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Highlight results

- **Quite complete mapping of wind forecasting technology**
- **111-page report with over 380 references**
- **Standard work in forecasting, cited over 220 times**

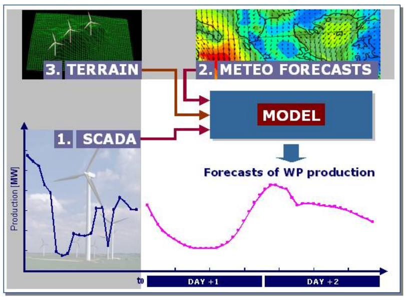
History:

Short-term prediction of wind power has attracted some scientific interest already in the 1970ies, when wind power first made its mark as a large-scale resource. Then, the first tries were done with different types of time series analysis models, like Kalman Filters, autoregressive models or neural networks.

In 1990, Lars Landberg used Numerical Weather Prediction (NWP) results from Denmark in conjunction with the Risø wind flow model WAsP to physically parameterise the wind flow in the wind farm and to predict the power output. Prediktor, as the model later was called, ran operatively for the Eastern Danish Transmission System Operator Elkraft System from 1993. With increasing wind power penetration, several other models appeared in control rooms, mostly combining physical and statistical approaches, like WPPT (Western Denmark, 1994), WPMS (Germany, 2001), and Sipreólico (Spain, 2002).

ANEMOS:

The ANEMOS project (2002-2006) brought advances in all fields of forecasting, most notably in the definition of uncertainty. However, during the operational installations in the project we found that no TSO really had a decision rule attached to the uncertainty information. Therefore, during ANEMOS.plus (2008-2011) we tried to use the probabilistic forecasts as input to decision support tools like storage scheduling, power system scheduling, trading, congestion management and other uses. Finally, during the present SafeWind project (2009-2012) the forecasting technology itself was improved especially for the tails of the distribution. Spatiotemporal correlations were used, for error propagation and to use of upstream information for wind power. Additionally, the ties to weather modellers like ECMWF were improved, and the weather models themselves updated.



Best Practice Tool:

A “best practice” prediction model for wind power looks roughly like the following:

As input data, high-quality SCADA data from a representative number of wind farms in the area in question and model data from at least two NWPs is used. The SCADA data is used in two ways: with an autoregressive component for the direct forecast for the next minutes and hours, and in order to recursively tune the wind farm power curve based on the NWP wind speeds (and/or other explanatory variables). The NWP wind speed should be close to hub height, to avoid extrapolation errors.

From the representative selection of wind farms, the total production of the area is generated. A module for optimal combination of forecasts based on recent performance (possibly dependent on the weather type or other exogenous input) combines the various single forecasts to yield the best possible forecast. This module also combines the individual probability distributions. A dedicated ramp and/or variability forecast is produced alongside the standard forecast, since the forecast of ramps is qualitatively different from the RMSE optimised forecast.

Not yet really common (though advantageous) is the direct integration of decision support tools, which use the probabilistic forecasts to solve some of the decision making problems an end user has. Those can be optimal scheduling of power plants, trading, storage or line management, erection of turbines or maintenance scheduling etc.

Whether the forecasting system is installed at the client’s site, or runs as a service on computers run by the service provider, depends on various issues, not least whether the data owned or collected by the client can leave the premises and the demands on timeliness of the forecasts.

Actual models:

The models in the market place closest to the best practice approach outlined above are ANEMOS, WPPT, WPMS, Previento and the models from AWS TruePower, 3Tier and NCAR.

Sipreolico follows the approach, but is not commercial. Among the more service oriented providers banking on their long experience with the wind and the wind industry, DTU Wind Energy (“Prediktor”), GL GarradHassan (“GH Forecaster”), Vortex, Meteologica, and more recently the UK Met Office and NCAR (“DieCast”) should be mentioned.