Leveraging stochastic differential equations for probabilistic forecasting of wind power using a dynamic power curve

Short-term (hours to days) probabilistic forecasts of wind power generation provide useful information about the associated uncertainty of these forecasts. Standard probabilistic forecasts are usually issued on a per-horizon-basis, meaning that they lack information about the development of the uncertainty over time or the inter-temporal correlation of forecast errors for different horizons. This information is very important for forecast end-users optimizing time-dependent variables or dealing with multi-period decision-making problems, such as the management and operation of power systems with a high penetration of renewable generation. This paper provides input to these problems by proposing a model based on stochastic differential equations that allows generating predictive densities as well as scenarios for wind power. We build upon a probabilistic model for wind speed and introduce a dynamic power curve. The model thus decomposes the dynamics of wind power prediction errors into wind speed forecast errors and errors related to the conversion from wind speed to wind power. We test the proposed model on an out-of-sample period of 1 year for a wind farm with a rated capacity of 21 MW. The model outperforms simple as well as advanced benchmarks on horizons ranging from 1 to 24 h.

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