ProPower: Evaluating the value of probabilistic forecasts in power systems

Lueder von Bremen[1], Bruno Schyska[1], Hauke Bents[1], Clara Buller[1]

1. German Aerospace Center (DLR), Oldenburg, LOWER SAXONY, Germany

Objective and Background

Probabilistic forecasts have been promoted by meteorologists for years. However, the use of probabilistic forecasts in the energy sector is still limited. One reason for that is that many real-world decision processes and applications to manage the power system are not designed to integrate uncertain information.

The objective of this presentation is to introduce ProPower, the Probabilistic Power Forecast Evaluation Tool developed at DLR. The main purpose of ProPower is to assess the value of probabilistic power forecasts for PV and wind power systems compared to the usage of deterministic forecasts that do not contain any uncertainty information. Conclusively, it is possible to test and rank different probabilistic forecasts, either post-processed ones or issued by different NWP centres. Finally, it will be researched how the value of wind and solar forecasts depend on the chosen power system (infrastructure) and the implemented power markets.

Method

Usual approaches to derive the cost-optimal power dispatch within a market region and where power constraints (e.g. grid capacities) are fully considered do not account for the potential balancing costs arising from forecast errors in wind and solar. It has been shown by Morales et al. [2014] for a quite simplistic network (i.e. two nodes) that dispatch decisions based on pure deterministic forecasts lead to sub-optimal market clearing. To overcome this issue they proposed a stochastic market clearing model. In this model, average balancing costs are estimated from a set of scenarios of renewables feed-in that are equivalent to ensemble members from an ensemble prediction system. The ProPower tool is capable to simulate more complex power system and is mainly restricted by the computational expenses of the optimization problem. Furthermore, we implemented a second market clearing that is based on updated forecasts of higher skills. Currently, we use ECMWF ensemble forecasts [Leutbecher and Palmer, 2007] for the day-ahead market clearing and the intraday market clearing. The amount of required balancing is determined by the deviation of forecasted renewables feed-in to feed-in computed from ERA5 reanalysis.

Principal Findings

We found that stochastic market clearing reduces total power system cost by saving balancing power compared to the conventional market clearing even for more complex networks. Furthermore, the use of forecast updates in an intraday market is beneficial as extreme day-ahead forecasts errors do not need to be balanced with more expensive balancing energy at the time of power delivery.

Conclusion

The ProPower tool is capable to translate probabilistic forecast skill into benefits for the power system respecting the most important characteristics of the real-world power system (i.e. grid constraints, network layouts, varying costs for different producers). ProPower has the potential to analyze which forecasts errors are most expensive to balance and how valuable skillful uncertainty information from different sources is.

References

Morales, J.M., Zugno, M., Pineda, S., and Pinson, P. (2014): Electricity Market Clearing with Improved Scheduling of Stochastic Production, *European Journal of Operational Research*, 253(3)

Leutbecher, M., and Palmer, T.N. (2007): Ensemble forecasting, *Journal of Computational Physics*, 227