# Implementation of artificial intelligence algorithms in climatic zoning according with energy demand in dwellings. A european case


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## I. Introduction

Science has shown, based on data and knowledge, that there is clear evidence that global warming is not a transient effect, and that it is caused mainly by human activity [1]. The consequences of climate change can be noted and quantified nowadays [2], but the worst thing is that these impacts are expected to intensify in the coming decades. Obviously, global problems require global solutions, and even if there are certain difficulties to define a clear path, there is no doubt that the worldwide efforts should lead to keep the global temperature increase to well below 1.5ºC [3].

Greenhouse gases (GHG) have a major influence on global warming, and they are mostly emitted as a consequence of anthropogenic processes which are linked with the high energy consuming society, low energy efficient systems and the use of fossil fuels as primary energy. In this sense, in the European Union (EU), buildings are responsible for 40% of the energy consumption and 36% of GHG emissions [5]. By the year 2018, households accounted for 26.1% of final energy consumption in the EU, being the main use of energy to maintain adequate comfort conditions [4].

Then, it is clear that in order to achieve the ambitious goal of carbon neutrality by 2050 [6], improving the energy efficiency in buildings has to play a key role. Given the fact that most of the energy use is employed in satisfying the heating and cooling demands, there is a clear dependence between weather or climate conditions and energy consumption in the buildings. However, there is no climatic zoning of Europe which would be of high importance to define clear objectives in terms of energy consumption in buildings; to allow the replication of successful experiences with low energy consumption in similar weather conditions; and to define realistic energy plans.

Buildings are part of districts, and being Positive Energy Districts [7] the intermediate step between positive energy building and positive energy city, the results from the research could be of high interest.

## II. Methods

So far, the climatic zoning for energy demand in buildings in different EU Members States do not follow a common pattern or methodology. In fact, being an issue which apparently does not require many input data, it could be reasonable to think that the climatic zoning in Europe has already been developed.

There are 3 main methodologies to define the climatic zoning. One of these methodologies employs the Köppen-Geiger classification [8] which has been employed for many different applications and is the most employed worldwide so far. This classification takes into consideration temperature and rain precipitation, and clearly classifies the weather conditions based on defined thresholds. There are 5 main climate zones and up to 30 subzones, and it is really useful for vegetation purposes. The second type of methodologies takes into consideration the Degree-Days (DD) concept [9], both for Heating (HDD) and Cooling (CDD) purposes. However, the threshold values for the HDD and CDD calculations vary and so does the threshold values for the classifications. ASHRAE standard 169-2013 [10] defines a climatic classification based on HDD and CDD, but despite the fact of being a methodology easy to calculate and understand, it does not consider other input values such as solar radiation. Finally, the third kind of methodologies are based on the definition of Severity Climate Indexes for Winter (WCS) and Summer (SCS) obtained from the use of energy simulation calculations. These methodologies require the use of computational resources and are difficult to understand, since are based on mathematical modelling. Spain's climatic zoning was defined based on Severity Climate Indexes.

Then, the objective of the research is to follow the Montecarlo method and run a huge number of parametric energy simulations varying the most influence variables (air infiltration, wall insulation, orientation...), and making use of Artificial Intelligence define the number and the boundaries of the climatic zoning in Europe.

## III. Main Results

When comparing the different methodologies, there are several inconsistencies among the results from the methods when using the typical meteorological years from several locations in Europe. The main issue is to classify correctly the "intermediate" climates, since hot and cold climates are simple to classify. However the definition of a clear boundary between the zones varies from one method to another, and so does the number of zones.

After a total of 88,704 energy simulation run with TRNSYS software [11], it is clear that there is a dependence of energy demand in buildings on solar radiation, so the climatic classification to be defined should consider this variable on the calculations.

HDD and CDD are good predictors, but the performance is increased when another variable such as solar radiation is employed.

## IV. Discussions

A common approach should be employed, in order to be able to compare results from similar weather conditions. Nowadays, two countries with apparently similar climates (Spain and Italy), employ different methodologies in climatic zoning, although it should be easier to define the climatic zones in those countries. When this issue is extrapolated to the EU, it seems more obvious to have a common strategy towards a common objective.

Some of the methodologies employed so far lack of accuracy, and this leads to a variety of results among them.

This way, a minimum of 5 climatic zones have to be defined in Europe.

## V. Future Work

The first results from the parametric study showed good performance. The future work is to define a number of different buildings based on the typology (block of apartment, detached houses, etc) and the comfort conditions considering the comfort levels in different European countries.

An update of weather climates based on recent weather data has to be done, because most of Typical Meteorological Years need periods of time longer that 20-25 years, and in the last years the weather has varied. As a consequence of global warming, HDD (and therefore heating demand) is decreasing, and the opposite occurs to CDD (and Cooling Demand).

The authors will investigate about the most appropriate AI techniques to carry out the most suitable climatic zoning in Europe. These developments will help to define the planning of the building sector pathways considering energy, $CO_2$ emissions and economic savings under a common strategy.

## References

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