensees maintain competent management.” Prior to 2000, the NRC’s oversight of plants’ compliance was criticized because it did not always focus on the most importance safety issues and some activities were redundant, inefficient, and overly subjective. (Ibid.: 1) The fiasco at Davis-Besse, the 9/11 terrorist attacks, loss of qualified inspectors, and other problems exacerbated these difficulties. In 2004 NRC increased inspection by 9% and in 2005 another 5%. (Ibid.: 10)

How safe is the station today? To replace aging, deteriorating, damaged parts, the operator has made four unprecedented large cuts through the Davis-Besse concrete shield building that prevents release of lethal radiation. In 2011 a series of cracks and concrete voids were discovered, the cause of which is unknown. NRC engineers have calculated a minor earthquake or accident could cause the shield building to collapse onto the reactor releasing catastrophic radiation.

4. Facts and Figures

4.1. Data summary

The US has 99 currently operating commercial nuclear reactors, or 22% of the total 446 in the world. There are over sixty reactors currently under construction in the world, 20 in China, and 5 in the United States, although a number of utilities have entered the process to build new NPPs.

- Nuclear power took off in the United States in the 1960s and 1970s, reaching a peak in construction permits being issued and units brought on line in the 1970s and 1980s. Most of the NPPs are located in the eastern and southern US, and most of the requests for new permits are in southern states.
- Twenty-eight (28) units in the US have been permanently closed, many in the 1970s – first generation smaller units, and again in the 1990s. The general trend has been to work with the federal government, the NRC, and state governments to secure licenses to extend up to 20 years the life of existing stations.
- The US is a nation of electricity based on coal and increasingly natural gas. But nuclear power provides 20% of electricity and has provided roughly this percentage for many years.
- Most NPPs are located near major urban centers to keep electricity transmission costs down, in the eastern and southern states, and on the west coast.

4.2. Key dates and abbreviations

Key dates:

1941	Letter from Einstein and Szilard to Roosevelt on need for atomic bomb
1942	Manhattan Project commences
1945	July 1st, Alamagordo, bomb test
	August, bombing of Hiroshima and Nagasaki
1946	Atomic Energy Act of 1946, Formation of AEC
1953	Eisenhower Speech, UN, “Atoms for Peace”
1954	Atomic Energy Act of 1954
	Obninsk (south of Moscow) Reactor goes critical at 5,000 kW

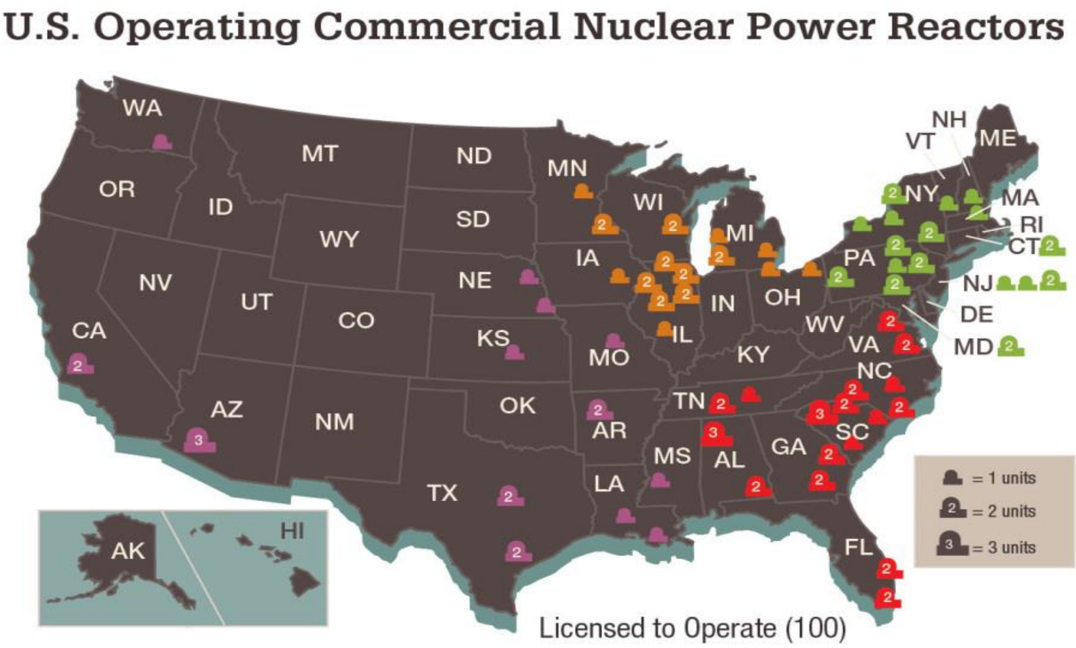
1958	Shippingport, PA, Nuclear Power Station goes critical at 60,000 kW
1962	*Civilian Nuclear Power: A Report to the President*
1966	Meltdown of Detroit's LMFBR "Enrico Fermi"
1969	Sheldon Novick publishes *The Careless Atom*
1975	WASH-1400 – the "Rassmussen Report"
1973	AEC → NRC and creation of ERDA – Later DOE
1979	Three Mile Island Disaster
1979	The Kemmeny Report
1987	The Nuclear Waste Policy Act of 1987

Abbreviations:

ACRS	AEC Advisory Committee on Reactor Safety
AEC	Atomic Energy Committee
BWR	Boiling Water Reactor
ConEd	Consolidated Edison (Electric) Co.
DOE	Department of Energy
ERB-1	Experimental Breeder Reactor-1
ECCS	Emergency Core Cooling System
EIA	Energy Information Administration (US)
ERDA	Energy Research and Development Administration
GAO	General Accounting Office
JCAE	Joint Committee on Atomic Energy
LMFBR	Liquid Metal Fast Breeder Reactor
LOCA	Loss of Coolant Accident
MW	Megawatt
NGOs	Non-governmental organization
NPP	Nuclear power plant
NRC	Nuclear Regulatory Commission
NRDC	National Resources Defense Council
ORNL	Oak Ridge National Laboratory
PG&E	Pacific Gas and Electric

PDRC	Power Demonstration Reactor Corporation
PSNH	Public Service of New Hampshire
PWR	Pressurized Water Reactor
SNF	Spent nuclear fuel
TMI	Three Mile Island
TVA	Tennessee Valley Authority
UCS	Union of Concerned Scientists
WPPSS	Washington Public Power Supply System

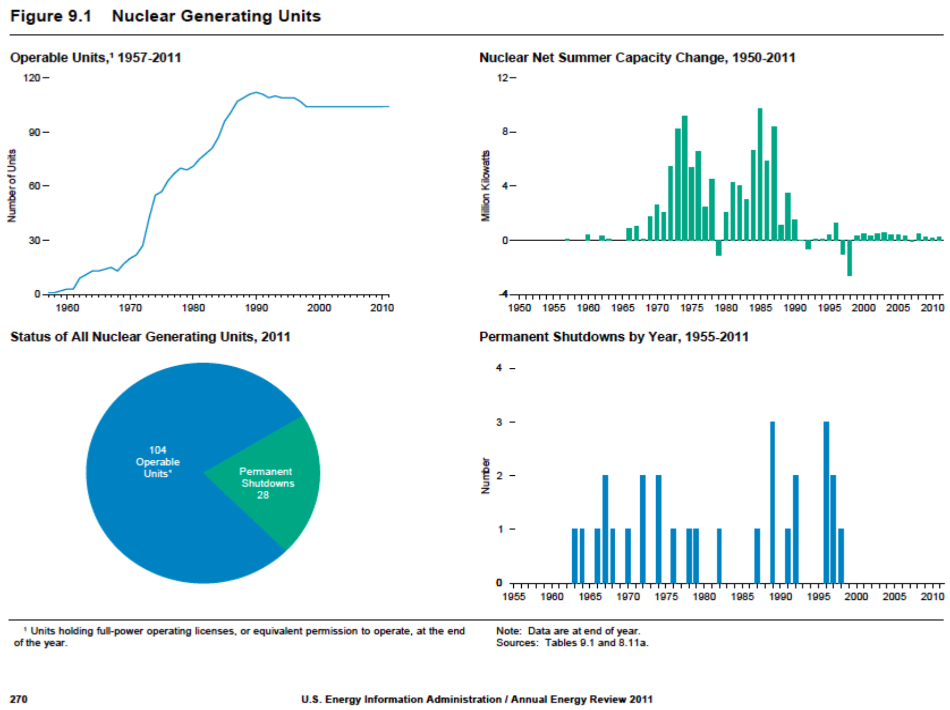
4.3. Map of nuclear power plants



Source: Nuclear Regulatory Commission

4.4. List of reactors and technical, chronological details

US Commercial Nuclear Power Stations, 1955-2011



Source: US Energy Information Administration

US Nuclear Reactors, by Construction Permits Issued and Operable Units, 1955-2011

Years	Construction Permits	Operable Units	Units Added in 5 year period
1955-60	15	3	3
1961-65	13	13	10
1966-70	59	20	7
1970-75	58	57	37
1976-80*	39	71	14
1981-85	0	96	25
1986-90**	0	112	16
1991-95	0	109	1 (-shutdowns)
1996-00	0	104	1 (-shutdowns)
2001-11	0	99	

** TMI in 1979. ** Chernobyl in 1986.*

Table 9.1 Nuclear Generating Units, 1955-2011

Year	Original Licensing Regulations (10 CFR Part 50) [1]			Current Licensing Regulations (10 CFR Part 52) [1]			Permanent Shutdowns	Operable Units [7]
	Construction Permits Issued [2,3]	Low-Power Operating Licenses Issued [3,4]	Full-Power Operating Licenses Issued [3,5]	Early Site Permits Issued [3]	Combined License Applications Received [6]	Combined Licenses Issued [3]		
1955	1	0	0	--	--	--	0	0
1956	3	0	0	--	--	--	0	0
1957	1	1	1	--	--	--	0	1
1958	0	0	0	--	--	--	0	1
1959	3	1	1	--	--	--	0	2
1960	7	1	1	--	--	--	0	3
1961	0	0	0	--	--	--	0	3
1962	1	7	6	--	--	--	0	9
1963	1	3	2	--	--	--	R1	11
1964	3	2	3	--	--	--	1	13
1965	1	0	0	--	--	--	0	13
1966	5	1	2	--	--	--	1	14
1967	14	3	3	--	--	--	2	15
1968	23	0	0	--	--	--	R1	13
1969	7	4	4	--	--	--	0	17
1970	10	4	3	--	--	--	R1	20
1971	4	5	2	--	--	--	0	22
1972	8	6	6	--	--	--	R2	27
1973	14	12	15	--	--	--	0	42
1974	23	14	15	--	--	--	2	55
1975	9	3	2	--	--	--	0	57
1976	9	7	7	--	--	--	1	63
1977	15	4	4	--	--	--	0	67
1978	13	3	4	--	--	--	1	70
1979	2	0	0	--	--	--	1	69
1980	0	5	2	--	--	--	0	71
1981	0	3	4	--	--	--	0	75
1982	0	6	4	--	--	--	1	78
1983	0	3	3	--	--	--	0	81
1984	0	7	6	--	--	--	0	87
1985	0	7	9	--	--	--	0	96
1986	0	7	5	--	--	--	0	101
1987	0	6	8	--	--	--	R1	107
1988	0	1	2	--	--	--	0	109
1989	0	3	4	--	--	--	R3	111
1990	0	1	2	--	--	--	R0	112
1991	0	0	0	--	--	--	1	111
1992	0	0	0	--	--	--	2	109
1993	0	1	1	--	--	--	0	110
1994	0	0	0	--	--	--	R0	109
1995	0	1	0	--	--	--	0	109
1996	0	0	1	--	--	--	R3	109
1997	0	0	0	0	0	0	2	107
1998	0	0	0	0	0	0	R1	104
1999-2006	0	0	0	0	0	0	0	104
2007	0	0	0	3	5	0	0	104
2008	0	0	0	0	R12	0	0	104
2009	0	0	0	1	1	0	0	104
2010	0	0	0	0	0	0	0	104
2011	0	0	0	0	0	0	0	104
Total	177	132	132	4	R18	0	28	--

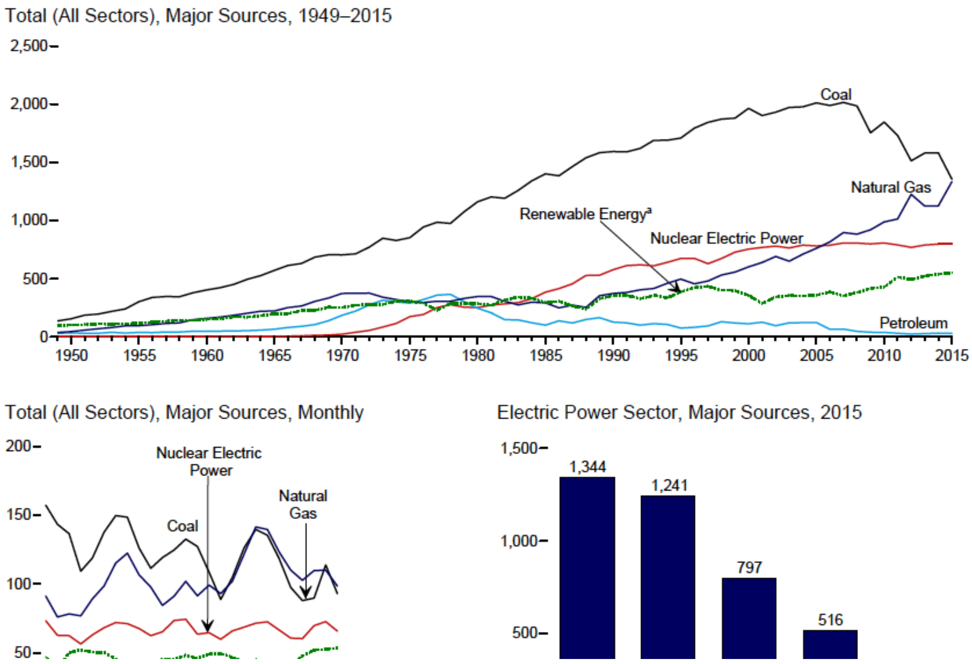
Source: US EIA, 2011.

Alphabetical List of Operating Nuclear Power Reactors by Name

A - C	D - L	M - P	Q - W
Arkansas Nuclear 1	D.C. Cook 1	McGuire 1	Quad Cities 1
Arkansas Nuclear 2	D.C. Cook 2	McGuire 2	Quad Cities 2
Beaver Valley 1	Davis-Besse	Millstone 2	River Bend 1
Beaver Valley 2	Diablo Canyon 1	Millstone 3	Robinson 2
Braidwood 1	Diablo Canyon 2	Monticello	Saint Lucie 1
Braidwood 2	Dresden 2	Nine Mile Point 1	Saint Lucie 2
Browns Ferry 1	Dresden 3	Nine Mile Point 2	Salem 1
Browns Ferry 2	Duane Arnold	North Anna 1	Salem 2
Browns Ferry 3	Farley 1	North Anna 2	Seabrook 1
Brunswick 1	Farley 2	Oconee 1	Sequoyah 1
Brunswick 2	Fermi 2	Oconee 2	Sequoyah 2
Byron 1	FitzPatrick	Oconee 3	South Texas 1
Byron 2	Fort Calhoun	Oyster Creek	South Texas 2
Callaway	Ginna	Palisades	Summer
Calvert Cliffs 1	Grand Gulf 1	Palo Verde 1	Surry 1
Calvert Cliffs 2	Harris 1	Palo Verde 2	Surry 2
Catawba 1	Hatch 1	Palo Verde 3	Susquehanna 1
Catawba 2	Hatch 2	Peach Bottom 2	Susquehanna 2
Clinton	Hope Creek 1	Peach Bottom 3	Three Mile Island 1
Columbia Generating Station	Indian Point 2	Perry 1	Turkey Point 3
Comanche Peak 1	Indian Point 3	Pilgrim 1	Turkey Point 4
Comanche Peak 2	La Salle 1	Point Beach 1	Vogtle 1
Cooper	La Salle 2	Point Beach 2	Vogtle 2
	Limerick 1	Prairie Island 1	Waterford 3
	Limerick 2	Prairie Island 2	Watts Bar 1
			Watts Bar 2
			Wolf Creek 1

Source: NRC

Figure 7.2 Electricity Net Generation
(Billion Kilowatthours)



Source: US EIA

Plant Applications for License Renewal

Applications Currently Under Review:

Plant Name and Unit(s)	Application Received
Indian Point 2 & 3	04/30/07
Diablo Canyon 1 & 2	11/24/09
Seabrook 1	06/01/10
South Texas Project 1 & 2	10/28/10
Grand Gulf 1	11/01/11
Fermi, Unit 2	04/30/14
LaSalle 1 & 2	12/09/14
Waterford 3	03/23/16

Source: NRC

4.5. List of influencing actors

Major National Groups Influencing Public Opinion,

For and Against Nuclear Power (OTA, 1984: 215)

Table 32.-Major National Groups Influencing Public Opinion For and Against Nuclear Power

Groups supporting nuclear power

Category 1: Large organizations with a focus on nuclear energy targeting a broad audience.
- U.S. Committee for Energy Awareness
- Atomic Industrial Forum
- American Nuclear Society

Category 2: Lobbying organizations with a primary or secondary focus on nuclear energy.
- Americans for Nuclear Energy
- American Nuclear Energy Council
- Americans for Energy Independence

Category 3: Trade and professional associations that support commercial nuclear energy.
- Edison Electric Institute
- American Public Power Association
- National Rural Electric Cooperative Association
- Institute of Electrical and Electronics Engineers
- American Association of Engineering Societies
- Health Physics Society
- Scientists and Engineers for Secure Energy

Category 4: Industry research organizations indirectly influencing public opinion.
- Electric Power Research Institute
- Institute for Nuclear Power Operations
- Nuclear Safety Analysis Center

Groups opposing some aspects of nuclear power

Category 1: Groups with a focus on nuclear energy and alternatives to it.
- Union of Concerned Scientists
- Critical Mass Energy Project of Public Citizen, Inc.
- Nuclear Information and Resource Service
- Safe Energy Communications Council

Category 2: Large environmental groups that participate in lobbying and public criticism of nuclear energy.
- Sierra Club
- National Audubon Society
- Natural Resources Defense Council
- Friends of the Earth
- Environmental Policy Center
- Environmental Defense Fund
- Environmental Action, Inc.

SOURCES Terry Lash, "Survey of Major National Groups Influencing Public Opinion Against Nuclear Power," Office of Technology Assessment contractor report, April 1983, M & D Mills, "Activities of Groups Which Influence Public Opinion in Favor of Nuclear Power," Off Ice of Technology Assessment contractor report, May 1983

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6. Appendix 1: Current Status and Plans: Nuclear power in the US

Current Status of the Industry

As of May 2016, 99 nuclear reactors in the US produce electricity, down from a high of 103, 68 of which (69%) are PWRs (pressurized water reactors), and 31 of which (32%) are BWRs (boiling water reactors). (Nuclear Energy Institute, 2016) Fifty-two reactors have net capacity at greater than 1,000 MWe (the largest is Grand Gulf, Mississippi, at 1,400 MW), and 10 of them have net capacity at under 700 MW. They operate largely at 85% to 95% capacity.

There are 61 commercially operating nuclear power plants with 99 nuclear reactors in 30 states in the United States. Thirty-five of these plants have two or more reactors. The Palo Verde power plant in Arizona has three reactors and had the largest combined net summer generating capacity of 3,937 megawatts (MW) in 2014. Fort Calhoun in Nebraska with a single reactor had the smallest net summer capacity at 479 megawatts (MW) in 2014.

In essence, a virtual moratorium on ordering and construction of new reactors was in effect from the mid-1980s because of public concerns about nuclear power connected with the accident at Three Mile Island, Pennsylvania, in 1979, growing costs to design, build and license new reactors, declining demand, low cost for coal and natural gas, and other reasons. The reactors already under construction were completed. According to the US EIA, the last newly built reactor to enter service was Tennessee's Watts Bar 1, a TVA NPP, in 1996, with Watts Bar 2 scheduled to come on line in 2016.

In the meantime, the industry and utilities have determined to pursue extension of operating licenses to terms of operation far longer than the originally forecast lifetimes of nuclear power stations. Some critics worry about whether the margin of safety is sufficient to justify license extensions given the high temperatures, high pressures and radiation regimes under which reactors operate that may subject pumps, piping, pressure vessels, fuel assemblies and other components to great stress, and requiring expensive upgrades.

Eight stations with 12 reactors are currently under review for license renewal, while over fifty stations have completed applications for license renewal and have been approved for extended operation.

In the mid-2000s, as worries about global warming and greenhouse gases associated with fossil fuels grew, representatives of the nuclear industry began to push again to create broad government, utility, and public support for the bringing on line of a new generation of nuclear power stations. As a result, Congress passed the Energy Policy Act of 2005, which is offered extensive subsidies for nuclear power and other alternatives to fossil fuels. It offered billions of dollars in tax credits, loan guarantees for advanced nuclear reactors or other emission-free technologies up to 80% of the project cost, $2 billion in insurance to cover licensing delays to the industry, extension for 20 years of the Price Anderson Act for nuclear liability protection, and support for advanced nuclear technology.

Renewed Interest in Nuclear Power in the 2010s?

In mid-2008, the Department of Energy (DOE) invited applications for loan guarantees to support the construction of advanced nuclear power plants (up to $18.5 billion total) and uranium enrichment plants (up to $2 billion initially, but then $4 billion). A further $78.5 billion was offered for renewable energy projects, and $8 billion for "clean coal." According to the NRC, as of April 2016, utilities have begun planning to bring 28 new PWRs reactors (at 1,000 MW or greater capacity) on line in the coming years, with applications for 15 of these NPPs received by the NRC. Most are located in southern states and Texas. (US NRC, 2016b) These include 8 Westinghouse AP-1000. Westinghouse calls its new reactor "the most advanced commercially available nuclear power plant," and touts its advanced passive safety systems for "defense in depth," using gravity rather than operator invention to ensure safety. In the event of a design-basis accident, such as a main coolant-pipe break, the plant is designed to achieve and maintain safe shutdown condition without operator action, and without the need for ac power or pumps. Rather than relying on active components, such as diesel generators and pumps, the AP1000 plant relies on natural forces - gravity, natural circulation and compressed gases - to keep the core and the containment from overheating. (Westinghouse, n. d.)

Fukushima

The nuclear disaster at Fukushima in March 2011 may have dampened hopes for new reactor permits and construction starts, even with these multi-billion dollar subsidies, and has certainly provoked response among a broad sector of the public about the risks of a catastrophic nuclear accident. The public favored nuclear solution to future energy needs after Fukushima, but in 2016 a majority seem to be against nuclear futures. (Newport, 2012; Riffkin, 2016)

Nuclear Futures in the US

The US Energy Policy Act of 2005 offered significant subsidies for nuclear power and other alternatives to fossil fuels, demonstrating that Congress tends to ignore its stated mantra that market mechanisms are preferable to government funding of expensive technologies through billions of dollars in tax credits, loan guarantees, and insurance to cover licensing delays. In response to the Act, a number of large utilities and manufacturers turned from build coal-fired boilers to reactors. The nuclear industry touted the climate-friendliness of NPPs. CEO Jeff Immelt of GE said in 2007, “It's hard to believe simultaneously in energy security and reduction of greenhouse gas emissions without believing in nuclear power. It’s just intellectually dishonest.” Immelt saw as many as five reactors being built annually throughout the world in a matter of years. (Malone, 2007)

The Energy Policy Act included the following incentives for the domestic nuclear power industry:

- Production tax credit of 1.8 or 2.1 ¢/kWh from the first 6,000 MWe of new nuclear capacity in their first eight years of operation (the same rate as available to wind power on an unlimited basis).
- Federal risk insurance of $2 billion to cover regulatory delays in full-power operation of the first six advanced new plants.
- Rationalized tax on decommissioning funds (some reduced).
- Federal loan guarantees for advanced nuclear reactors or other emission-free technologies up to 80% of the project cost.
- Extension for 20 years of the Price Anderson Act for nuclear liability protection.
- Support for advanced nuclear technology.

Also $1.25 billion was authorized for an advanced high-temperature reactor (Next Generation Nuclear Plant) to be built at INL capable of cogenerating hydrogen. In 2006, it was spelled out that the 6000 MWe eligible for production tax credits would be divided pro-rata among those applicants which filed combined construction and operating license (COL) applications by the end of 2008, which commence construction of advanced plants by 2014, and which enter service by 2021.

In October 2007, DOE announced that it would guarantee the full amount of loans covering up to 80% of the cost of new clean energy projects including advanced nuclear power plants under the 2005 Energy Policy Act. The first round of loan guarantees went to renewable energy and advanced gas (*e.g.* integrated gasification combined cycle) projects, while those for nuclear had to be authorized by Congress. In mid-2008, DOE invited applications for loan guarantees to support the construction of advanced nuclear power plants (up to $18.5 billion total) and uranium enrichment plants (up to $2 billion initially, but then $4 billion). A further $78.5 billion was offered for renewable energy projects, and $8 billion for "clean coal." Loan guarantees are to encourage the commercial use of new or significantly improved energy technologies and "will enable project developers to bridge the financing gap between pilot and demonstration projects to full commercially viable projects that employ new or significantly improved energy technologies." They are a form of support that allows companies to finance debt at reduced rates.

Yet even in France, the most active nuclear power in the 2010s, and even with Russian Rosatom's self-proclaimed "nuclear renaissance," it seems unlikely Immelt's prediction can be met. To be sure, no new reactor has come on line yet in the US, and the earliest date may be 2020. Beyond costs and delays, many people oppose nuclear technology, not only because of the Fukushima disaster in March 2011, but because of fear of terrorism, on top of which gas and oil processes have dropped precipitously. Perhaps the major argument for nuclear power in 2016, then, is the argument that nuclear power does not produce greenhouse gases.

NRC Ongoing Reviews of Licenses for NPPs in the 2010s

In the US, in 2013, the Nuclear Regulatory Commission (NRC) was reviewing nine applications for combined construction and operating licenses (COLs) to build 14 new nuclear reactors, as well as three design certification applications for new reactor types (EPR, ESBWR & APWR) and two design certification renewals (both ABWR). Just three years later 18 COL applications had been docketed; four received COLs; five (totaling 8 nuclear reactors) remained under active of the NRC, and 9 were suspended due to utility economic or other considerations. A Reference COL (R-COL) application has been submitted for five reactor designs; subsequent COLs (S-COLs) will incorporate the corresponding R-COL application by reference, noting any site-specific departures. Southern Nuclear's Vogtle units 3 and 4, SCE&G's V.C. Summer units 2 and 3, DTE Energy's Fermi unit 3, and have received COLs.(DOE, 2016b: 1)

TVA expects Watts Bar 2 to enter commercial operation by mid-2016. Southern Nuclear's Vogtle units 3 and 4 are expected to come online in mid-2019 and 2020, respectively. And SCE&G's V.C. Summer units 2 and 3 are expected to come online in mid-2019 and 2020, respectively. (DOE, 2016b: 3)

To quote the World Nuclear Association at length, in 2008, with a fee of $200,000 for the first part and $600,000 for the second part, the government

received 19 initial applications from 17 utilities to support the construction of 14 nuclear power plants involving 21 new reactors of five different designs. The total capacity involved was 28,800 MWe. The total requested came to $122 billion, significantly more than the $18.5 billion offered. The aggregate estimated construction cost involved the 14 projects was $188 billion. The DOE also received two applications for enrichment plants, total $4 billion, against $2 billion initially on offer. (World Nuclear Association, 2016b)

In the light of the interest shown and the fact that the scheme is borrower-funded, the industry called for the amount available for power plants to be increased to $100 billion. In February 2010, the Administration added $36 billion to its FY2011 budget proposal to expand the reactor part of the scheme to $54.5 billion, covering 6 to 8 projects involving up to 13 reactors of several different designs, but this was not approved by Congress. In February 2011 the request was repeated for FY 2012 but was again refused. The FY 2013 budget proposal contained no such request. In the meantime, DOE conditionally granted the applications for one project (Vogtle) and sought to increase the $8.3 billion sum available before October 2010 by $9 billion through other legislation, so that it could approve the other three short-listed power plant applications involving five reactors. (Ibid.)

7. Appendix 2: List of Anti-nuclear Groups in the US (from wiki)

Groups include:

- Abalone Alliance
- Alliance for Nuclear Accountability
- Alliance for Nuclear Responsibility
- Arms Control Association
- Beyond Nuclear
- Citizens Energy Council
- Cactus Alliance (in Utah)
- Catfish Alliance (in Alabama)
- Nuclear Energy Information Service of Chicago (NEIS)
- Citizen's Committee for Protection of the Environment
- Clamshell Alliance
- Coalition for Nuclear Power Postponement
- Committee for a Nuclear Free Island
- Committee for a Nuclear Overkill Moratorium
- Committee for Nuclear Responsibility
- Concerned Citizens Against the Bailly Nuclear Site
- Corporate Accountability International
- Council for a Livable World
- Crabshell Alliance (in Seattle)
- Critical Mass
- Musicians United for Safe Energy
- North Anna Environmental Coalition
- Nevada Desert Experience
- New England Coalition
- Nuclear Age Peace Foundation
- Nuclear Control Institute
- Nuclear Disarmament Partnership
- Nuclear Information and Resource Service
- Nuclear Policy Research Institute
- Nuclear Threat Initiative
- Nuclear Watch of New Mexico
- Nuclear Watch South
- Oystershell Alliance (in New Orleans)
- Palmetto Alliance (in South Carolina)
- Peace Action
- People's Alliance for Clean Energy
- Physicians for Social Responsibility
- Pilgrim Watch
- Plowshares Movement
- Public Citizen
- Red Clover Alliance (in Vermont)

- Don't Make a Wave Committee
- Economists for Peace and Security
- Environmental Coalition on Nuclear Power
- Federation of American Scientists
- Friends of the Earth
- Heart of America Northwest
- Greenpeace
- Institute for Energy and Environmental Research
- Lawyers' Committee on Nuclear Policy
- Maryland Public Interest Research Group
- Mothers for Peace
- Rocky Flats Truth Force
- Riverkeeper
- Shad Alliance
- Shundahai Network
- Sierra Club
- Southern Alliance for Clean Energy
- Seneca Women's Encampment for a Future of Peace and Justice
- Two Futures Project
- Tri-Valley CARE
- White House Peace Vigil
- Wisconsin Project on Nuclear Arms Control
- Women Strike for Peace

Source: http://en.wikipedia.org/wiki/Anti-nuclear_groups_in_the_United_States

8. Appendix 3: Reactor Safety Studies

In the effort to encourage rapid commercialization of nuclear power, the AEC encountered the challenge of balancing public safety with promotion of nuclear power at a stage when the technology of commercial reactors was at an early stage of development. The problem of estimating risk of a catastrophic accident persisted as reactors grew manyfold in size. As they grew in size, so too determining how far to site from population centers became more difficult. AEC commissioners and staff considered siting, emergency reactor core cooling, seismic safety and a series of other issues, in the process often determining that the utilities and reactor manufacturers managers would do the right thing (in terms of safety) even in the absence of complete information. AEC procedures were necessarily ad hoc since these decisions occurred in often uncharted territory. As a result, the AEC too often assumed a promotional, not sufficiently regulatory role.

Brookhaven National Laboratory (March 1957)

WASH-740 scientists concluded that “if the assumed accident happened under what is known as a common nocturnal inversion condition, the lethal cloud of radioactive gases and particles would kill an estimated 3,400 people within 15 miles of the plant. Severe radiation sickness would fell another 43,000 people up to 44 miles away from the accident. Another 182,000 people up to 200 miles away from the source would be exposed to a dose that would double the chances of cancer. Property damage alone would amount to $7 billion about 10 percent of the government receipts at the time in 1957.” WASH-740 also concluded that if containment worked, there would be no danger to the surrounding population. (AEC, 1957)

Gomberg at al. on the “Enrico Fermi” LMFBR (1957)

Gomberg et al. warned in 1957 on the potential for massive and fatal exposures over a large region with millions of residents – depending on wind speed and direction and weather – in the face of the effort quickly to license and build an untried, new technology (a commercial liquid metal fast breeder reactor) near Detroit. (Gomberg, 1957)

ORNL and INL (Idaho National Laboratory, from 1949 the National Reactor Testing Station) (1960s)

A series of experiments in 1960s at ORNL and INL revealed that a LOCA would have a devastating impact and that it would be challenging to get an ECCS to operate in time within parameters.

WASH-1250 (1973)

WASH-1250 was published on a very limited basis as a final draft in July 1973 contains a brief discussion about the development of public sentiment toward nuclear energy in the United States from inception up to the time of publication of this final draft in 1973. (AEC, 1973)

WASH 1400 “Rassmussen” (1975)

WASH-1400, conducted under chairmanship of MIT Professor Norman Rasmussen, considered the course of events that might arise during a serious accident at a large PWR or BWR. It estimated the radiological consequences of these events, and the probability of their occurrence, using a fault tree/event tree approach based on Probabilistic Risk Assessment. The report concluded that the risks to the individual posed by nuclear power stations were acceptably small, compared with other tolerable risks. The report concluded the probability of a complete core meltdown is about 1 in 20,000 per reactor per year. “Contrary to commonly held belief,” the researchers observed, the probability is high “that the consequences” of a core melt accident would be modest to other types of risks. “The likelihood of relatively severe consequences is quite low.” On top of these “the consequences of reactor accidents are often smaller than many people have believed.” Previous studies were based on “unrealistic assumptions” that predicted “relatively large consequences” for reactors that were much smaller than current reactors.” Finally, the likelihood of reactor accidents was smaller than that of many other accidents having similar consequences.” The authors noted that we do not live in a risk free society and never will. But “what level of risk from nuclear accidents should be accepted by society has not been addressed in this study.” (US NRC, 1975)

TABLE 6-3 INDIVIDUAL RISK OF FATALITY BY VARIOUS CAUSES (U.S. Population Average 1969)

Accident Type	Total Number for 1969	Approximate Individual Risk Early Fatality Probability/yr (a)
Motor Vehicle	55,791	3×10^{-4}
Falls	17,827	9×10^{-5}
Fires and Hot Substance	7,451	4×10^{-5}
Drowning	6,181	3×10^{-5}
Poison	4,516	2×10^{-5}
Firearms	2,309	1×10^{-5}
Machinery (1968)	2,054	1×10^{-5}
Water Transport	1,743	9×10^{-6}
Air Travel	1,778	9×10^{-6}
Falling Objects	1,271	6×10^{-6}
Electrocution	1,148	6×10^{-6}
Railway	884	4×10^{-6}
Lightning	160	5×10^{-7}
Tornadoes	118 (b)	4×10^{-7}
Hurricanes	90 (c)	4×10^{-7}
All Others	8,695	4×10^{-5}
All Accidents (from Table 6-1)	115,000	6×10^{-4}
Nuclear Accidents (100 reactors)	—	2×10^{-10} (d)

(a) Based on total U.S. population, except as noted.
(b) (1953-1971 avg.)
(c) (1901-1972 avg.)
(d) Based on a population at risk of 15×10^6.

US NRC, *Reactor Safety Study*, WASH-1400 (Washington: US NRC, October 1975), p. 112.

WASH-1400 provoked extensive commentary and criticism. According to Wiki, for instance, a panel of American Physical Society (APS) criticized WASH-1400 for making fatality estimates only deaths during the first 24 hours after an accident and ignoring other pathways of exposure, let alone the long period before many cancers might arise. Several studies found estimates of probabilities to be too low, others too high. The Union of Concerned Scientists published a highly critical report of WASH-1400 in 1977 for “seriously” underestimating the hazards of nuclear reactor accidents. They argued that the risk of a reactor accident in the early 1980s “is over 400 times greater than that predicted by the reactor safety study” – largely because of the methodology used. In June 1976, the House Subcommittee on Energy and Environment held hearings on WASH-1400, leading the NRC to convene a study group to examine the validity of the report's conclusions under Harold Lewis of the University of California that concluded that "the uncertainties in WASH-1400's estimates of the probabilities of severe accidents were in general, greatly understated.” In 1979 the NRC accepted the criticisms and withdrew its endorsement of the executive summary. (US NRC, 1980; Hendrie, 1979)

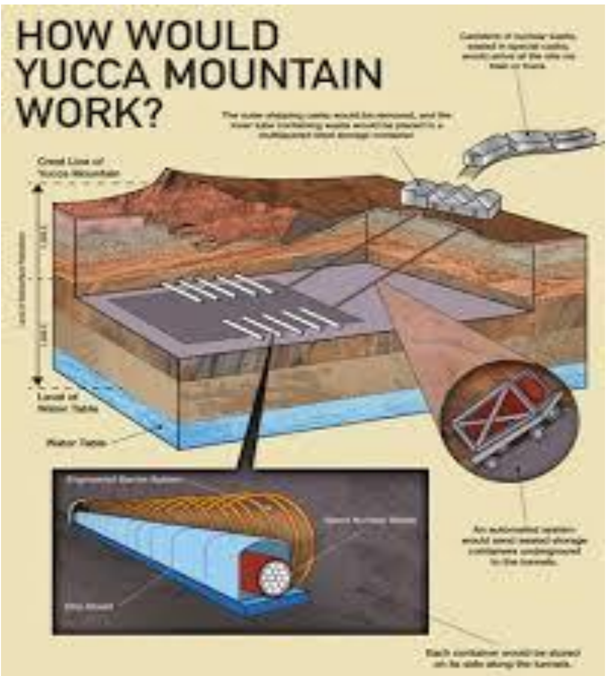
By the 1970s already fifty reactors had come on line, and few of them had ECCS.

9. Appendix 4: Radioactive Waste and Spent Nuclear Fuel

To date, no comprehensive action has been taken to solve the problem of the accumulation of radioactive waste and spent fuel at power stations around the country, the latter amount which has reach 70,000 tons stored in basins or in dry cask storage at the power stations themselves and may be at risk, according to the US Academy of Sciences, from terrorist attack.

Long-term Disposal and Yucca Mountain

Shepherded through a long political process that was intended to select a geographically and scientifically sound place for disposal of radioactive waste, including the 70,000 tons of spent fuel from the operation of 104 commercial reactors, the US DOE selected Yucca Mountain as a site for deep burial. The Nuclear Waste Policy Act of 1987 specified a deep geological repository. Long term, costly, scientific and cultural disputes led to the abandonment of Yucca Mountain even after a number of preliminary tunnels and storage areas had been drilled. But after being initially approved by the Bush administration in 2002, the Obama administration abandoned the site.



The Secretary of Energy asserted to President George W. Bush in 2002 that "sound science" supported the decision to move ahead with Yucca Mountain Repository. But as Rodney Ewing and Allison Macfarlane argued, a number of government agencies that reviewed the suitability of the site determined among other things that "relies on modeling assumptions that mask a realistic assessment of risk" and that "computations and analyses are assumption-based, not evidence-supported." The GAO concluded that, "DOE will not be able to submit an acceptable application to NRC within the express statutory time frames for several years because it will take that long to resolve many technical issues." Ewing and Macfarlane write that "The necessary science to support this decision requires an analysis that couples atomic-scale processes, such as spent fuel and waste package corrosion, to crustal-scale processes, such as volcanic activity and climate change, that extend over temporal scales of thousands, if not tens of thousands, of years." They concluded "At Yucca Mountain, the passive properties of the repository site do not provide a long-term barrier to radionuclide release. The concept of placing spent nuclear fuel in the unsaturated zone where it will experience oxidizing conditions is simply a poor strategy." Other uncertainties include the frequency and impact of volcanic activity, the role of sorption in the unsaturated zone in reducing radionuclide mobility, and the role of colloids in enhancing transport. They called for further study to ensure that Yucca Mountain "may be judged to be an adequate site for the disposal of nuclear waste, but a project of this importance, which has gone on for 20 years, should not go forward until the relevant scientific issues have been thoughtfully addressed." (Ewing and Macfarlane, 2002: 659-670; Macfarlane, 2003)

Table 1. U.S. spent nuclear fuel discharged and stored at commercial sites

Reactor type	1968 through 2002	1968 through June 30, 2013	Increase
	number of assemblies		
Boiling-water reactor	89,843	136,821	46,978
Pressurized-water reactor	69,352	104,647	35,295
Total	**159,195**	**241,468**	**82,273**
	metric tons of uranium (MTU)		
Boiling-water reactor	16,051.6	24,314.8	8,263.2
Pressurized-water reactor	29,893.4	45,366.8	15,473.4
Total	**45,945.0**	**69,681.6**	**23,736.6**

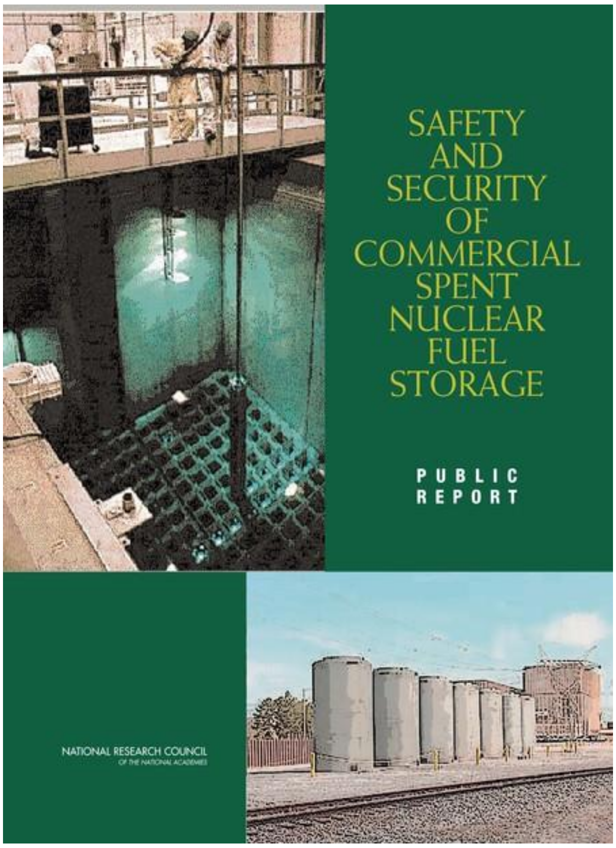
Notes: A number of assemblies discharged prior to 1972, which were reprocessed, are not included in this table (no data is available for assemblies reprocessed before 1972). Utilities were not required to report assemblies shipped to away-from-reactor, off-site facilities. This table shows only assemblies reported on Form GC-859. Totals may not equal sum of components because of independent rounding.
Source: U.S. Energy Information Administration, Form GC-859, "Nuclear Fuel Data Survey" (2013).

The administration of President Obama abandoned the site after 20 years of effort in 2008, and after several billion dollars of effort. The GAO criticized the decision as political, not scientific, (GAO, 2011) and pointed to the liability of the government for up to $15.4 billion because of industry lawsuits. There is a great deal of scientific uncertainty about the seismic and other characteristics of the site. Also the Shoshone people rejected Yucca Mountain as their land, a violation of a treaty with them, and they want their land inviolable to any more nuclear incursions. Ultimately, the absence of a facility indicates yet one more obstacle standing in the way of rejuvenated nuclear in the US.

The repository would have accepted about 175 shipments by train and truck every other day for 24 years in “robust” transportation containers or casks designed to protect them again puncture, immersion, thermal risk or a highspeed crash. (US DOE, 2006)

Terror and SNF

According to the National Academy of Sciences, spent nuclear fuel stored in pools at some of the nation’s commercial nuclear reactors may be at risk from terrorist attacks. The Board on Radioactive Waste Management issued a report that calls on the NRC to conduct additional analyses to obtain a better understanding of potential risks and to ensure that power-plant operators take prompt and effective measures to reduce the possible consequences of such attacks. Because potential threats may differ according to a specific plant's design, the committee recommended that plant-by-plant vulnerability analyses be performed. The Bush administration attempted to classify and prevent publication of parts of this report.



The GAO pointed to some improvements made on physical security but noted that others in the design basis to threats must be improved. (US GAO, 2006)

Nuclear Fuel

The United States has an extensive nuclear fuel industry whose roots are with the Manhattan Project (the atomic bomb project) and the construction of the Oak Ridge (later ORNL) gaseous diffusion facility for the separation of U^{235} from non-fissile U^{238}, and the Hanford, Washington, site for plutonium production. Later other facilities were added to produce enriched uranium at Paducah, Kentucky, and Piketon, Ohio (closed in 2001). Centrifuge production of enriched uranium has occurred in Eunice, NM, Bonneville County, ID. The only US facility that enriches uranium in 2016, USEC, in Eunice, NM, has struggled with bankruptcy pressures, so that uranium enrichment, pioneered in the US, “may become primarily a European and Russian technology.”(Wald, 2014) Currently, almost all the uranium used in US commercial reactors is imported. After reaching a peak in 1980, domestic mining now accounts for only 10% of the fuel used in US reactors. Between 1977 and 2005, government policy did not allow reprocessing of used fuel for commercial reactors.

Fuel Actors in 2010s (World Nuclear Association, 2016b)

Thus the US currently has one operating enrichment plant owned by Urenco (formerly National Enrichment Facility), and USEC's Paducah, Kentucky facility built by the government in the early 1950s to provide fuel for military reactors. Two proposed enrichment plants could begin operation around 2020. In addition, USEC had started building its own enrichment plant, the American Centrifuge Plant in Piketon, Ohio, which had been due to begin operation in 2010, but the project was put on hold in July 2009. In 2014 USEC became Centrus Energy Corp as it emerged from bankruptcy.

Urenco USA (formerly National Enrichment Facility) has a major centrifuge enrichment plant at Eunice, New Mexico. It uses 6th generation Urenco technology from Europe and was planned by the Louisiana Energy Services (LES) partnership – comprising Urenco, Exelon, Duke Power, Entergy, and Westinghouse. Construction of the $1.5 billion plant was licensed by the Nuclear Regulatory Commission (NRC) in mid-2006 when as agreed the three utilities then passed their share to Urenco, and the company is now a subsidiary of Urenco USA. Utility support for the venture – initially amounting to $3.15 billion in orders – was crucial in persuading the NRC that further US enrichment capacity was required beyond that provided and envisaged by USEC.

The USEC and Paducah old plant was the last gaseous diffusion plant still operating in the world, having been commissioned in 1952 for military use. It began providing enriched uranium for civilian reactors in the 1960s. Originally government-owned, USEC became a private sector corporation in 1998, and leased its two large enrichment plants from the DOE. In 2001, it consolidated its enrichment operations at the Paducah site after closing the older Portsmouth facility at Piketon, Ohio[b]. Both plants were very energy-intensive and costly to run.

In November 2013 the DOE announced that it had selected a proposal from **Global Laser Enrichment** (GLE) to build a plant to enrich uranium. In the same announcement, the DoE said it would enter negotiations with Areva to process off-specification uranium hexafluoride as blend stock for domestic nuclear fuel. This would be carried out using Areva's existing nuclear fuel fabrication facility in Richland, Washington. DOE said that the GLE and Areva projects represented "an important next step" in planning for potential future uses and clean-up efforts at Paducah as well as reducing the costs to the taxpayer of the clean-up operation. Fluor has a three-year $420 million DOE contract to clean up the Paducah site from 2014.

The United States Enrichment Corporation (Centrus)[1]

"In the 1960s, it began providing commercial sales of enriched uranium to the commercial nuclear power industry worldwide. Over the next twenty years, the U.S. government's uranium enrichment complex became the primary supplier of low-enriched uranium to reactor operators around the world, helping to promote the peaceful use of nuclear power and advance the nation's nonproliferation agenda. In the 1970s, the Nixon administration first proposed the privatization of the government's enrichment business. Two decades later, the Energy Policy Act of 1992 created the United States Enrichment Corporation, a government corporation, out of the U.S. Department of Energy's Uranium Enrichment Enterprise, with plans to eventually fully privatize the government's uranium enrichment organization. The new government corporation began operations in July 1993.

'The U.S. government sold the company in an initial public offering in 1998, and USEC Inc., a private, investor-owned company, began trading on the New York Stock Exchange. Proceeds from the sale provided more than $3 billion to the U.S. Treasury. The company continued to operate the country's Cold War era enrichment plants safely and efficiently until the last one was shut down for economic reasons in 2013.

"In the early 1990s, the United States and Russia reached a landmark agreement that would turn former Soviet nuclear weapons material into fuel to power America's civilian nuclear reactors. The company played a key role in implementing the deal, marketing the downblended material to U.S. utilities and arranging for deliveries. From 1993 to 2013, the "Megatons to Megawatts" partnership provided enough fuel to generate 10% of America's electricity needs. It was the most successful non-proliferation effort in history – eliminating more than 20,000 warheads worth of weapons-grade material. That corresponds to the elimination of three bomb equivalents per day for twenty years.

"After a financial restructuring in 2014, the company re-emerged as Centrus Energy Corp., with a stronger balance sheet and a new board of directors. In 2015, the Board selected a new leadership team, which is focused on expanding and diversifying its business. Today, the company has a multibillion-dollar long-term order book with customers around the world, a diverse base of nuclear fuel supply contracts stretching to 2026 and beyond, world-class technical capabilities, and a strong market opportunity as the global nuclear industry continues to grow."