EGU21-16091
https://doi.org/10.5194/egusphere-egu21-16091
EGU General Assembly 2021

Assessment of Alternative Ways to Integrate Weather Predictions in Photovoltaic Generation Forecasting.

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In recent years, the share of photovoltaic (PV) power in Europe has grown: the installed capacity increased from around 10 GW in 2008 to nearly 119 GW in 2018 [1]. Due to the intermittent nature of PV generation, new challenges arise regarding economic profitability and the safe operation of the power network. To overcome these issues, a special effort is made to develop efficient PV generation forecasting tools.

For short-term PV production forecasting, past production observations are typically the main drivers. In addition, spatio-temporal (ST) inputs such as Satellite-Derived Surface Irradiance (SDSI) provide relevant information regarding the weather situation in the vicinity of the farm. Moreover, the literature shows us that Numerical Weather Predictions (NWPs) provide relevant information regarding weather trends.

NWPs can be integrated in the forecasting process in two different ways. The most straightforward approach considers NWPs as explanatory input variables to the forecasting models. Thus, the atmosphere dynamics are directly carried by the NWPs. The alternative considers NWPs as state variables: weather information is used to filter the training data set to obtain a coherent subset of PV production observations measured under similar weather conditions as the PV production to be predicted. This approach is based on analog methods and makes the weather dynamics to be implicitly contained in the PV production observations. This conditioned learning approach permits to perform local regressions and is adaptive in the sense that the model training is conditioned to the weather situation.

The specialized literature focuses on spot NWPs which permits to find situations that evolve in the same way but does not preserve ST patterns. In this context, the addition of SDSI features cannot make the most of the conditioning process. Ref. [3] proposes to use geopotential fields, which are wind drivers, as analog predictors.

In this work, we propose the following contributions to the state of the art:

We investigate the influence of spot NWPs on the performances of an auto-regressive (AR) and a random forest models according to the two above-mentioned approaches: either as additional explanatory features and/or as analog features. The analogy score proposed by [2] is used to find similar weather situations, then the model is trained over the associated PV production observations. The results highlight that the linear model performs better with the conditioned approach while the non-linear model obtains better performances when fed with explanatory features.

Then, the similarity score is extended to gridded NWPs data through the use of a principal component analysis. This method allows to condition the learning to large-scale weather information. A comparison between spot and gridded NWPs conditioned approaches applied with AR model highlights that gridded NWPs improves the influence of SDSI over forecasting performances.

The proposed approaches are evaluated using 9 PV plants in France and for a testing period of 12 months.

References

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