

## Forecasting of wind generation: Recent advances and future challenges

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### Short Abstract

Short-term forecasting of wind power is recognized as an efficient and cost-effective manner of easing the integration of wind power into power systems and electricity markets. However, recent studies have shown that reaching an *optimal* integration would necessitate significant advances in several domains. This includes for instance the optimal use of available information, appropriate uncertainty estimation and communication, or the design of new advanced decision-making methods. A high number of new methods, concepts and implementation projects have appeared in the last few years. The paper gives an overview of these recent advances and of the challenges left for the short to medium-term.

### Extended Description

The significant penetration of wind power and resulting uncertainties in their production schedule has motivated the introduction of forecasting systems. They provide wind power producers, traders, transmission operators or utilities with estimates of the wind generation for horizons up to 48-72 hour ahead, by taking advantage of relevant measurements and meteorological forecasts. Nowadays, a large number of alternative forecasting methods and commercial systems are available. Wind power forecasting seems to be a complex but mature research field that requires expertise from the areas of meteorology, statistics and power systems.

Numerous recent studies have shown that much more could be done for improving forecasts, as well as the use of forecasts. An optimal integration of wind power will not be attained without spending the necessary research efforts in that sense. Improving Computational Fluid Dynamics (CFD) based models or evaluating new statistical approaches to point forecasting may lead to higher accuracy of point predictions. However, the next breakthrough in forecasting will come from the recent and future research developments in the following main areas:

- *(i)* optimal use of available information, e.g. selection of relevant measured and forecast data at the spatio-temporal level or combination of forecast for error reduction.
- *(ii)* appropriate uncertainty estimation and communication, with probabilistic forecasts, ensemble forecasting systems, power generation scenarios or possibly prediction risk indices
- *(iii)* the design of new advanced decision-making methods, i.e. accounting for the complete forecast and uncertainty information

The paper outlines the main achievements in these three different areas, based on published results and projects outcomes. They result from tighter collaboration between meteorologists, wind power forecasters and forecast users. So far, these achievements are at the research or demonstration level. However, one may witness that transfer from research to commercially available products has been particularly fast in the last few years, owing to intensification of collaboration between researchers, software developers and forecast users, but also to potential commercial interests. Therefore, it is expected that new methodologies appearing in the research world will soon be in the hand of forecast users.