

# Development of an Offshore-Specific Wind Power Forecasting Model based on Ensemble Weather Prediction and Wave Parameters

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## Abstract

In the future, offshore wind energy will contribute significantly to the electricity demand. According to the German government, the installed capacity of electricity generation from offshore wind power in Germany 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 mitigating the network problems raised by offshore wind energy. In this investigation, 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 approach consists of two steps. First, wind power forecasts for each of the 75 ensemble members are calculated individually with a neural network. In the second step, the predictions from the individual ensemble members are combined by applying different statistical and artificial intelligence based methodologies.

In order to improve this ensemble based forecasting neural network approach specifically for offshore conditions, the influence of additional oceanographic and atmospheric parameters on the forecast accuracy is investigated. The parameters with most influence such as mean wave period and significant height of wind waves have been integrated into the prediction system to improve the prediction accuracy. These improvements will be presented in this paper. The error reduction in terms of nMAE (normalized mean absolute error) as obtained by the use of the new offshore wind power forecasting model reaches 22 % for day ahead and 5.5% for 2 hours ahead predictions.