Short-term photovoltaic generation forecasting using multiple heterogenous sources of data based on an analog approach.

Kevin Bellinguer1, Robin Girard1, Guillaume Bontron2, and Georges Kariniotakis1
1MINES ParisTech, PSL University, PERSEE – Centre for Processes, Renewable Energies and Energy Systems 1 rue Claude Daunesse, CS 10207, 06904 Sophia Antipolis Cedex, France (kevin.bellinguer@mines-paristech.fr, robin.girard@mines-paristech.fr, georges.kariniotakis@mines-paristech.fr)
2Compagnie Nationale du Rhône, Lyon, France (g.bontron@cnr.tm.fr)

Abstract

Over the past years, environmental concerns have played a key role in the development of renewable energy sources (RES). In Europe, the installed capacity of photovoltaic (PV) has increased from around 10 GW in 2008 to nearly 119 GW in 2018 [1]. Due to this high penetration rate and the intermittent nature of RES, several challenges appear related to the economic and secure operation of a power system. To overcome these challenges, it is necessary to develop reliable forecasts of RES, and namely of PV production, for the next hours to days to adjust production planning, while intra-hourly forecasts may contribute to optimize operation of storage units coupled to RES plants.

The aim of this paper is to present a novel spatio-temporal (ST) spot forecasting approach able to use multiple heterogeneous sources of data as inputs to forecast short-term PV production (i.e. from 15 minutes up to a day ahead).

First, we consider measured production data from nearby power plants as input to forecast the output of a specific PV plant. These data permit to exploit the correlation between the production data of spatially distributed PV sites. The classical ST approach in the literature, based only on this source of data [2], permits to improve predictability for the next few minutes up to 6 hours ahead.

Then, we extend the model by the use of satellite images (i.e. global horizontal irradiance (GHI)) which provide meaningful spatial information at a larger extent.

Finally, we consider Numerical Weather Predictions (NWPs) as input, which permit to extend the applicability of the model to day-ahead lead times, so that, overall, the resulting model covers efficiently horizons ranging from a few minutes to day ahead.

The spatio-temporal relationships being dependent on the particular meteorological situation of the day at hand, we apply an analog ensemble approach, to condition the learning process with historical observations corresponding to similar meteorological situation. We used the analogue approach to select a subset of similar historical situations over which a dynamical calibration of
the forecasted model is done, as it was for example suggested by [3,4]. In our paper we extend the analogs ensemble approach by considering geographically distributed observations of the physical variables of interest (as suggested by [4] for hydrological issues) rather than only those at the level of the PV plant.

The performance of the proposed ST model with heterogeneous inputs is compared with reference models and advanced ones such as the Random Forest model. Historical production data collected from 9 PV plants of CNR are considered. The power units, located in the South-East France, exhibit relevant spatial correlations which make them suitable for the proposed ST model.

References

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