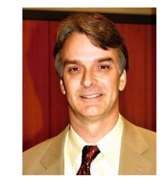
IEA Wind Task 36 Forecasting

EGU 2017

Gregor Giebel DTU



Joel Cline DoE · Helmut Frank DWD · Will Shaw PNNL · Bri-Mathias Hodge NREL · Pierre Pinson DTU · Jakob Messner DTU · George Kariniotakis Mines ParisTech · Caroline Draxl NREL · Corinna Möhrlen WEPROG

DTU Wind Energy, Department of Wind Energy · U.S. Department of Energy, Office of Science · Deutscher Wetterdienst · Pacific Northwest National Laboratory · NREL · Mines ParisTech · WEPROG

iea wind

Summary

This poster gives an overview of the IEA Wind Task for Wind Power Forecasting. The Operating Agent is Gregor Giebel of DTU, Co-Operating Agent is Joel Cline of the US Department of Energy. Collaboration in the task is solicited from everyone interested in the forecasting business. We will collaborate with IEA Task 31 Wakebench, which developed the Windbench benchmarking platform, which this task will use for forecasting benchmarks. The task will run for three years, 2016-2018.

Main deliverables are an up-to-date list of current projects and main project results, including datasets which can be used by researchers around the world to improve their own models, an IEA Recommended Practice on performance evaluation of probabilistic forecasts, a position paper regarding the use of probabilistic forecasts, and one or more benchmark studies both for purely meteorological test cases as well as for power. Additionally, spreading of relevant information in both the forecasters and the users community is paramount.

Participation is open for all institutions in member states of the IEA Annex on Wind Power, see ieawind.org for the up-to-date list and the flags to the right.

Source: Red Electrica de España, ree.es.

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 below (tall met masts and experiments). Additionally, this WP will Verify and Validate the improvements through a common data set to test model results upon and discuss at IEA Task meetings.

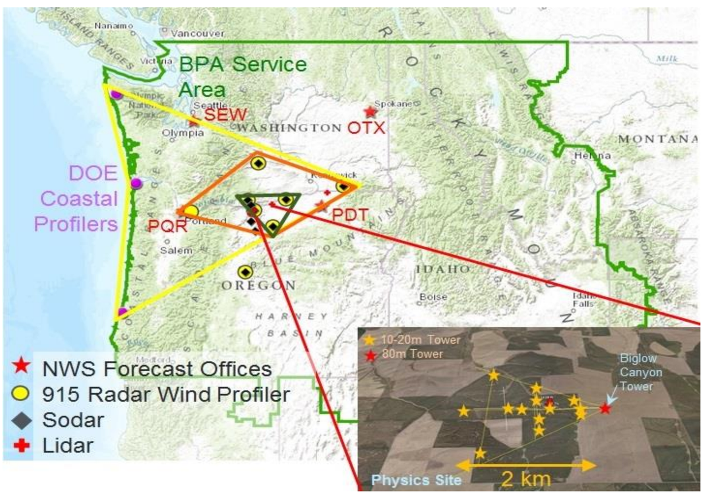


Figure 1: The instrumentation of WFIP2, in the Northwest of the USA. Source: Joel Cline.

Benchmarks

This second WP will review 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.

Typical pitfalls encountered by the forecast providers lead to invalid trial results, which are a waste of time for all involved parties (typically the client and 3-8 forecasters). Those pitfalls include too short trials, not concurrent timing, different wind farms for different forecasters to work on, insufficient communication of details of the data, and other issues. The Task will prepare an IEA Best Practice Recommendation.

Additionally, we will collect and distribute public benchmarks, e.g. on Kaggle or the IEA WindBench platform.

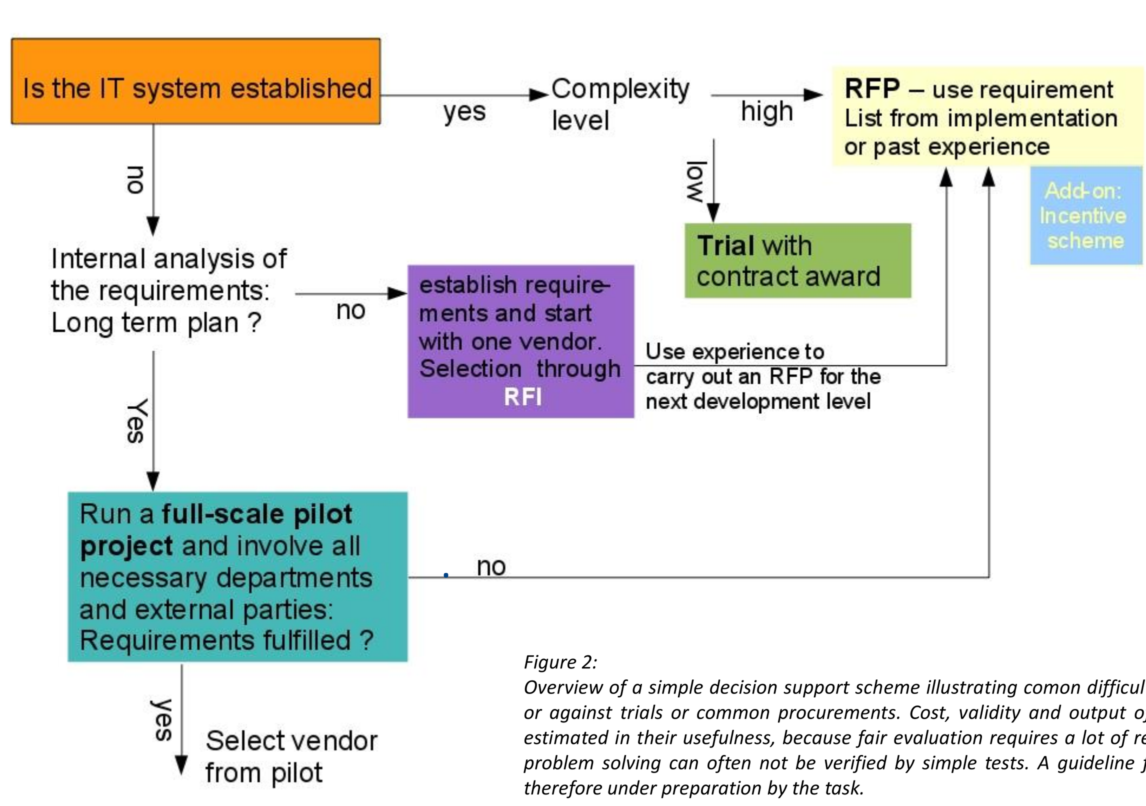


Figure 2: Overview of a simple decision support scheme illustrating comon difficulties when deciding for or against trials or common procurements. Cost, validity and output of trials are often over estimated in their usefulness, because fair evaluation requires a lot of resources, and complex problem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

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 a report 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 needs of the industry. Indicators of which forecast approach serves which requirements are being developed.

A very general conclusion from our first year's study regarding the use of uncertainty forecasts in the power industry is that as wind penetration increases, the interest for uncertainty forecasts increases. This trend is evident once penetration goes beyond 20% of energy consumption and installed wind capacity is at times capable of delivering the bulk of power demand. While it seems like the interest and demand for uncertainty forecasts is not that large yet, we can conclude from our study that it is only a matter of time until this demand will rise. The most common applications for uncertainty forecasts today are:

- reserve allocation
- trading and dispatch processes using a best guess from uncertainty forecasts
- situational awareness and risk assessment.

Results

Public Lists

A list with **masts** useful for validation of the forecasts is underway, measuring at least 100m. The list currently contains more than a dozen masts on- and offshore.

A list of **meteorological experiments** going on currently or recently, either to participate or to verify a flow model against.

A list of current or finished **research projects** in the field of wind power forecasting.

See

IEAWindForecasting.dk.

Site name	Coordinates	altitude above MSL	Tower height	Data policy	Obs. period	Other
Cabauw, NL	4.926° E, 51.97° N	-0.7 m	200 m	Cesar data policy	2000-04-01 to previous month	
IJmuiden, NL	52.848° E, 3.436° N	0 m	92 m		since 2012	offshore North Sea
Risø, DK	12.088° E, 55.694° N	0 m	125 m	Ask nicely	1995-11-20 -	Data measured since 1958; some months break in 2008.
Østerild, DK	12.088° E, 55.694° N	0 m	250 m	Ask nicely	2015-01-28 -	Two 250m masts in 4.3 km distance, both instrumented. Additionally, 7 smaller masts up to turbine hub heights.
Taggen, SE	14.519° E, 55.8726° N	0 m	100 m		2014-07-29 -	Owned by Vattenfall.
Stora Middelgrund, SE	12.1047° E, 56.5613° N	0 m	120 m		2008-11-28 - 2015-12-22	Offshore.
FINO 1, DE	54.015° E, 6.588° N	0 m	100 m	FINO project	since 01/2004	offshore North Sea, INNWIND.EU report Deliverable 1.11 (pages 10f)
FINO 2, DE	55.0069° E, 13.1542° N	0 m	100 m	FINO project	since 08/2007	offshore Baltic Sea, INNWIND.EU report Deliverable 1.11 (pages 10f)
FINO 3, DE	55.195° E, 7.158° N	0 m	100 m	FINO project	since 09/2009	offshore North Sea, INNWIND.EU report Deliverable 1.11 (pages 10f)
KIT, DE	49.0925° E, 8.426° N	110.4 m	200 m		since 1972-12-01	
Hamburg, DE	53.51992° E, 10.105139° N	0.3 m	280 m	Data policy (in german)	since 1995	Description of mast in Brümmer et al.
Falkenberg, MOL-RAO, DE	52.17° E, 14.12° N	73 m	98 m		since 2003	Data from CEOP
National Wind Technology Center, USA	105.23° W, 39.6° N	1835 m	135 m	NWTC 135-m Meteorological Towers Data Repository	M4 from 2012 to 2015, M5 since 2013	There is another 80 m tower measuring since 1996.
Boulder Atmospheric Observatory (BAO), USA	105.0° W, 40.05° N	1584 m	300 m	README_BAO.pdf	1977 to 2016	Unfortunatelly the tower was decommissioned on 2016-07-31.

High met masts useful for verification of hub height wind forecasts. Source: ieawindforecasting.dk. There is more information available, for example how to access the data.

Workshop Future Issues

In July 2016, the group held a public workshop in Barcelona on Experiences with Forecasts and Gaps in Research. The slides are available from the website.

The **most important gaps** were identified as:

- More frequent, and higher time and spatial resolution data.
- Short-term ensembles with the correct spread.
- Data assimilation of wind power data, and improved NWP model physics, including icing.
- Interaction between wind farms.
- Ramps, and seasonal forecasting.
- Optimal use of probabilistics, and reliable quantiles.

The participants of the workshop in Barcelona.

Other recommendations have been suggested as first deliverables in the IEA Wind Task 36 to provide guidelines for the integration of wind power into the power grid:

- Derive and test business cases for the use of uncertainty forecasts, particularly at the system operation level, where it is mainly used for situational awareness.
- The quality of measurements is becoming very relevant due to the increasing need of intra-day balancing. Spatial-temporal modeling of wind power time series can improve the forecast skill, but require data with good quality and high update frequency.

Advanced Usage Questionnaire

We currently conduct a mapping of the use of probabilistic forecasts in the industry. **Please help us filling it in (scan the QR code):**

Preliminary results (see also Figure 3):

- Knowledge about how to make use of uncertainty forecasts is lacking:
- 98% use multiple forecasts
- 60% know provider and products of uncertainty forecasts
- < 10% make use of uncertainty forecasts
- Less than 10% of all organisations employ meteorologists or engineers with an atmospheric science education.

Results: Use of Forecasting...

Trading type	day-ahead market	intra-day market	ancillary services	reserve market
percent [%]	92	63	25	29

Business hours:	24/7	7-- 22	9—5
percent [%]	60 (64)	5	35

Trading Model:	price taker	price maker
percent [%]	78 (80)	22 (20)

Type of forecast	single forecast	multiple forecasts
percent [%]	36 (37)	68

Knowledge of Ensemble Forecasting	Knowledge	Use EPS Forecasts	work after OPR rules
percent [%]	71	21	38

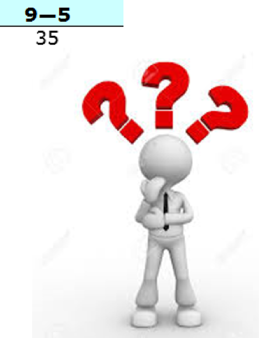


Figure 3: Preliminary results of the questionnaire. Source: C. Möhrlen, R.J. Bessa, M. Barthod, G. Goretti and M. Siefert: Use of Forecast Uncertainties in the Power Sector: State-of-the-Art of Business Practices. 15th Int. Workshop on Large-Scale Integration of Wind Power into Power Systems as well as on Transmission Networks for Offshore Wind Farms, Vienna, 15 - 17 November, 2016.

This first overview showed that there are many different levels of knowledge about the application of uncertainty forecasts in the power industry today. In some countries regulations lack transparency, spreading insecurity among the market players, while in other countries the wind penetration is not high enough yet, leading to production uncertainty being an integration bottleneck.