IEA Wind Task 51:

“Forecasting for the Weather Driven Energy System”

John Zack, MESO, Inc.

G. Giebel, H. Frank, C. Draxl, J. Browell, C. Möhrlen, G. Kariniotakis, R. Bessa, D. Lenaghan

14 October 2022

International Energy Agency History

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- *Specific Technology Collaboration Programs (in renewable energy):*
- Bioenergy TCP
- Concentrated Solar Power (SolarPACES TCP)
- Geothermal TCP
- Hydrogen TCP
- Hydropower TCP
- Ocean Energy Systems (OES TCP)
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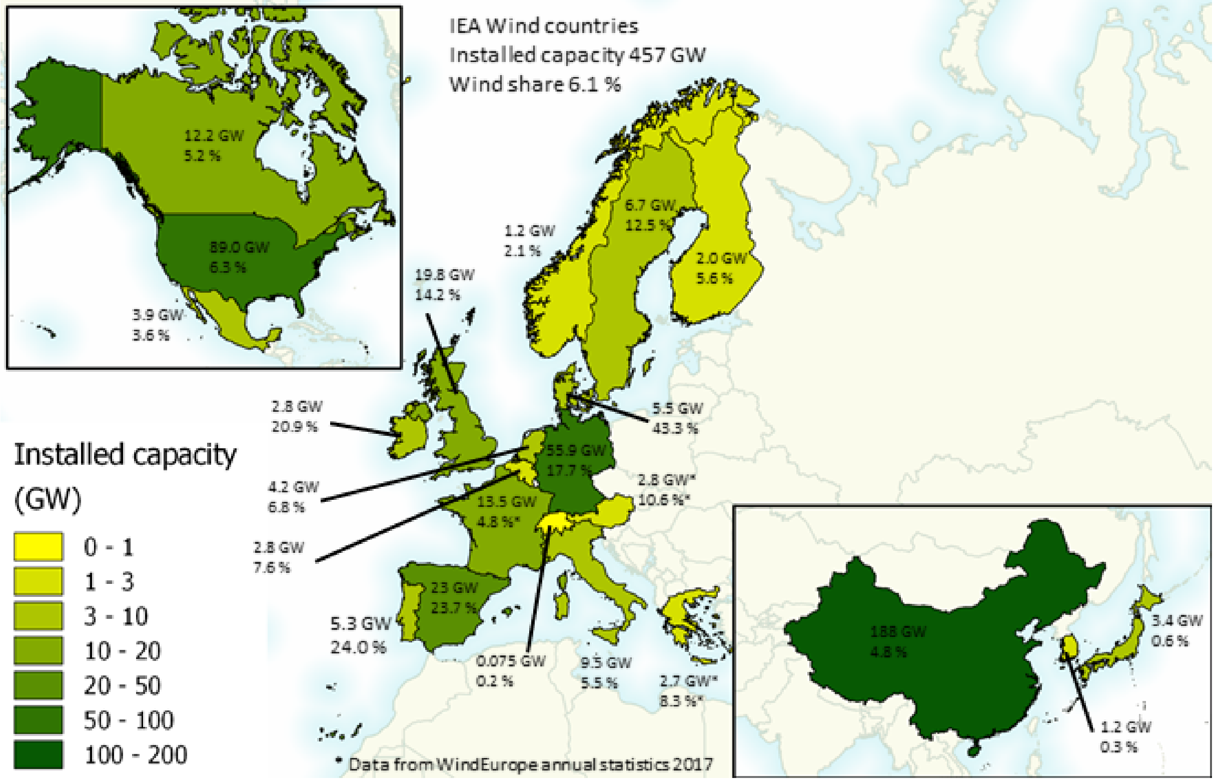

- Task 51 Members:
    - AT, CN, DE, DK, ES, FI, FR, IE, PT, UK, US

- Task 11 Base Technology Exchange
- Task 19 Wind Energy in Cold Climates
- Task 29 Mexnext III: Analysis of Wind Tunnel Measurements and Improvements of Aerodynamic Models
- Task 30 Offshore Code Comparison Collaboration, Continued, with Correlation (OC5)
- Task 39 Quiet Wind Turbine Technology
- Task 40 Downwind Turbines
- Task 41 Distributed Energy
- Task 42 Wind Turbine Lifetime Extension
- **Task 51 Forecasting for the Weather-driven Energy System**

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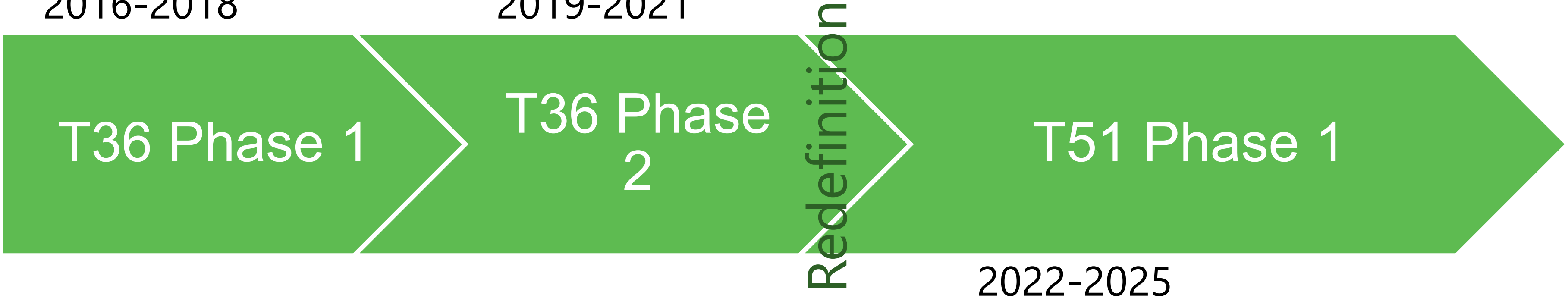
- Task 31 WAKEBENCH: Benchmarking Wind Farm Flow Models
- Task 32 LIDAR: Wind Lidar Systems for Wind Energy Deployment
- Task 36 Forecasting for Wind Energy
- Task 25 Design and Operation of Power Systems with Large Amounts of Wind Power
- Task 27 Small Wind Turbines in High Turbulence Sites
- Task 37 Wind Energy Systems Engineering
- Task 26 Cost of Wind Energy
- Task 28 Social Acceptance of Wind Energy Project
- Task 34 Working Together to Resolve the Environmental Effects of Wind Energy (WREN)

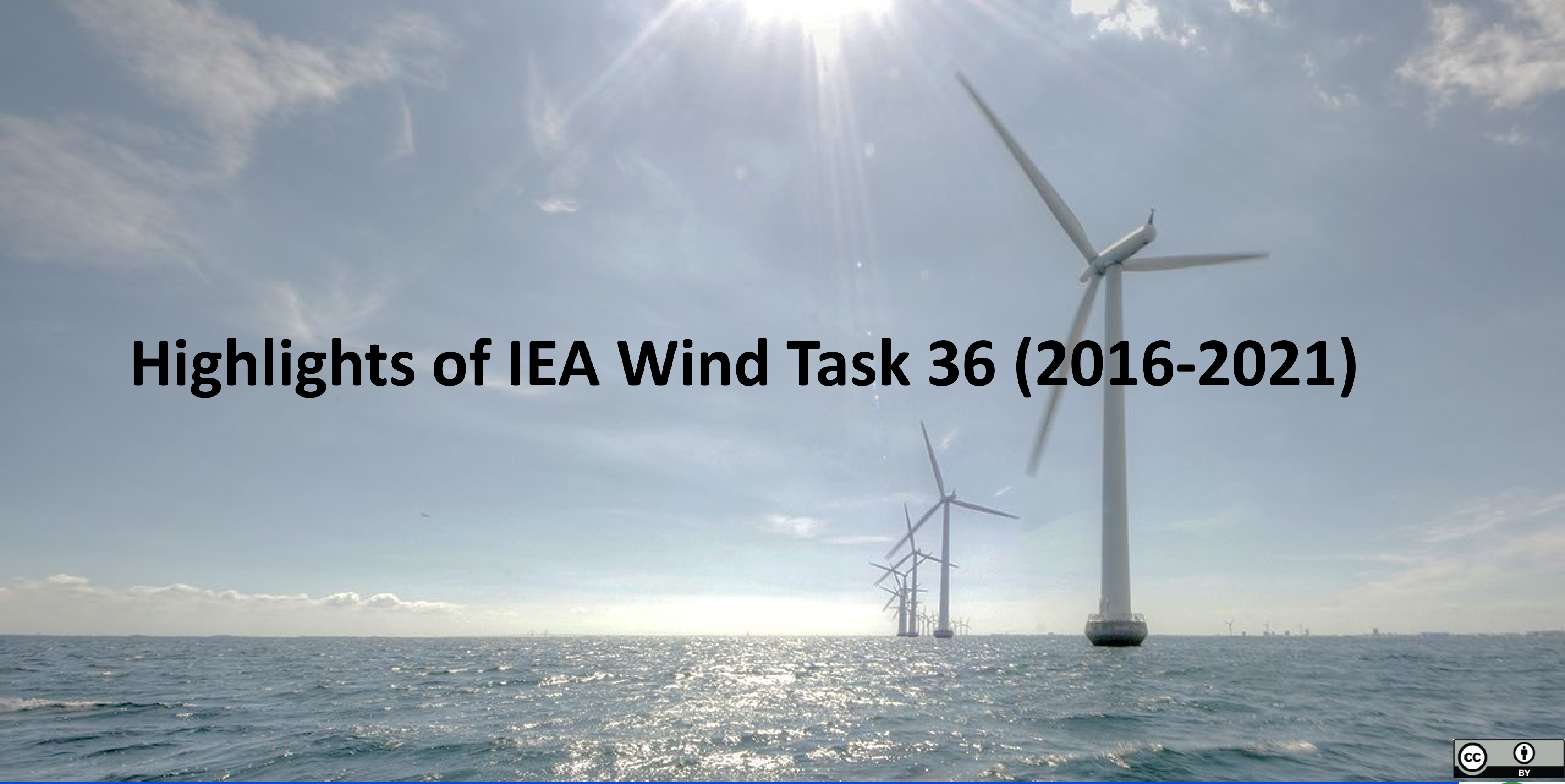
Forecasting for Wind Energy

2016-2018 2019-2021



2022-2025

Forecasting for the Weather Driven Energy System

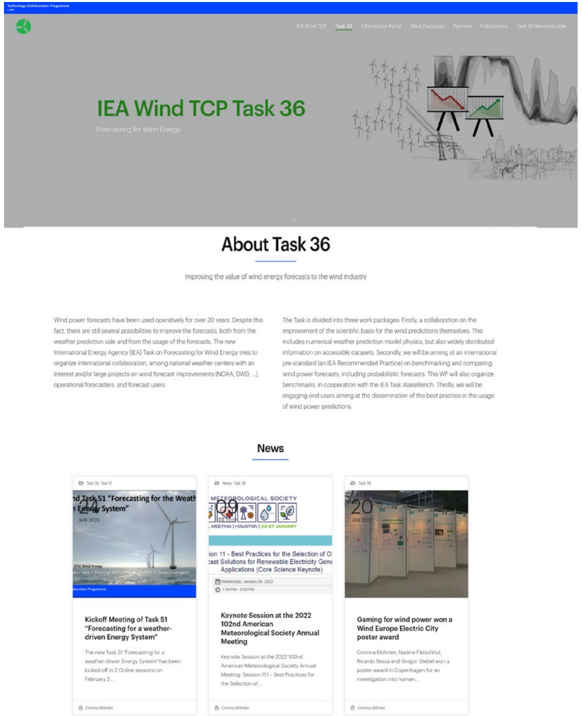


Highlights of IEA Wind Task 36 (2016-2021)

Task 36 Web Presence

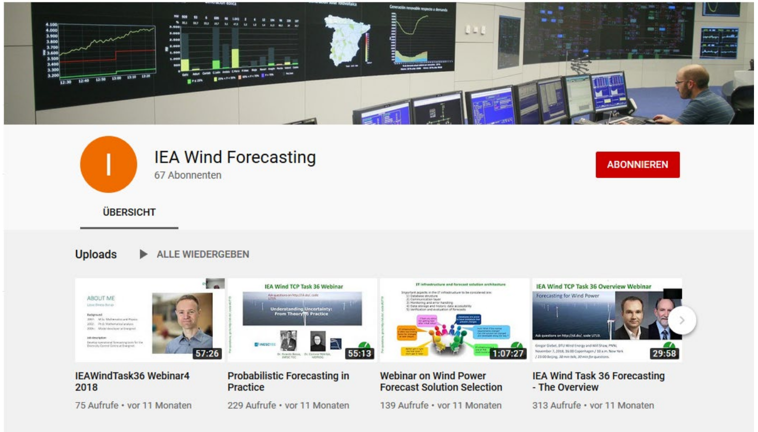
Website

www.iea-wind.org/task36



YouTube Channel

https://www.youtube.com/c/IEAWindForecasting



Task 36 (2016-2021) Key Accomplishments

1. List of wind forecasting validation datasets
2. Recommended Practices for Forecast Solution Selection: Versions 1 and 2
3. Several publications that address origin, use and value of forecasting uncertainty information
4. Publications that document 2 games/experiments that illustrate & analyze the value of probabilistic forecast information in human operational decision-making
5. Community workshops
   - Forecasting state-of-the-art workshop
   - Minute-scale forecasting workshop
   - Task 36 end-user workshop

IEA Best Practice Recommendations for the Selection of a Wind Forecasting Solution Version 2: Set of 4 Documents

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RECOMMENDED PRACTICE FOR THE IMPLEMENTATION OF RENEWABLE ENERGY FORECASTING SOLUTIONS

- Part 1: FORECAST SOLUTION SELECTION PROCESS -

2. EDITION

Draft for Review by the Executive Committee of the International Energy Agency Implementing Agreement

Prepared by IEA Wind Task 36

Part 1: Selection of an Optimal Forecast Solution

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RECOMMENDED PRACTICE FOR THE IMPLEMENTATION OF RENEWABLE ENERGY FORECASTING SOLUTIONS

- Part 2: DESIGNING AND EXECUTING FORECASTING BENCHMARKS AND TRIALS -

2. EDITION

Draft for Review by the Executive Committee of the International Energy Agency Implementing Agreement

Prepared by IEA Wind Task 36

Part 2: Design and Execution of Benchmarks and Trials

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RECOMMENDED PRACTICE FOR THE IMPLEMENTATION OF RENEWABLE ENERGY FORECASTING SOLUTIONS

- Part 3: Forecast Solution Evaluation -

2. EDITION

Draft for Review by Executive Committee of the International Energy Agency Implementing Agreement

Prepared by IEA Wind Task 36

Part 3: Evaluation of Forecasts and Forecast Solutions

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RECOMMENDED PRACTICE FOR THE IMPLEMENTATION OF RENEWABLE ENERGY FORECASTING SOLUTIONS

- Part 4: Meteorological and Power Data Requirements for real-time forecasting Applications-

1. EDITION

Draft for Review by the Executive Committee of the International Energy Agency Implementing Agreement

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Part 4: Data Requirements for Real-time Applications

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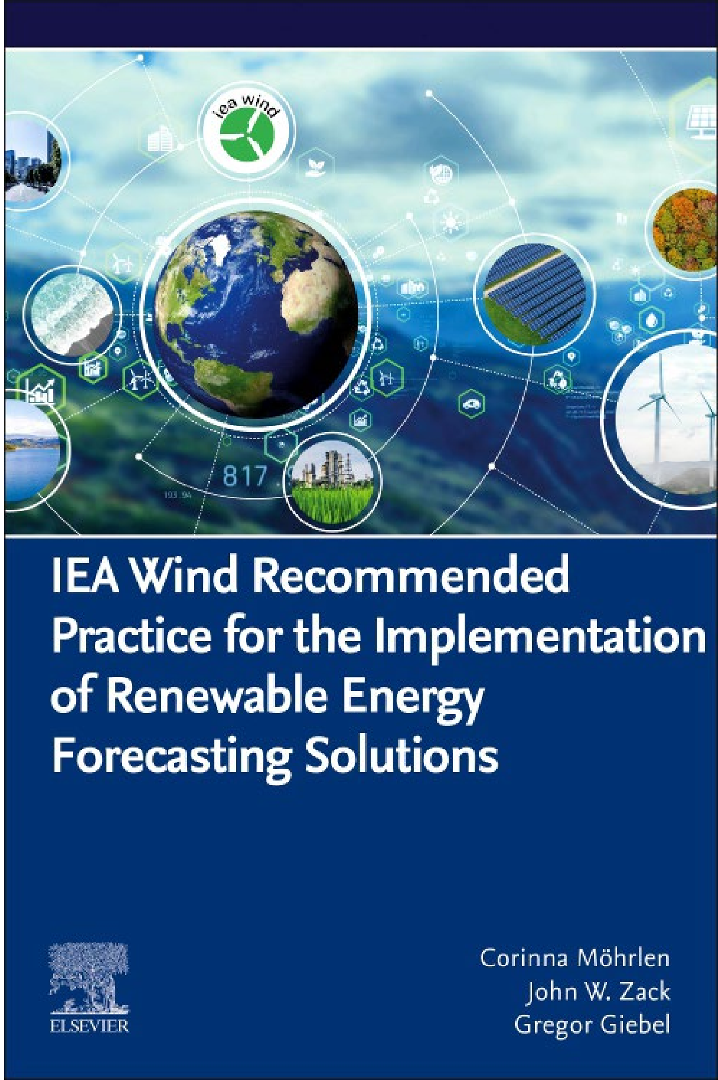

Broad Overview of Uncertainty Forecasting


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

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

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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.

DOI: *10.1109/MPE.2017.2729100*

Use of Probabilistic Forecasting

- Open Access journal paper
- 48 pages on the use of uncertainty forecasts in the power industry
- Scope:
    - Definition
    - Methods
    - Communication of Uncertainty
    - End-user Cases
    - Pitfalls
    - Recommendations

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

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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]

1 INESC Technology and Science (INESC TEC), 4200-465 Porto, Portugal
2 WEPROG, 5610 Assens, Denmark; com@weprog.com
3 Deutscher Wetterdienst, 63067 Offenbach, Germany; vanessa.fundel@dwd.de
4 Fraunhofer Institute for Wind Energy and Energy System Technology (IWES), 34119 Kassel, Germany; malte.siefert@iwes.fraunhofer.de
5 University of Strathclyde, Department of Electronic and Electrical Engineering, Glasgow G1 1XQ, UK; jethro.browell@strath.ac.uk
6 Royal Institute of Technology, Department of Mechanics, SE-100 44 Stockholm, Sweden; sheg@kth.se
7 National Renewable Energy Laboratory, Golden, CO 80401, USA; bri-mathias.hodge@nrel.gov
8 University of North Carolina Charlotte, Dept. of Engineering Technology and Construction Management, Charlotte, NC 28223, USA; ucali@uncc.edu
9 MINES ParisTech, PSL Research University, Centre for Processes, Renewable Energies and Energy Systems (PERSEE), 06904 Sophia Antipolis Cedex, France; georges.kariniotakis@mines-paristech.fr
* Correspondence: ricardo.j.bessa@inesctec.pt; Tel.: +351-22209-4216

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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 practices.

Evaluation of Probabilistic Forecasts

- Review Paper by Blicher Bjerregård et al
  - Includes case studies

- "Our overall recommendation for evaluation of a multivariate probabilistic forecast is thus to apply VarS [**Variogram score**] to the full, multivariate forecast, while simultaneously evaluating its marginal densities by either univariate CRPS [Continuous ranked probability score] or LogS [Logarithmic score/log score], depending on whether the shapes of the tails are considered important (LogS) or not (CRPS). "

- Mathias Blicher Bjerregård, Jan Kloppenborg Møller , Henrik Madsen: *An introduction to multivariate probabilistic forecast evaluation*. Energy and AI 4 (2021) 100058. https://doi.org/10.1016/j.egyai.2021.100058

Energy and AI 4 (2021) 100058

Contents lists available at ScienceDirect

Energy and AI

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Review

An introduction to multivariate probabilistic forecast evaluation

Mathias Blicher Bjerregård*, Jan Kloppenborg Møller, Henrik Madsen

Technical University of Denmark Department of Applied Mathematics and Computer, Denmark

H I G H L I G H T S

- An introduction to multivariate probabilistic forecast evaluation.
- A demonstration of how the probabilistic forecasting evaluation methods may be implemented for univariate as well as multivariate problems.
- A demonstration of how the probabilistic forecasting evaluation methods can be applied, exemplified in three case studies, with an emphasis on the evaluation on wind power forecasts.
- A summary table that highlights the advantages and drawbacks of the methods discussed.

A R T I C L E I N F O

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Probabilistic forecast evaluation
Multivariate scoring rules
Wind power forecast
Ensemble forecast
Time series analysis

A B S T R A C T

Probabilistic forecasting is becoming increasingly important for a wide range of applications, especially for energy systems such as forecasting wind power production. A need for proper evaluation of probabilistic forecasts follows naturally with this, because evaluation is the key to improving the forecasts. Although plenty of excellent reviews and research papers on probabilistic forecast evaluation already exist, we find that there is a need for an introduction with some practical application. In particular, many forecast scenarios in energy systems are inherently multivariate, and while univariate evaluation methods are well understood and documented, only limited and scattered work has been done on their multivariate counterparts. This paper therefore contains a review of a selected set of probabilistic forecast evaluation methods, primarily scoring rules, as well as practical sections that explain how these methods can be calculated and estimated. In three case studies featuring simple autoregressive models, stochastic differential equations and real wind power data, we implement, apply and discuss the logarithmic score, the continuous ranked probability score and the variogram score for forecasting problems of varying dimension. Finally, the advantages and disadvantages of the three scoring rules are highlighted, and this provides a significant step towards deciding on an evaluation method for a given multivariate forecast scenario including forecast scenarios relevant for energy systems.

1. Introduction

Forecast evaluation refers to the assessment of the quality of a forecast or to the selection between several competing forecasts. Traditionally, forecasters have used point forecasts [1] such as the conditional expectation for prediction of real processes. If the process is Gaussian, the uncertainty of the prediction is completely characterized by a simple symmetrical confidence interval. However, since real processes are often far from Gaussian, in order to capture all information of a process of interest, it is generally necessary to consider the entire forecast distribution. The evaluation of this is called probabilistic forecast evaluation [2].

A reliable forecast of future events is of crucial importance in, but not limited to, the design and operation of energy systems. A classic application is in the wind power sector, where the associated revenue is very dependent on reliable wind power forecasts [3]. In particular, one unexpected extreme event under which an entire wind farm is forced to shut down temporarily, can easily negate several months of revenue. This is a powerful example of why not only the expectation, but also the uncertainty of the forecasted wind power must be taken into account to minimize such a risk, ideally by forecasting the full probability distribution [4]. In order to obtain accurate probabilistic forecasts, it is necessary to have a good forecasting model, and in order to obtain the best forecasting model, it is necessary to be able to evaluate the forecasts in a meaningful way. Therefore, probabilistic forecast evaluation is clearly very important in energy systems. Besides energy systems, other examples of relevant applications include weather and climate prediction [5], economic and financial risk management [6] and epidemiological forecasting [7]. A shift from point forecasts towards probabilistic forecasts is becoming increasingly important in all of these areas [8].

Forecasting of energy systems may concern univariate or multivariate forecasts. A forecast is multivariate when it consists of multiple variables, which may refer to multiple time-steps, multiple sites or multiple parameters. Plenty of good research about probabilistic forecast evaluation has been published in the univariate case [8]. However, most practical forecast applications consider a sequence of future time points

* Corresponding author.
E-mail address: matbb@dtu.dk (M.B. Bjerregård).

https://doi.org/10.1016/j.egyai.2021.100058

Overview of Uncertainty Propagation in the Forecasting Chain

- Conceptual paper on the origins and propagation of uncertainty through the forecasting chain
- Applicable to wind and solar power
- Published in *Renewable and Sustainable Energy Reviews 2022*
- Recommendation: Next paper should use data and quantify the contributions

Uncovering wind power forecasting uncertainty origins and development through the whole modelling chain[⋆,⋆⋆]

Jie Yan[a], Corinna Möhrlen[b], Tuhfe Göçmen[c], Mark Kelly[c], Arne Wessel[d] and Gregor Giebel[c,*]

[a]North China Electric Power University, State Key Lab of Alternate Electrical Power System with Renewable Energy Sources, Beijing, P.R. China
[b]WEPROG, Dreijervaenget 8, 5610 Assens, Denmark
[c]Technical University of Denmark, Department of Wind Energy, Frederiksborgvej 399, 4000 Roskilde, Denmark
[d]Fraunhofer Institute for Energy Economics and Energy System Technology IEE, Kassel, Germany

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ABSTRACT

Wind power forecasting has been supporting operational decision-making for power system and electricity markets since 30 years. Efforts of improving the accuracy and/or certainty of wind power forecasts, either deterministic or probabilistic, are continuously exerted by academics and industries. Forecast errors and associated uncertainties, which propagate through the whole forecasting chain, from weather provider to the end user, cannot be eliminated completely due to many reasons; for instance, endogenetic randomness of weather systems and varying wind turbine performance. Therefore, understanding the sources of uncertainty and how these uncertainties propagate throughout the modelling chain is significant to implement more rational and targeted uncertainty mitigation strategies and standardise the uncertainty validation. This paper presents a thorough review of the uncertainty propagation through the modelling chain, from the planning phase of the wind farm and the forecasting system through the operational phase and market phase. Moreover, the definition of the uncertainty sources throughout these phases build the guiding line of uncertainty mitigation throughout this review. In the end, a discussion on uncertainty validation is provided along with some examples. Highlights of this paper include: 1) forecasting uncertainty exists and propagates everywhere throughout the entire modelling chain and from planning phase to market phase; 2) the mitigation efforts should be exerted in every modelling step; 3) standardised uncertainty validation practice and global data samples are required for forecasters to improve model performance and for forecast users to select and evaluate the model's output.

1. Introduction

High penetration of wind power has been recognised globally as one of the most important features of current and future sustainable power systems. The natural randomness and variability of the wind itself can aggravate negative impacts of wind power on power system operation and market trading, which strengthens the significance of forecasting technology. Wind power forecasting (WPF) started more than three decades ago [16], with the first operational forecasting tools arriving at system operation level some 10 years later at the Danish transmission system operator ELSAM [10]. Since then, researchers have been making continuous efforts to improve the forecasting accuracy and reliability.

It is impossible to achieve perfect predictions of wind power at any given time or location, due to chaotic atmospheric motions having temporal and spatial scales that typically span more than six orders of magnitude [17, 18, 19]. Along with the complex wind field, wind turbine performance creates nonlinear and time-varying uncertainties in wind power forecasting. To improve the value of forecasts and their usage, we practically consider three questions: why, when and to what extent the forecasting uncertainty will happen [20]. Accordingly, this further guides the mitigation of forecasting uncertainty. There is plenty of literature in this area, and can be clarified into following three categories.

* This paper was coordinated under the auspices of IEA Wind Task 36 'Forecasting for Wind Energy'. Corinna Mörlen, Tuhfe Göçmen, Mark Kelly and Gregor Giebel were funded by the Danish EUDP project "IEA Wind Task 36 Phase II Danish Consortium", Grant Number 64018-0515.
*Corresponding Author: Gregor Giebel
grgi@dtu.dk (G. Giebel)
www.dtu.dk (G. Giebel)
ORCID(s): 0000-0002-9412-0999{0000-0002-9412-0999} (J. Yan); 0000-0002-8842-1533{0000-0002-8842-1533} (C. Möhrlen); 0000-0002-4453-8756{0000-0002-4453-8756} (G. Giebel)

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How do Humans Decide under Wind Power Forecast Uncertainty

- Paper & Poster by Corinna Möhrlen et al.
- "In the first part of IEA Wind Task 36 initiative, a forecast game was designed as a demonstration of a typical decision-making task in the power industry. The game had been played by 120 participants. We will discuss the results of our first experience with the experiment and introduce some new features of the second generation of experiments as a continuation of the initiative."
- Möhrlen, C., Giebel, G., Bessa, R.J., and Fleischhut, N. How do Humans decide under Wind Power Forecast Uncertainty — an IEA Wind Task 36 Probabilistic Forecast Games and Experiments initiative, Journal of Physics: Conference Series, Volume 2151, WindEurope Electric City 2021 23/11/2021 – 25/11/2021 Copenhagen, Denmark, DOI: [10.1088/1742-6596/2151/1/012014](https://doi.org/10.1088/1742-6596/2151/1/012014)

Award-winning Poster at Wind Europe Electricity 2021

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PAPER • OPEN ACCESS

How do Humans decide under Wind Power Forecast Uncertainty — an IEA Wind Task 36 *Probabilistic Forecast Games and Experiments* initiative

Corinna Möhrlen[1], Gregor Giebel[2], Ricardo J. Bessa[3] and Nadine Fleischhut[4]

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Article PDF

References

+ Article information

Abstract

The need to take into account and explicitly model forecast uncertainty is today at the heart of many scientific and applied enterprises. For instance, the ever-increasing accuracy of weather forecasts has been driven by the development of ensemble forecasts, where a large number of forecasts are generated either by generating forecasts from different models or by repeatedly perturbing the initial conditions of a single forecast model. Importantly, this approach provides robust estimates of forecast uncertainty, which supports human judgement and decision-making. Although weather forecasts and their uncertainty are also crucial for the weather-to-power conversion for RES forecasting in system operation, power trading and balancing, the industry has been reluctant to adopt ensemble methods and other new technologies that can help manage highly variable and uncertain power feed-ins, especially under extreme weather conditions.

In order to support the energy industry in the adaptation of uncertainty forecasts into their business practices, the IEA Wind Task 36 has started an initiative in collaboration with the Max Planck Institute for Human Development and Hans-Ertel Center for Weather Research to investigate the existing barriers in the industry to the adoption of such forecasts into decision processes. In the first part of the initiative, a forecast game was designed as a demonstration of a typical decision-making task in the power industry. The game was introduced in an IEA Wind Task 36 workshop and thereafter released to the public. When closed, it had been played by 120 participants. We will discuss the results of our first experience with the experiment and introduce some new features of the second generation of experiments as a continuation of the initiative. We will also discuss specific questions that emerged when we started and after analysing the experiments. Lastly we will discuss the trends we found and how we will fit these into the overall objective of the initiative which is to provide training tools to demonstrate the use and benefit of uncertainty forecasts by simulating decision scenarios with feedback and allowing people to learn from experience, rather than reading articles, how to use such forecasts.

A Decision-making Experiment under Wind Power Forecast Uncertainty

- Paper by Corinna Möhrlen et al
- ”In the framework of an IEA Wind Task 36 workshop, the experiment aimed to investigate existing psychological barriers in the industry to adopt probabilistic forecasts and to better understand human decision processes”.
- ”The focus was on a decision-making process dealing with extremes that can cause high cost….”
- Möhrlen, C., Bessa, R. J., & Fleischhut, N.(2022). A decision-making experiment under wind power forecast uncertainty. Meteorological Applications, 29(3), e2077. https://doi.org/10.1002/met.2077

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Meteorological Applications
Science and Technology for Weather and Climate
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RESEARCH ARTICLE

A decision-making experiment under wind power forecast uncertainty

Corinna Möhrlen[1] | Ricardo J. Bessa[2] | Nadine Fleischhut[3]

[1]Department of Research and Development, WEPROG ApS, Assens, Denmark

[2]INESC Technology and Science (INESC TEC), Porto, Portugal

[3]Center for Adaptive Rationality, Max Planck Institute for Human Development, Berlin, Germany

Correspondence
Nadine Fleischhut, Center for Adaptive Rationality, Max Planck Institute for Human Development, 14195 Berlin, Germany.
Email: nfleischhut@gmail.com

Present address
Nadine Fleischhut, Center for Adaptive Rationality, Max Planck Institute for Human Development, Berlin, Germany

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Abstract

As the penetration levels of renewable energy sources increase and climatic changes produce more and more extreme weather conditions, the uncertainty of weather and power production forecasts can no longer be ignored for grid operation and electricity market bidding. In order to support the energy industry in the integration of uncertainty forecasts into their business practices, this work describes an experiment conducted with 105 participants from the energy industry. In the framework of an IEA Wind Task 36 workshop, the experiment aimed to investigate existing psychological barriers in the industry to adopt probabilistic forecasts and to better understand human decision processes. We designed and ran a ‘decision game’ to demonstrate the potential benefits of uncertainty forecasts in a realistic—although simplified—problem, where an energy trader had to decide whether to trade 100% or 50% of the energy of an offshore wind park on a given day based on deterministic and probabilistic uncertainty day-ahead forecasts. The focus thus was on a decision-making process dealing with extremes that can cause high costs in the form of security issues in the electric grid for system operators, or high monetary losses for traders, who have bid a power production into the market that failed to be produced due to high-speed shutdown of the wind turbines. This paper presents the obtained results, extracts behavioural conclusions and identifies how to overcome psychological barriers to the adoption of uncertainty forecasts in the energy industry.

KEYWORDS
ensemble forecasting, experiment, forecast value, *human decision-making*, uncertainty, wind power

Minute-scale Forecasting Workshop

- Workshop with Task 32 Lidars at Risø 12/13 June 2018.
- How to use Lidars, Radars or SCADA for very short-term forecasts
- Target: 30 sec – 15 min look-ahead.
- Slides available from workshop website.
- Complete workshop on YouTube.
- Summary paper in Energies journal.

energies

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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]

1 Stuttgart Wind Energy, University of Stuttgart, Allmandring 5b, 70569 Stuttgart, Germany
2 ForWind-University of Oldenburg, Institute of Physics, Küpkersweg 70, 26129 Oldenburg, Germany; laura.valldecabres@forwind.de
3 DTU Wind Energy (Risø Campus), Technical University of Denmark, Frederiksborgvej 399, 4000 Roskilde, Denmark; ellsim@dtu.dk (E.S.); grgi@dtu.dk (G.G.)
4 WEPROG, Willemoesgade 15B, 5610 Assens, Denmark; com@weprog.com
5 Department of Engineering Sciences, Division of Electricity, Uppsala University, The Ångström Laboratory, Box 534, 751 21 Uppsala, Sweden; bahriuzunoglu@computationalrenewables.com
6 Department of Mathematics, Florida State University, Tallahassee, FL 32310, USA
7 Department of Electronic and Electrical Engineering, University of Strathclyde, 204 George St, Glasgow G11XW, UK; ciaran.gilbert@strath.ac.uk
8 Wind Energy Technology Institute, Flensburg University of Applied Sciences, Kanzleistraße 91–93, 24943 Flensburg, Germany; david.schlipf@hs-flensburg.de
9 Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg, Meitnerstraße 1, 70563 Stuttgart, Germany; anton.kaifel@zsw-bw.de
* Correspondence: wuerth@ifb.uni-stuttgart.de; Tel.: +49-711-685-68285

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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

WP3 End-user Workshop in Glasgow

“Maximising Value from State-of-the-art Wind Power Forecasting Solutions”

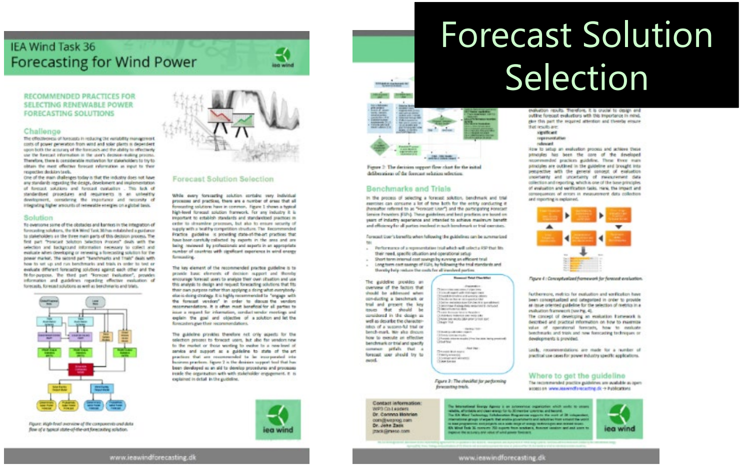
hosted by Jethro Browell at Strathclyde University, Glasgow, 21 Jan 2020

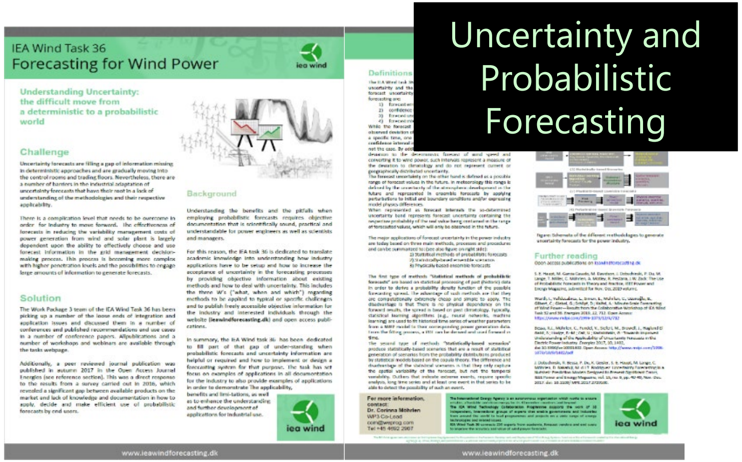
- Talks by academia and industry (e.g. UK National Grid, WindPoint, UStrathclyde)
- Open Space discussion on RP, data and forecast value
- First Game introduced on value of probabilistic forecasts
  (see https://iea-wind.org/task51/task51-work-streams/ws-decision-making-under-uncertainty/
- Streamed on YouTube: https://www.youtube.com/watch?v=1NOIr7jIuXI

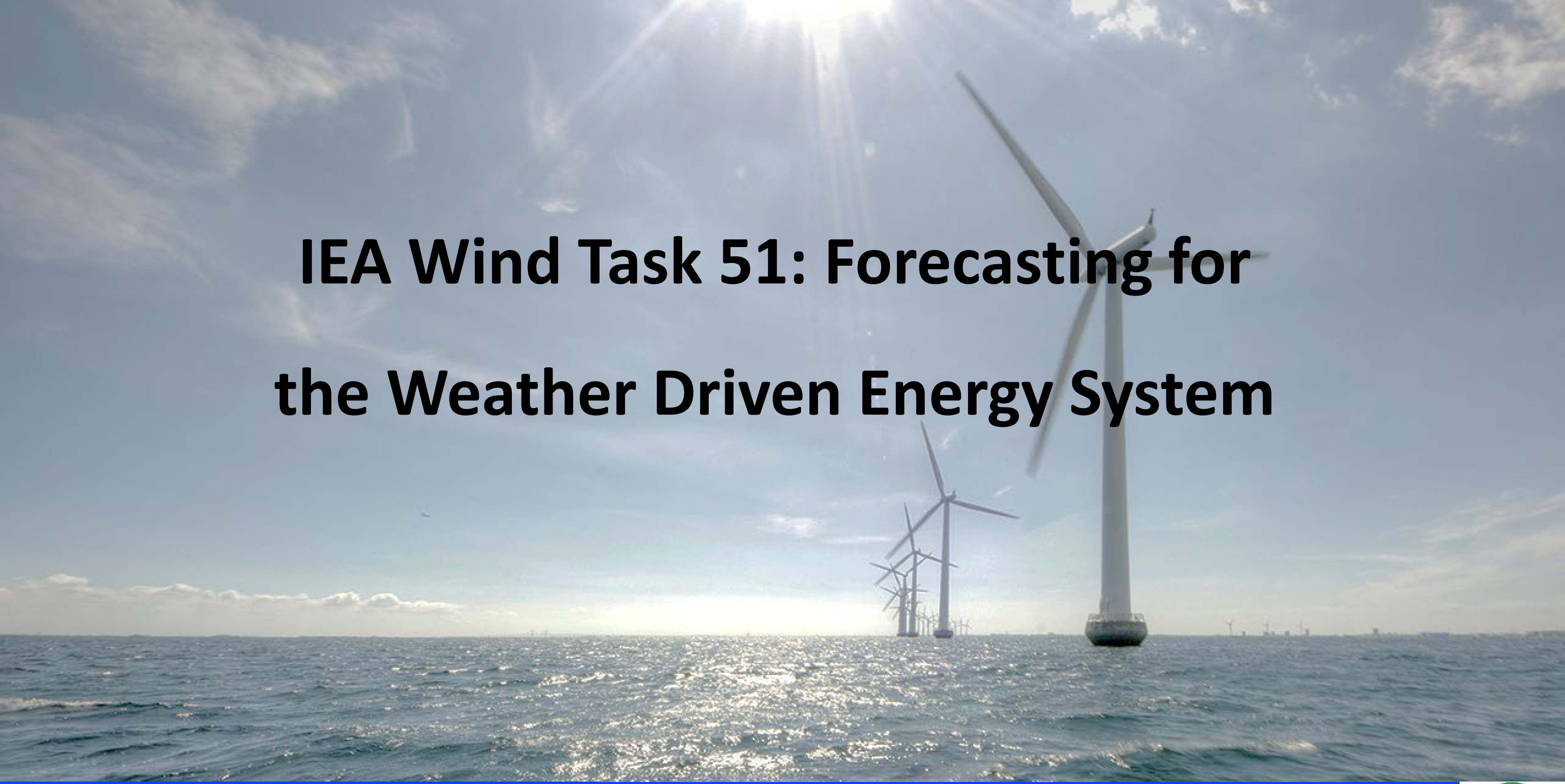
Handouts

- 2-page handouts: quick overview of major results
- 3 currently available; can be obtained from:

  http://www.ieawindforecasting.dk/publications/posters-og-handouts







IEA Wind Task 51: Forecasting for the Weather Driven Energy System

Technology Collaboration Programme

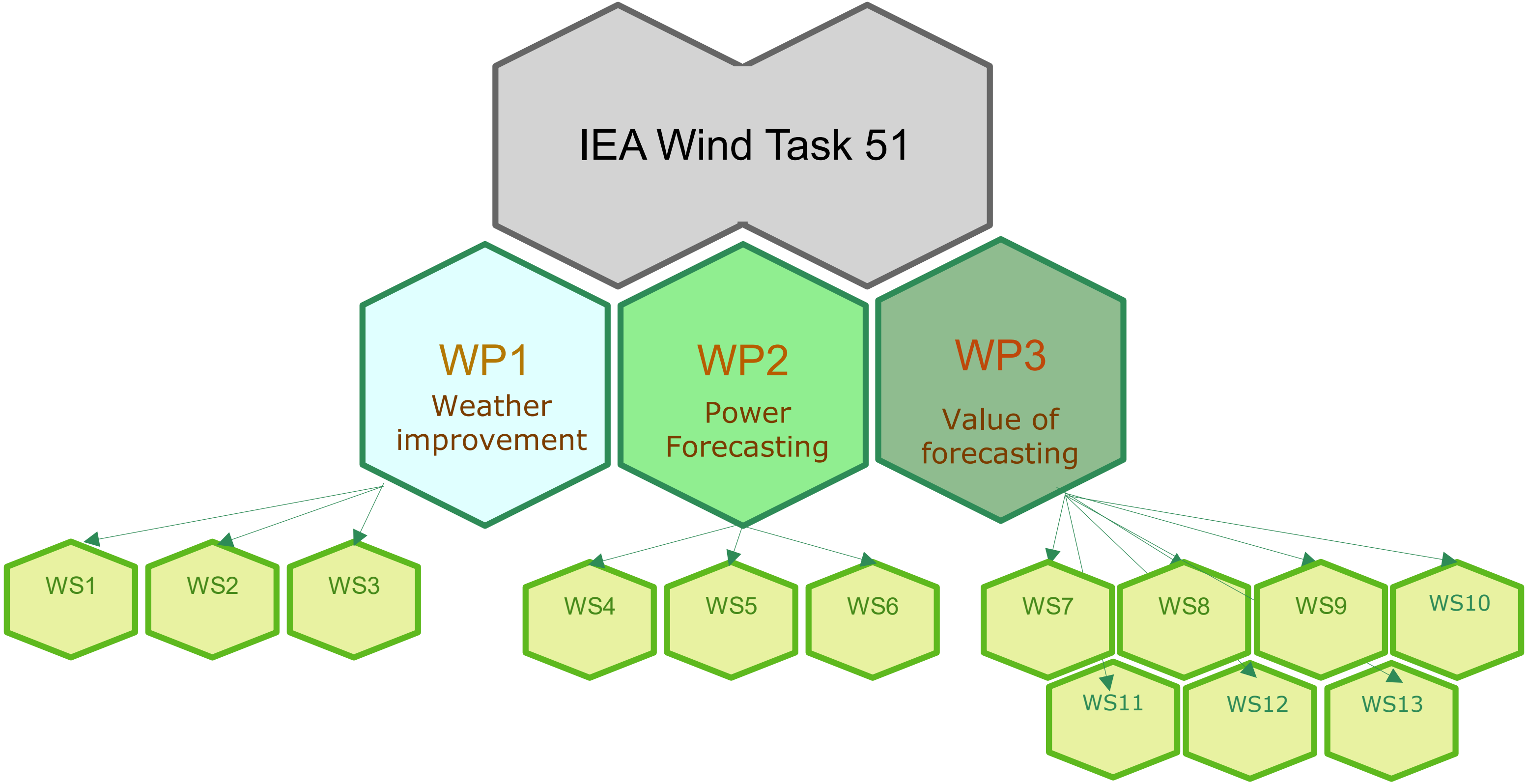
by iea

iea wind

Overview of Task 51:
Forecasting for the Weather Driven Energy System

- ”Relaunch” of Task 36
- Framework conditions have changed since first phase of Task 36: RES is not small addition to system, but IS the system; sector coupling is critical
- New challenges for new forecast horizons (e.g. seasonal forecasting…)
- Needs strong **collaboration with related TCPs** (solar, hydro, hydrogen…) and related Tasks (Integration, Lidar, Farm Flow Control, Hybrids, …)
- Data markets coming into focus
- 4 public workshops: State of the Art (2022), Seasonal Forecasting (2023), Minute-scale Forecasting (2024) and Extreme Power System Events (2025).

Overall Structure of Task 51



Work Streams:	WP1 Weather	WP2 Power	WP3 Applications	Deliverable	#, Due	Collaboration
Atmospheric physics and modelling (WP1)				List of experiments and data	D1.1, Ongoing	WMO, PVPS T16
Airborne Wind Energy Systems (WP1)				Presentations on workshops	Part of D2.1	Task 48 Airborne Wind Energy
Seasonal forecasting (WP1)				Workshop / Paper	D1.6 / M19	Hydro TCP, Hydrogen TCP, Biomass TCP
State of the Art for energy system forecasting (WP2)				Workshop / Paper RecPract on Forecast Solution Selection v3	D2.1 / M7, M12 M2.1 / M36	PVPS Task 16, Hydro TCP, Hydrogen TCP, …
Forecasting for underserved areas (WP2)				Public dataset	D2.4 / M24	WMO
Minute scale forecasting (WP2)				Workshop / Paper	D2.5 / M31, M36	Wind Tasks 32 Lidar, 44 Farm Flow Control and 50 Hybrids
Uncertainty / probabilistic forecasting (WP3)				Uncertainty propagation paper with data RecPract v3	D 2.6 / M42 M48	PVPS T16
Decision making under uncertainty (WP3)				Training course Games	M12 M18	
Extreme power system events (WP3)				Workshop	D3.6 / M42	Task 25, ESIG, IEA ISGAN, PVPS T16, G-PST
Data science and artificial intelligence (WP3)				Report	D2.3 / M30	
Privacy, data markets and sharing (WP3)				Workshop / Paper Data format standard	D3.5 / M15	ESIG IEEE WG Energy Forecasting

Workshop

State of the Art and Research Gaps in Forecasting for the Weather Driven Energy System

UCD DUBLIN

iea wind

September 12/13 2022, University College Dublin

http://www.iea-wind.org/task51/

State of the Art and Research Gaps Workshop, Dublin 2022

- Personal and online some 60 participants
- Slides and video on https://iea-wind.org/task51/task51-work-streams/ws-state-of-the-art-for-energy-system-forecasting/
- Journal paper being worked on

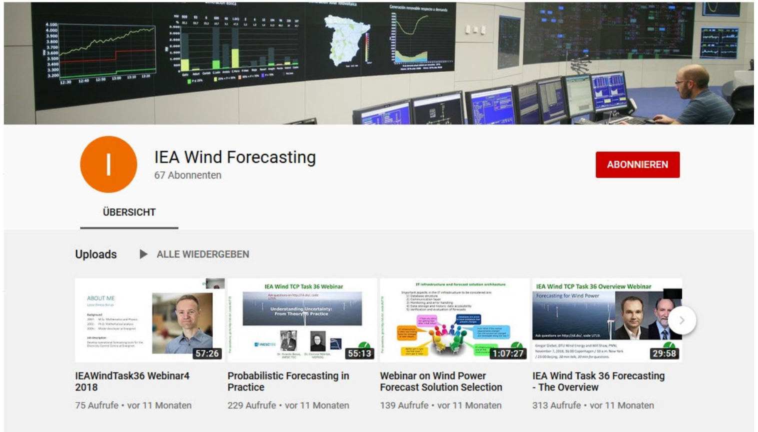
Task 51 Web Presence

Website

www.iea-wind.org/task51

YouTube Channel

https://www.youtube.com/c/IEAWindForecasting



Follow us at:

www.IEA-Wind.org/task51 or

www.IEAWindForecasting.dk

Get in touch with the operating agents of the task:

Gregor Giebel

grgi@dtu.dk

Caroline Draxl

caroline.draxl@nrel.gov