From meteorological ensembles to reliable probabilistic forecasts of wind generation

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Abstract

Significant variability and limited predictability of wind power production make its optimal management a challenge for the various actors of the energy sector. The necessity of making decisions from forecasts (with forecast length up to 48-72 hour ahead) is already recognized, while the additional benefits coming from the consideration of reliable and situation-specific information on forecast uncertainty are being demonstrated for a large range of decision-making problems. It appears today that the most appropriate way of estimating and communicating forecast uncertainty is with probabilistic forecasts, i.e. forecasts of the probability distribution (or some of its quantiles) of wind generation for each look-ahead time. The resolution of such probabilistic forecasts, that is, their ability to resolve among situations with various level of uncertainty, can be maximized by using meteorological ensemble predictions as input. Meteorological ensembles consist of a set of (ideally equiprobable) scenarios for the coming period. Ensemble forecasts of wind power can be obtained by passing ensemble forecasts of meteorological variables through a suitable power curve. This power curve is modeled here with local linear regression, the coefficients of which are adaptively and orthogonally fitted. The obtained ensemble forecasts of wind power can then be converted into nonparametric predictive distributions with adaptive Kernel dressing. Kernels to be attached to each ensemble members are parameterized with a mean–variance model accounting for known characteristics of wind power prediction uncertainty. These parameters are then adaptively estimated with a recursive Bayesian moving average method. This complete methodology for probabilistic forecasting is applied to the test case of the Horns Rev offshore wind farm in Denmark, over a period of one year. It is shown that the obtained nonparametric predictive distributions from the set of ensemble members are reliable, and exhibit a high resolution. Perspectives regarding further works will finally be given.