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IEA Wind Task 36 Forecasting - Phase II

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Publication date:
2019

Document Version
Publisher's PDF, also known as Version of record

Citation (APA):
Giebel, G., Shaw, W., Frank, H., Pinson, P., Draxl, C., Zack, J., Kariniotakis, G., Möhrlen, C., & Bessa, R. (2019). *IEA Wind Task 36 Forecasting - Phase II*. Poster session presented at EGU General Assembly 2019, Vienna, Austria.

IEA Wind Task 36 Forecasting – Phase II

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EGU General Assembly 2019

Summary

This poster provides an overview of the IEA Wind Task for Wind Power Forecasting. Main deliverables are an information portal including main project results from other forecast projects, including data sets, which can be used by researchers around the world for analysis and model improvements, an IEA Recommended Practice on how to choose a (new) forecast provider, a position paper regarding the use of probabilistic forecasts. Additionally, the communication of relevant information regarding state of the art and progress in both the forecasters and the end-users community is paramount.

Collaboration in the Task is solicited from everyone interested in the forecasting business. Participation is open for all institutions in member states of the IEA Annex on Wind Power. See up-to-date list is at ieawind.org and the flags to the right. The Operating Agent is Gregor Giebel of DTU (*grgi@dtu.dk*), Co-Operating Agent is Will Shaw from Pacific Northwest National Laboratory (*will.shaw@pnnl.gov*). The second phase of the Task runs for three years, 2019-2021.

Activities

NWP Improvements

This WP brings together global leaders in NWP models as applied to the wind industry to exchange information about future research areas. The emphasis will be on improvements of the wind-related forecast performance of these models especially in typical rotor heights.

Two lists of up-to-date data are mentioned under Results (tall met masts and experiments). Additionally, this WP discusses how to verify and validate the improvements through a common data set to test model results upon and discuss at IEA Task meetings.

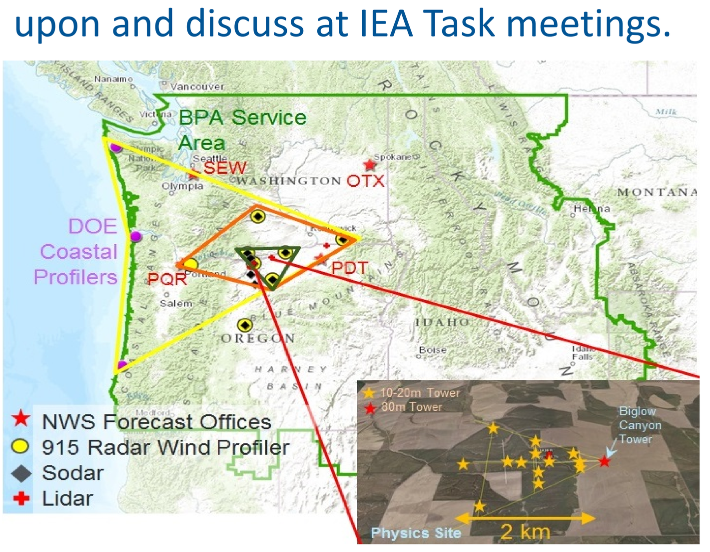


Figure 1: The instrumentation of WFIP2, in the Northwest of the USA. Source: Joel Cline.

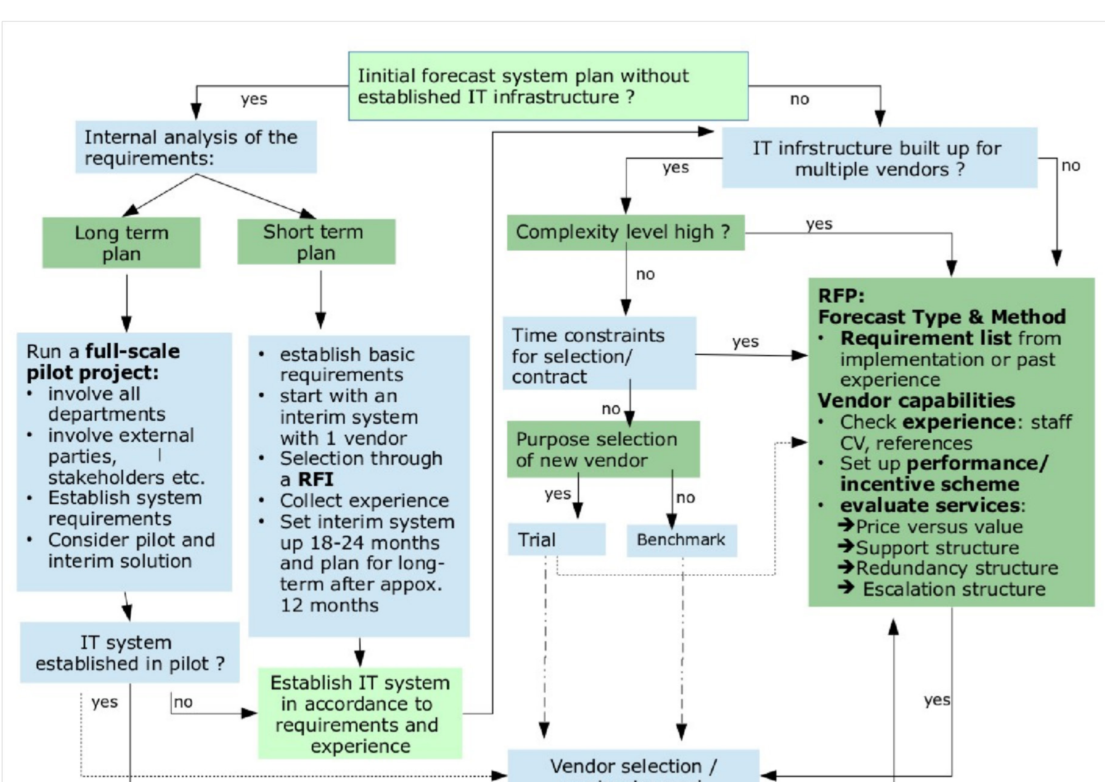


Figure 2: Overview of a decision support scheme illustrating common difficulties when deciding for or against trials or common procurements. Cost, validity and output of trials are often over estimated in their usefulness, because fair evaluation requires a lot of resources, and complex problem solving can often not be verified by simple tests. A guideline for decision making is therefore under preparation by the Task group.

Power and Uncertainty

This second WP reviews the state-of-the-art for error and uncertainty quantification for wind and wind power forecasting models, with a special emphasis on the underlying NWP forecasts. This activity will further engage both NWP and field measurement researchers to develop guidelines, best practices, and perhaps standards, for forecasting trials and benchmarks, but also for real-time forecasting applications, where meteorological measurements are becoming necessary for operations of wind farms and handling of grid issues, e.g. at high-speed shut down wind ranges or at times of curtailment.

A review paper on forecasting error metrics is underway. Besides the well-known metrics for deterministic forecasts (such as MAE, RMSE or correlation coefficient), quality measures for probabilistic forecasts are handled as well.

Advanced Usage

The third WP surveys the current state of use of forecast uncertainties by the power systems sector and documents and publishes results in reports and publications. It engages both actors of the wind industry and the research communities to identify how current and emerging capabilities to determine uncertainties can be used to address the variety of decision-support needed by the industry. The most common applications for uncertainty forecasts today are:

- reserve allocation
- trading and dispatch processes
- situational awareness
- risk assessment for unit commitment
- extreme event analysis and warning

Phase II

The second phase of the Task adds some new targets.

- Discussion of possible parts of the forecasting processes for standard-isation.
- Online verification and benchmarking of current NWP models with met mast data (see home page for details).
- Review publication detailing a full uncertainty propagation through the modeling chain.
- Assessment of the value of probabilistic forecasts, both on a theoretical basis as well as through collection of actual use cases
- Development of Recommended Practice for data and instrumentation require-ments for real-time forecasting

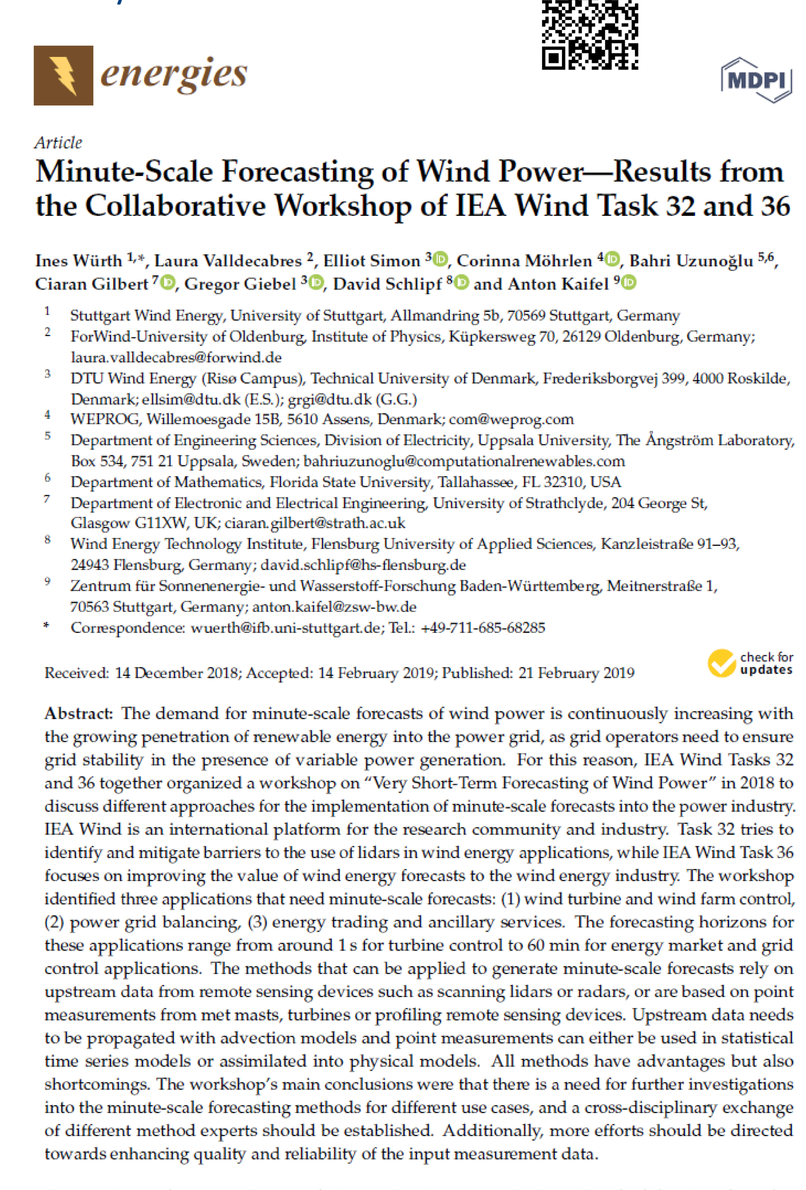
Results

Minute scale forecasts

In June 2018, IEA Wind Task 32 Lidars and 36 Forecasting held a combined workshop on Very Short Term Forecasting of Wind Power. The main tools employed were lidars, radars and SCADA data. Main results were:

- Forecasts on the minute time scale are getting more important in high-wind-penetration power systems.
- A combination of weather models and instrumentation provide important information when persistence fails, namely at fast changing weather conditions, ramping and high speed wind events.
- Data quality is a major issue, including sensor availability (e.g. for Lidars).

Journal paper is published in Energies 2019, DOI: 10.3390/en12040712.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Article

Minute-Scale Forecasting of Wind Power—Results from the Collaborative Workshop of IEA Wind Task 32 and 36

Ines Würth [1,*], Laura Valldecabres [2], Elliot Simon [3], Corinna Möhrlen [4], Bahri Uzunoğlu [5,6], Ciaran Gilbert [7], Gregor Giebel [3], David Schlipf [8] and Anton Kaifel [9]

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Received: 14 December 2018; Accepted: 14 February 2019; Published: 21 February 2019

Abstract: The demand for minute-scale forecasts of wind power is continuously increasing with the growing penetration of renewable energy into the power grid, as grid operators need to ensure grid stability in the presence of variable power generation. For this reason, IEA Wind Tasks 32 and 36 together organized a workshop on "Very Short-Term Forecasting of Wind Power" in 2018 to discuss different approaches for the implementation of minute-scale forecasts into the power industry. IEA Wind is an international platform for the research community and industry. Task 32 tries to identify and mitigate barriers to the use of lidars in wind energy applications, while IEA Wind Task 36 focuses on improving the value of wind energy forecasts to the wind energy industry. The workshop identified three applications that need minute-scale forecasts: (1) wind turbine and wind farm control, (2) power grid balancing, (3) energy trading and ancillary services. The forecasting horizons for these applications range from around 1 s for turbine control to 60 min for energy market and grid control applications. The methods that can be applied to generate minute-scale forecasts rely on upstream data from remote sensing devices such as scanning lidars or radars, or are based on point measurements from met masts, turbines or profiling remote sensing devices. Upstream data needs to be propagated with advection models and point measurements can either be used in statistical time series models or assimilated into physical models. All methods have advantages but also shortcomings. The workshop's main conclusions were that there is a need for further investigations into the minute-scale forecasting methods for different use cases, and a cross-disciplinary exchange of different method experts should be established. Additionally, more efforts should be directed towards enhancing quality and reliability of the input measurement data.

Keywords: wind energy; minute-scale forecasting; forecasting horizon; Doppler lidar; Doppler radar; numerical weather prediction models

Forecast Solution Selection

The Task prepared an IEA Recommended Practice for Forecasting Solution Selection. The document is divided into three parts, part 1 deals with the Forecast Solution Selection Process (see Figure 2 for an overview), part 2 gives recommendations for Designing and Executing Forecasting Benchmarks and Trials. Part 1 is written from the experience that conducting a trial is not always in the best interest of the client, and often does not end in results leading to contracts.

In part 2 typical errors in the design and the execution leading to invalid trial results and often in a lot of wasted resources (typically the client and 3-8 forecasters) have been collected and analyzed. Recommendation how to avoid pitfalls are provided. Part 3 of the recommended practices deals with the evaluation process of forecasts and forecast solutions. In this guideline we put specific focus on forecast skill versus forecast value. A forecast has skill, if it predicts the observed conditions well according to some objective or subjective criteria, but it only creates value, if it helps the user to make better decisions.

This first version of the recommended practices guideline focuses on:

1) Impact of forecast accuracy on application

2) Cost-Loss Relationship of forecasts

Evaluation of forecast solutions is a complex task and it is usually neither easy nor recommended to simplify the evaluation process. As a general recommendation, such a process needs to follow the evaluation paradigm with its three principles for an evaluation to be:

- representative
- significant
- relevant

How to setup an evaluation process and achieve these principles is the core of this recommended practices guideline.

Use of Probabilistic Forecasts

The IEA Task published two papers on the use of probabilistic forecasting, a scientific overview and a more popular note. While probabilistic forecasts have existed for more than a decade, and while their use has been shown to be bene-ficial, the industry is still struggling to make use of the information that can be provided today.


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Review

Towards Improved Understanding of the Applicability of Uncertainty Forecasts in the Electric Power Industry

Ricardo J. Bessa [1,*], Corinna Möhrlen [2], Vanessa Fundel [3], Malte Siefert [4], Jethro Browell [5], Sebastian Haglund El Gaidi [6], Bri-Mathias Hodge [7], Umit Cali [8] and George Kariniotakis [9]

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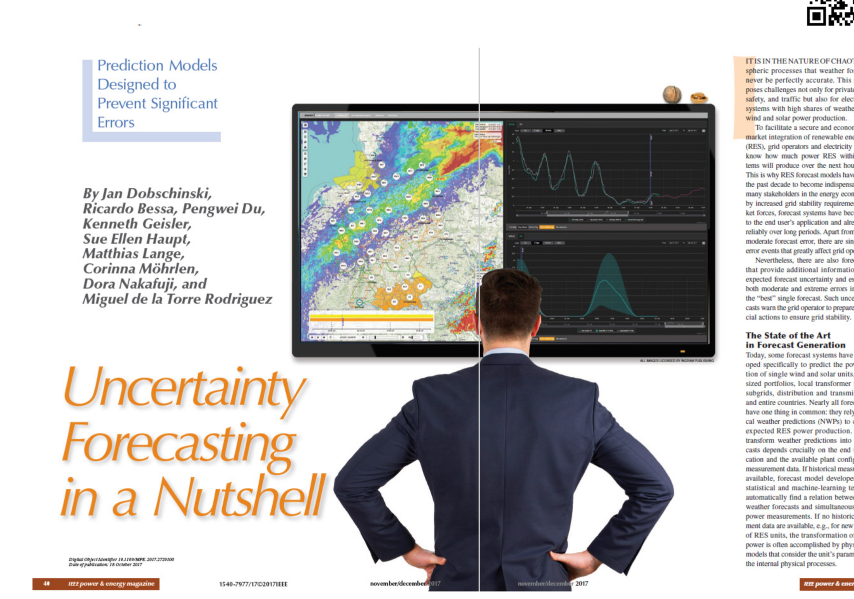
Academic Editor: David Wood
Received: 18 August 2017; Accepted: 8 September 2017; Published: 14 September 2017

Abstract: Around the world wind energy is starting to become a major energy provider in electricity markets, as well as participating in ancillary services markets to help maintain grid stability. The reliability of system operations and smooth integration of wind energy into electricity markets has been strongly supported by years of improvement in weather and wind power forecasting systems. Deterministic forecasts are still predominant in utility practice although truly optimal decisions and risk hedging are only possible with the adoption of uncertainty forecasts. One of the main barriers for the industrial adoption of uncertainty forecasts is the lack of understanding of its information content (e.g., its physical and statistical modeling) and standardization of uncertainty forecast products, which frequently leads to mistrust towards uncertainty forecasts and their applicability in practice. This paper aims at improving this understanding by establishing a common terminology and reviewing the methods to determine, estimate, and communicate the uncertainty in weather and wind power forecasts. This conceptual analysis of the state of the art highlights that: (i) end-users should start to look at the forecast's properties in order to map different uncertainty representations to specific wind energy-related user requirements; (ii) a multidisciplinary team is required to foster the integration of stochastic methods in the industry sector. A set of recommendations for standardization and improved training of operators are provided along with examples of best practic

Online available: http://www.mdpi.com/1996-1073/10/9/1402


Prediction Models Designed to Prevent Significant Errors

By Jan Dobschinski, Ricardo Bessa, Pengwei Du, Kenneth Geisler, Sue Ellen Haupt, Matthias Lange, Corinna Möhrlen, Dora Nakafuji, and Miguel de la Torre Rodriguez

Uncertainty Forecasting in a Nutshell

IT IS IN THE NATURE OF CHAOTIC ATMOspheric processes that weather forecasts will never be perfectly accurate. This natural fact poses challenges not only for private life, public safety, and traffic but also for electrical power systems with high shares of weather-dependent wind and solar power production.

To facilitate a secure and economic grid and market integration of renewable energy sources (RES), grid operators and electricity traders must know how much power RES within their systems will produce over the next hours and days. This is why RES forecast models have grown over the past decade to become indispensable tools for many stakeholders in the energy economy. Driven by increased grid stability requirements and market forces, forecast systems have become tailored to the end user's application and already perform reliably over long periods. Apart from a residually moderate forecast error, there are single extreme-error events that greatly affect grid operators.

Nevertheless, there are also forecast systems that provide additional information about the expected forecast uncertainty and estimations of both moderate and extreme errors in addition to the "best" single forecast. Such uncertainty forecasts warn the grid operator to prepare to take special actions to ensure grid stability.

The State of the Art in Forecast Generation

Today, some forecast systems have been developed specifically to predict the power production of single wind and solar units, differently sized portfolios, local transformer stations and subgrids, distribution and transmission grids, and entire countries. Nearly all forecast systems have one thing in common: they rely on numerical weather predictions (NWPs) to calculate the expected RES power production. The way to transform weather predictions into power forecasts depends crucially on the end user's application and the available plant configuration and measurement data. If historical measurements are available, forecast model developers often use statistical and machine-learning techniques to automatically find a relation between historical weather forecasts and simultaneously observed power measurements. If no historical measurement data are available, e.g., for new installations of RES units, the transformation of weather to power is often accomplished by physically based models that consider the unit's parameters to map the internal physical processes.

Digital Object Identifier 10.1109/MPE.2017.2729100
Date of publication: 18 October 2017

40 IEEE power & energy magazine 1540-7977/17©2017IEEE november/december 2017

J. Dobschinski, R. Bessak, P. Du, K. Geisler, S.E. Haupt, M. Lange, C. Möhrlen, D. Nakafuji and M. de la Torre Rodriguez: Uncertainty Forecasting in a Nutshell: Prediction Models Designed to Prevent Significant Errors. IEEE Power and Energy Magazine, vol. 15, no. 6, pp. 40-49, Nov.-Dec. 2017, doi: 10.1109/MPE.2017.2729100