Solar power plant performance evaluation through an Analog Ensemble scheme, based on satellite estimation of global irradiance at the surface.

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1. Introduction

In Italy, since 2008 there’s been an increase of more than 115% in renewable energy installations, according to the GSE (Energy Service Operator) statistical reports. Wind and solar energy plants, responsible of this boom, are not programmable and their production can change rapidly, according to the weather conditions, leading to instability on the voltage profile. Sometimes grid operators forced the shut down of some plants for the security of the power system. In this case the potential production of the plant, depending on the weather conditions, shall be estimated, in order to calculate the refund amount for the producer. Furthermore, it’s recommended to optimize the plant performance. In particular it is necessary to distinguish if a loss of production is due to bad weather or to equipment malfunctions. For these reasons, a performance evaluation system for solar plants, scattered across the territory, has been developed, using global irradiance data as input. The technique is suited for different types of plants (standard PV plants or solar tracking systems) and with no need of information about the plant characteristics, except for the position, necessary to calculate the exact solar position at each moment.

2. Method

2.1 Analog Ensemble technique

The ex-post potential production is obtained using the power production registered in the past in similar solar irradiance conditions. The similarity is evaluated minimizing the distance between few parameters. The predictors are:

- Global horizontal irradiance (GHI)
- Sun position

2.2 Global horizontal irradiation (GHI) estimation from Satellite

In order to apply the method everywhere, the irradiance is estimated with MSG satellite data. RSE developed a statistical method called RADSAF, by which the GHI is obtained from a third order polynomial on the basis of the sun altitude and the type of cloudiness, derived from the SAFNWC software (Software Application Facility for NoWCasting), developed by the EUMETSAT SAF Network.

3. Application

The following graphs are examples of monitoring of plants with different sizes and technologies, in Italy. In each graph, the black line shows the production of the plant, the red line the AN estimate, with the range of 1 σ in dark blue and 2 σ in light blue. The diamonds represent the GHI estimation from RADSAF, in order to examine the corresponding weather condition. The blue points, on the bottom, describe cloudless conditions, where the forecast uncertainty is lower. Finally, the orange circles are alarm conditions, due to a drift greater than 1 σ between power estimate and measurement.

4. Conclusions

- A power monitoring system has been developed, based on the Analog Ensemble technique.
- The predictors are the GHI estimation from MSG satellite data and information on sun position.
- No need of technical information about the powerplant.
- Applicable to heterogeneous plants and everywhere.
- Useful for early failure detection.
- Ideal for the validation of power measurements, used in the training phase.

References


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