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Integrated Wind Power Planning Tool

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ENFOR Forecasting and Optimization for the Energy Sector

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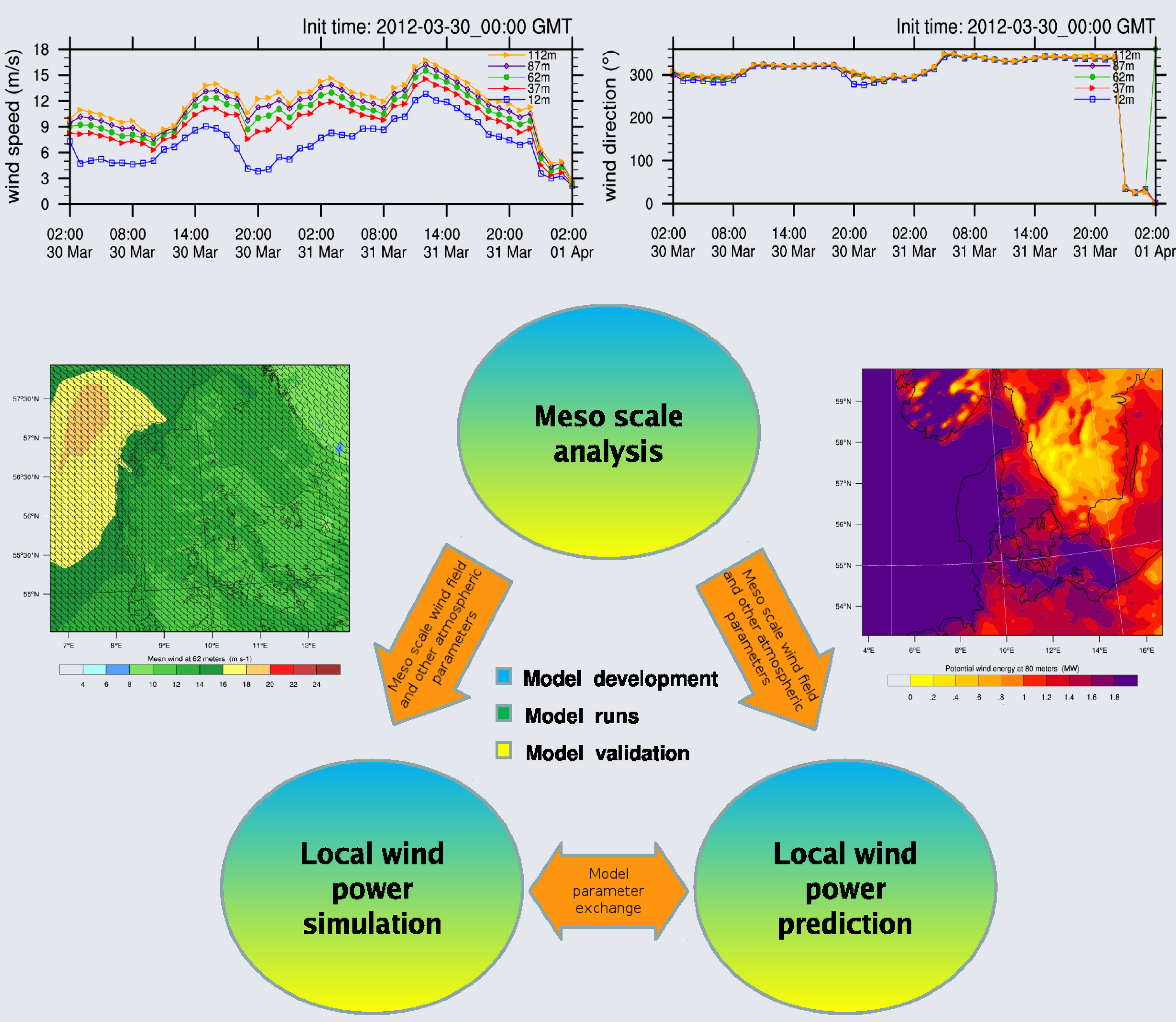
Abstract

This poster presents the Public Service Obligation (PSO) funded project PSO 10464 "Integrated Wind Power Planning Tool". The project goal is to integrate a Numerical Weather Prediction (NWP) model with statistical tools in order to assess wind power fluctuations, with focus on short term forecasting for existing wind farms, as well as long term power system planning for future wind farms.

Schematic Diagram



Expected Outcomes of PSO 10464

The major aim with PSO 10464 is to develop and improve wind power forecasting models, that allow for the description of:

- **The expected variability in wind power production in the coming hours to days,**
- **variability in wind power production over periods of several years, as well as estimates of future wind farm production,**

both depending upon prevailing weather conditions defined by a NWP model.

The high resolution of the WRF results used in the integrated short term prediction model will ensure a high accuracy data basis for use in the decision making process of the Danish transmission system operator and energy authority. The need for correct wind power predictions will only increase over the next decade as Denmark approaches the new goal of 50% wind power based electricity in 2020. In that respect, accurate simulations of the power contribution from future wind farms constitute valuable input to the planning process.

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Author(s): Poul Sørensen; Nicolaos A. Cutululis; Antonio Vigueras-Rodríguez; Henrik Madsen; Pierre Pinson; Leo E. Jensen; Jesper Hjerrild; Martin Donovan
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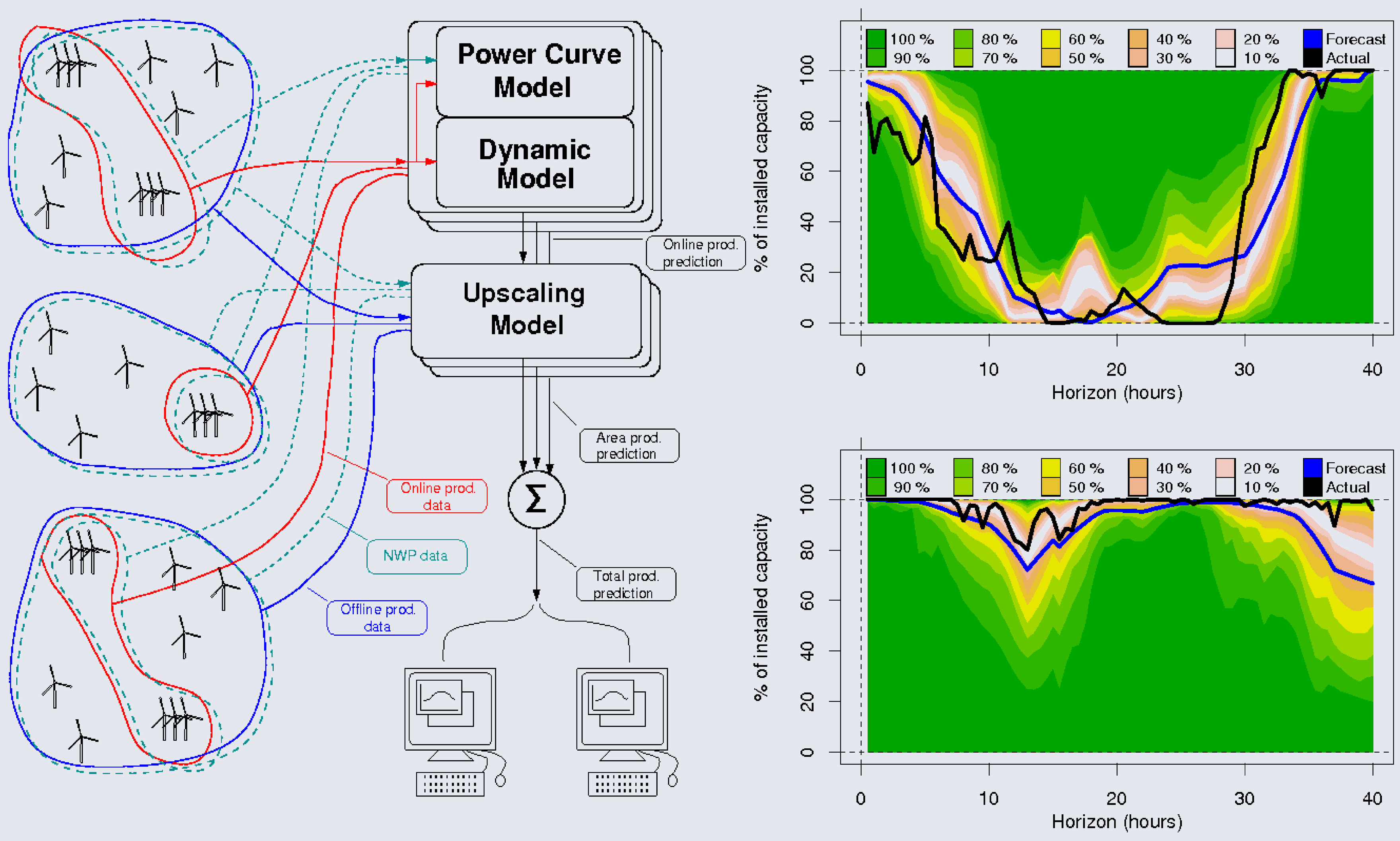
Objectives & Methods

Currently, wind power fluctuation models are either purely statistical or integrated with NWP models with limited resolution. The two objectives outlined below address this issue. For both tasks, the meso scale state-of-the-art Weather Research & Forecasting (WRF) NWP model is used to generate the required input wind fields in the domain of interest.

Short term forecasting: Tools and verification

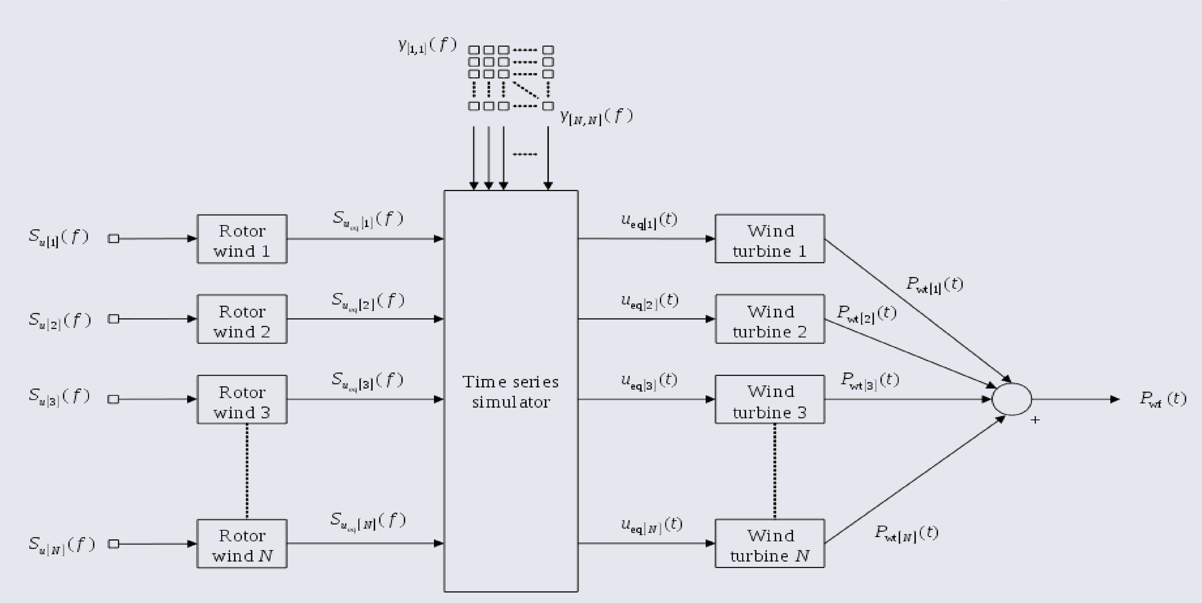
After validation[1,2,3], the WRF output wind fields will be coupled to a widely used wind power prediction model, namely the Wind Power Prediction Tool (WPPT), maintained by ENFOR A/S; a Danish company that specialises in forecasting and optimisation for the energy sector. The output from the integrated prediction tool constitutes scenario forecasts for the coming period, which can then be fed into any type of system model or decision making problem to be solved. The model output will be verified using state-of-the-art probabilistic forecast verification approaches[4,5], and also using some new concepts that are appearing in the literature (e.g. the spectral verification works performed at the Technical University of Denmark's DTU Wind Energy department[6]).

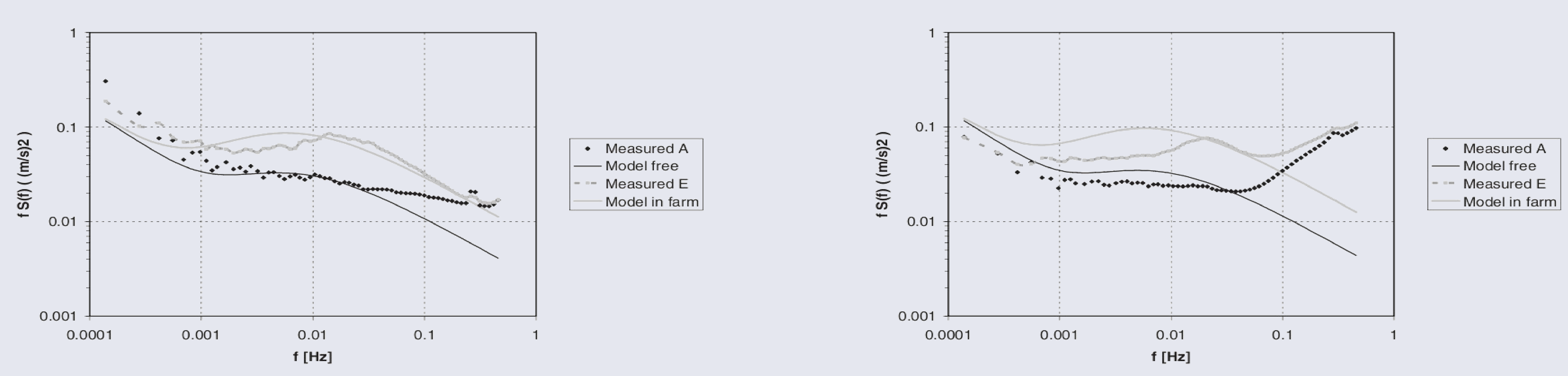


Long term planning: Tools and verification

A simulation tool, CorWind 7, has been developed at DTU Wind Energy[7], intended for long term power system planning. At present, this simulation model runs smoothly with 331 individual wind turbines, representing 6 large offshore wind farms simulated simultaneously. The current global NWP model will be replaced by the meso scale WRF model in order to improve the quality of the input wind fields. The aim is then to run the improved model for a setup including all wind turbines in Denmark simultaneously. The run period includes all years where meso scale data can be made available, but focus will be on using historical wind data from this millennium where most data is available for validation. Also, a 2025 scenario involving 3 GW offshore wind power and repowered wind turbines on land will be simulated. The basis for model validation is power data from the Danish transmission system operator, Energinet.dk, which is expected to be minute's resolution of data at transmission system station level.

Results obtained with the current version are shown below[8] in the plots of measured and simulated power spectral densities for Nysted (left) and Horns Rev (right) wind farms





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