Investigation of the potential improvement of Offshore Wind Power Forecast based on Ensemble Weather Prediction by using offshore specific parameters

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In the future, offshore wind energy will contribute significantly to the European electricity demand. According to the German government, the installed capacity of electricity generation from offshore wind power shall increase to 20 GW - 25 GW installed capacity in 2030.

The high concentration of large off-shore wind farms in the North and Baltic Seas is very challenging with respect to safe and reliable grid integration. Indeed, an important amount of wind energy will be produced in a relatively small area; hence smoothing effects are limited compared to onshore wind power. Therefore fluctuating wind power generation will become a critical issue concerning required balancing and reserve power with increasing offshore wind power deployment. In addition, the number of connections of offshore wind farms to the transmission system is very limited. Only a few lines are heavily used to transfer wind power to the peak demand areas in Germany resulting in critical power flow management.

Advanced wind power prediction models based on Numerical Weather Prediction (NWP) are a key technology for facing the network problems raised by offshore wind energy. In this paper, a new approach for an offshore-specific wind power prediction system is presented. The work was carried out with measured data from the offshore wind farm Horns Rev in Denmark in the scope of the project “High Resolution Ensemble for Horns Rev” (HRensembleHR) funded by the Danish PSO Programme 2006-2009.

A wind power prediction system based on a neural network approach using input from a 75 member Multi-Scheme Ensemble Prediction System (MSEPS) has been applied to the offshore wind farm Horns Rev. The multi-scheme ensemble prediction approach is a technique, where different parameterizations or schemes are used to vary the calculation of meteorological processes (e.g. vertical diffusion, condensation), giving the potential to provide a more realistic representation of the state of the atmosphere, the uncertainty of the forecasted weather situation and hence lower forecast errors.

The wind power forecasting system has been developed in two phases. In a first step, wind power forecasts for each of the 75 ensemble members have been calculated individually with a neural network. In a second step, all predictions from each ensemble member have been combined using different statistical methods (e.g. averaging, linear regression and optimal weights) and artificial intelligence based approaches (e.g. two step ANN approach).

A comparison of wind power prediction accuracy between onshore and offshore wind farms has been carried out to assess specific offshore wind power prediction error.

In order to further improve this wind power prediction system, the influence of additional oceanographic and atmospheric parameters on the forecast accuracy is investigated. For this purpose, the influence of different offshore specific parameters on the wind speed is investigated. The most influent parameters are then integrated in the prediction system to improve the prediction accuracy.

Strong wind power fluctuations that have been observed at Horns Rev seem to be caused by specific offshore conditions. In this paper we investigate which atmospheric and oceanic parameters are correlated with these fluctuations. The goal is to find sets of parameters that can be forecasted by NWP to determine the risk of strong fluctuations. Our investigations focus on Horns Rev within the HRensembleHR project and on measurements (of wind speed) at FINO1 within the “RAVE Grid Integration” project. Indices are developed to characterize atmospheric turbulence by convection and its influence on wind fluctuations.

The results of first trials to include these new oceanographic and atmospheric parameters in the ANN to improve offshore wind power forecasts and to determine the risk of strong fluctuations will be presented at the conference.