PV POWER FORECAST USING A PARAMETRIC MODEL

Mikel Muñoz*, Iñigo de la Parra, Miguel García, Luis Marroyo

Dept. of Electrical and Electronic Engineering
& Institute of Smart Cities
Public University of Navarre, Campus Arrosadía, 31006, Pamplona (Spain).
(mikel.munoz@unavarra.es)

ABSTRACT

- Nowadays, both system operators and PV plant owners can benefit from an accurate AC power output forecast of PV plants.
- After analyzing the existing commercial services of PV production forecast it has been identified the potential to improve the models used to calculate the AC power output.
- **Therefore, in this poster, a parametric model is proposed in order to improve the forecast performance.**
- A tool to implement this parametric methodology has been built upon the Matlab environment.
- The tool has been developed to provide the PV plant production one day in advance.
- It has been evaluated and validated using historical data of a fixed PV generator (2,24kWp) and a large PV power plant (45MWp).

OBJECTIVES

- Study and validation of a **PARAMETRIC MODEL** to provide the output AC power (Energy) of the PV plant using as forecast input variables:
  - Ambient temperature (T_a).
  - Global horizontal irradiance (G_0).

PARAMETRIC MODEL

Parts of the model

- **PART 1**: Transform global horizontal irradiance into effective irradiance in the plane of the PV array (G_I) and then both ambient temperature and irradiance in the array plane into cell temperature (T_c).
  - Calculate G_I from G_0.
    - Decomposition model that estimates diffuse and beam components from the global horizontal irradiance.
      - *(Erbs et al. 1982).*
    - Translation of irradiance values from the horizontal surface to the plane of PV modules and discount of power losses caused by shading, dirt, incidence angle and spectrum.
      - *Position of the sun, PV generator and incidence angle (Lorenzo 2011).*
      - *Shaded surface on the PV generator.*
      - *Irradiance on the PV generator plane (Hay & Mckay 1985)(Perez et al. 1987).*
      - *Dirt and incidence angle losses (Martin & Ruiz 2001).*
      - *Shading losses (Ruiz 1999).*
      - *Spectral corrections (Fuentes et al. 2007).*
  - Calculate T_c from T_a and G_I.
- **PART 2**: Simulate the losses in each element of the PV installation using:
  - Model PV panel performance.
    - *(Evans 1981, Osterwald 1986).*
  - Inverter characterization.
    - *(Jantsch et al. 1992).*
  - Power efficiency of the transformers.
    - *where*
  - Wiring power losses.
    - Calculated using a similar equation as P_{cu}.

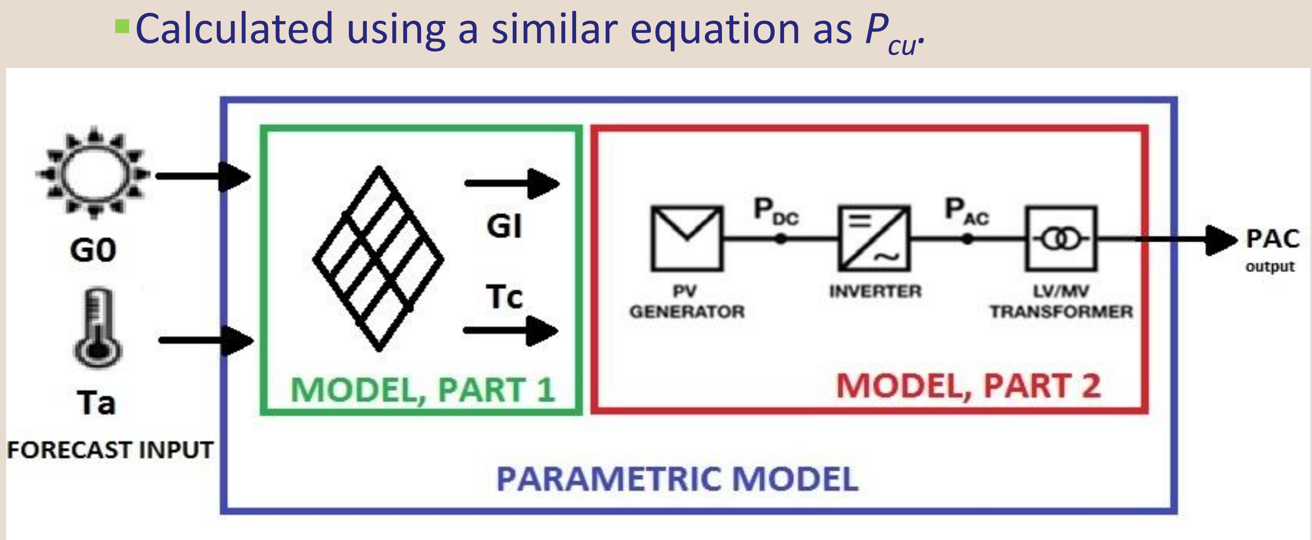


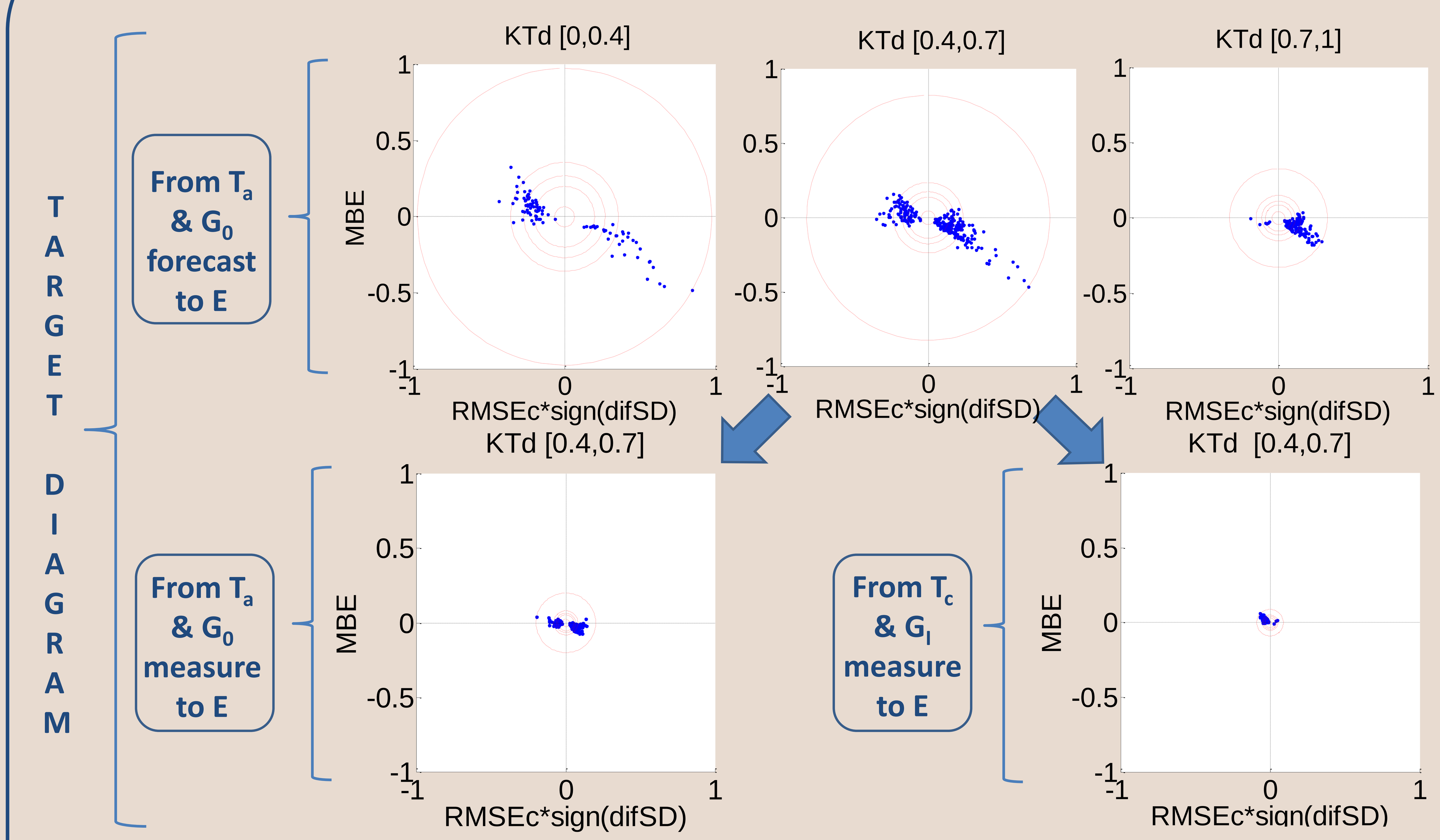
Diagram of a general configuration of a grid-connected PV system

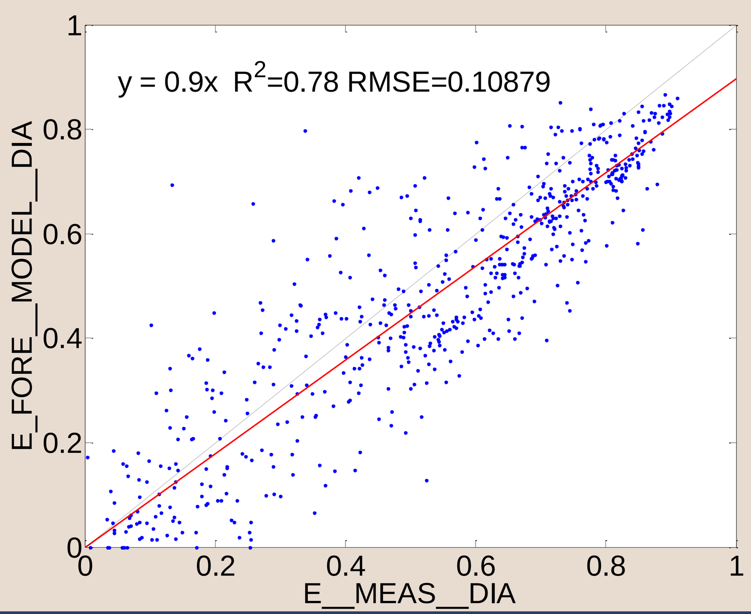
Model Validation

FIXED PV GENERATOR AND LARGE PV PLANT THROUGHOUT TWO YEARS HAVE BEEN VALIDATED

Below, as an example, the LARGE PV PLANT validation is shown.

Large PV plant Validation

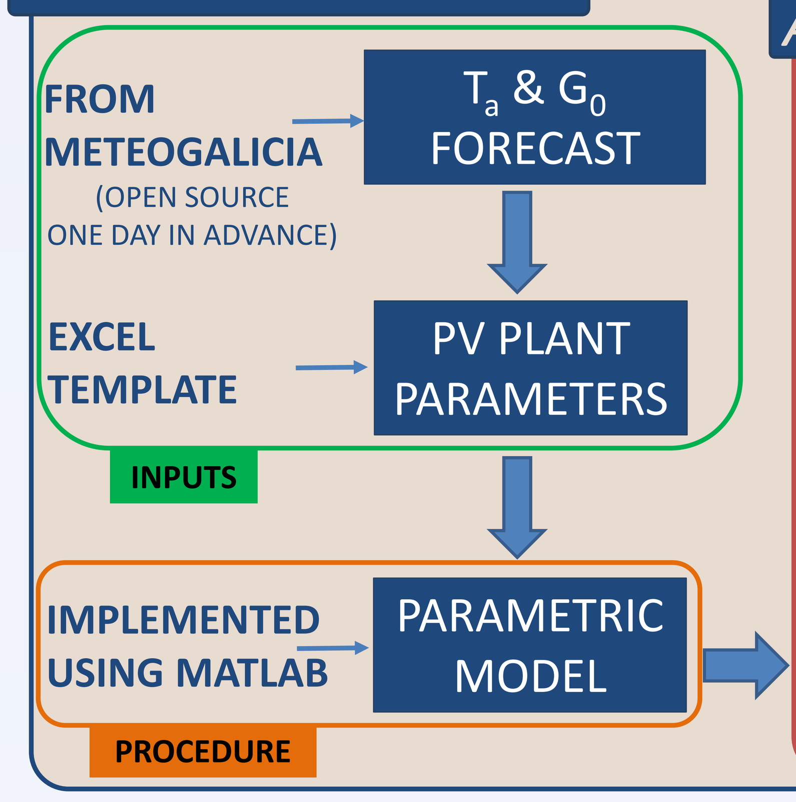




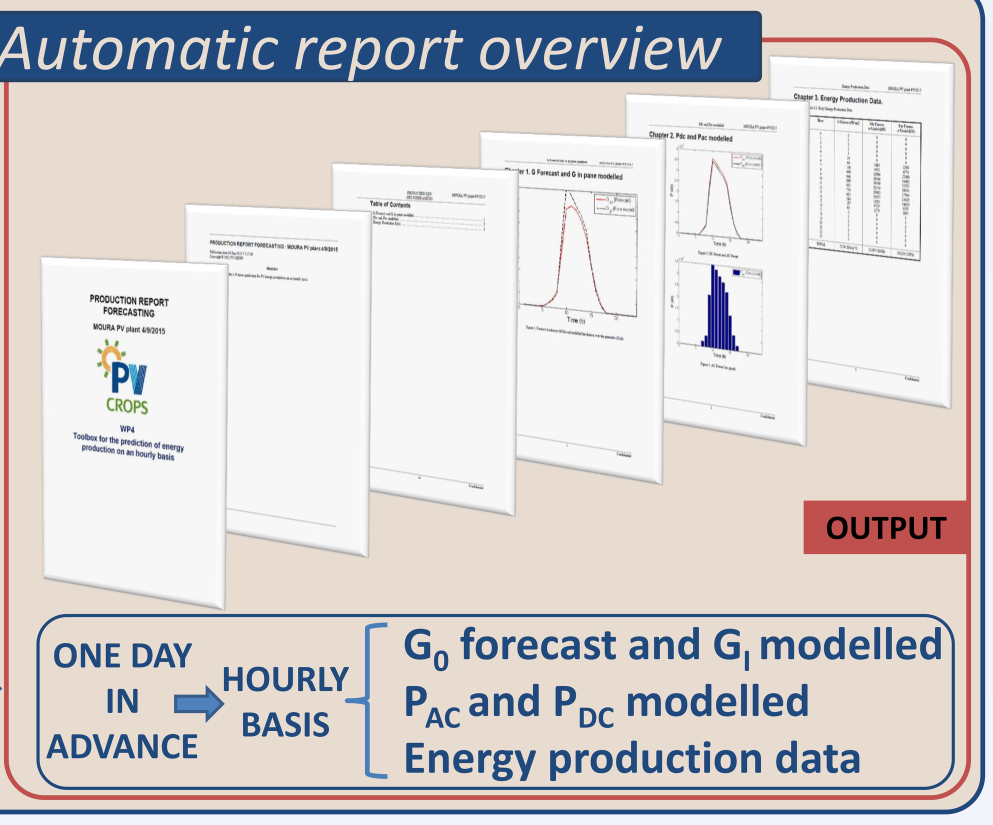
SUMMARY OF THE VALIDATION RESULTS			LARGE PV PLANT		
			Regression Coef.	R^2	RMSE
Complete model		E	0.9	0.78	0.109
Prediction		G_0	0.99	0.9	0.090
		T_a	0.83	0.98	0.026
PV plant models	Part 1	G_I	0.89	0.99	0.033
		T_c	1.36	0.98	0.098
	Part 2	E	1.06	1	0.018

ACCURACY
- Model Part 2 (From T_c & G_I measure): **±1%**
- Model Part 2 + Part 1 (From T_c & G_I measure): **±4%**
- Complete model (From T_a & G_0 forecast): **±18%**

TOOL OVERVIEW



Automatic report overview



CONCLUSIONS

- This parametric model offers an interesting solution to provide output AC power.
- The accuracy of the procedure mainly depends on the forecast precision.
- Greater accuracy is achieved at greater values of the clearness index where most of the energy production lies.
- If the forecast precision is not considered the parametric model has great accuracy.
- The tool is a useful solution to know the PV production plant one day in advance

31st European Photovoltaic Solar Energy Conference and Exhibition

EU PVSEC 2015. From 14th to 18th September in CCH Congress Centre Hamburg – Hamburg- Germany