

IEA Wind Task 51 “Forecasting for the Weather Driven Energy System”

Wind & Solar Integration Workshop

Session 4D - IEA WIND AND PVPS TASK 51 AND 16

Helsinki, Finland – 8th October 2024 -

C. Möhrlen (WEPROG) and John Zack (MESO)

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





International Energy Agency History

The IEA was founded in 1974 to help countries co-ordinate a collective response to major disruptions in the supply of oil.



Image source: dpa

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)
- Photovoltaic Power Systems (PVPS TCP)
- Solar Heating and Cooling (SHC TCP)
- **Wind Energy Systems (Wind TCP)**



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IEA Wind TCP Research Tasks

Technology Collaboration Programmes

Environmental Co-Design

- Avoiding, minimising, compensating for environmental impacts
- Incorporating environmental costs, benefits into decisions
- Addressing both immediate concerns, future impacts

Tasks 42, 45, 59 & 60

Social Science

- Acknowledging the transformational nature of development
- Creating just processes
- Valuating benefits, effects, burdens

Tasks 39, 53 & 62

Tasks 25, 41, 50, 55, 58 & 61

The Plant and Grid

- Improving modelling
- Optimising plant design for multiple objectives
- Ready wind plants for grid support

The Turbine

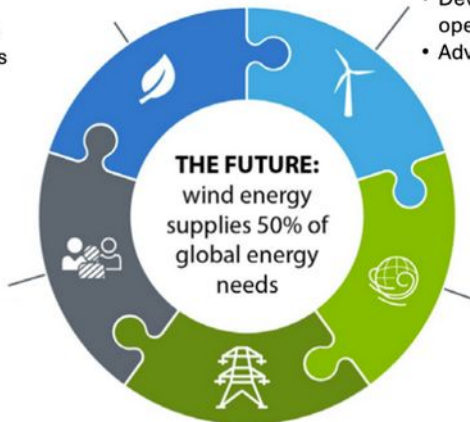
- Incorporating holistic design
- Developing intelligent controls, operation, maintenance
- Advancing industrialisation

Tasks 44, 49, 52, 54 & 57

The Atmosphere

- Increasing atmospheric observations
- Expanding, validating universal predictive capability
- Integration, adopting improved models

Tasks 43, 46, 47, 48, 49, 51, 56



Capacity

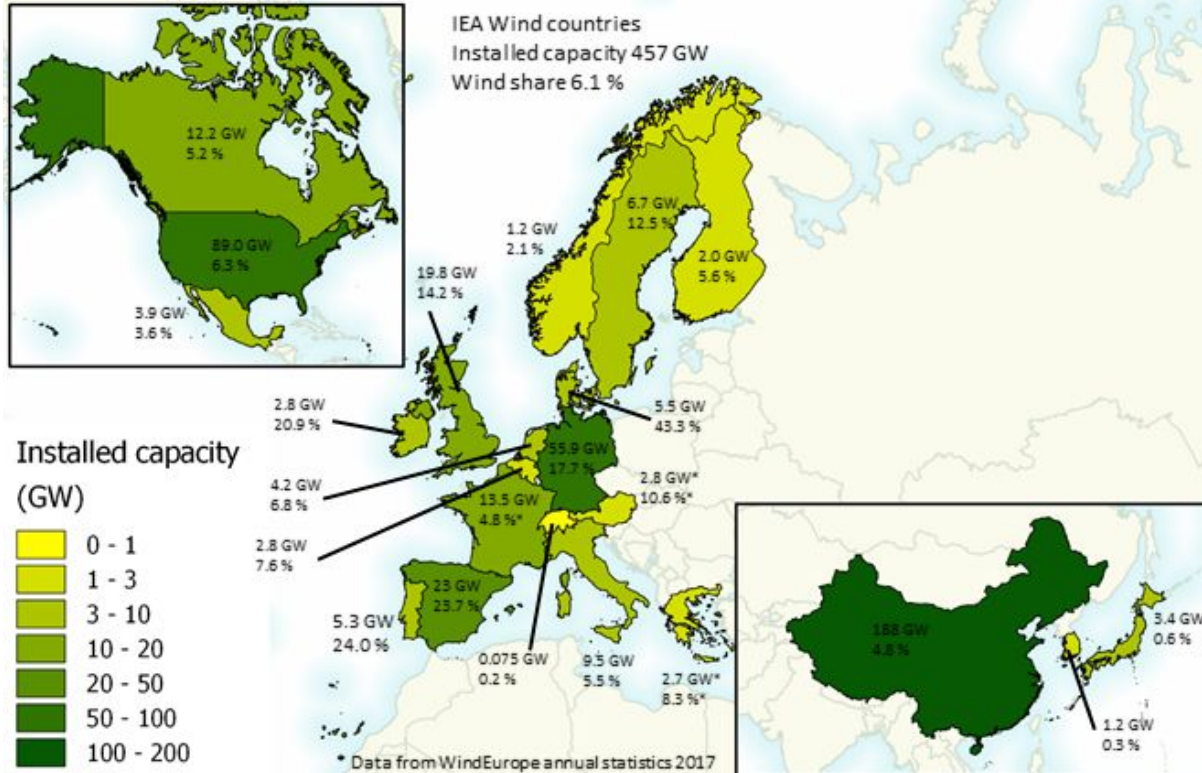
As of 2020, about 85% of the world's wind generating capacity—and nearly all offshore capacity—resides within the participating countries. To learn more about the work of each participating member, please click on any of the countries or sponsors below.





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task 51: forecasting for the weather-driven energy system



- Task 51 members (12)
- AT, CN, DE, DK, ES, FI, FR, IE, PT, SE, UK, US



Forecasting for Wind Energy

2016-2018

2019-2021

T36 Phase 1

T36 Phase
2

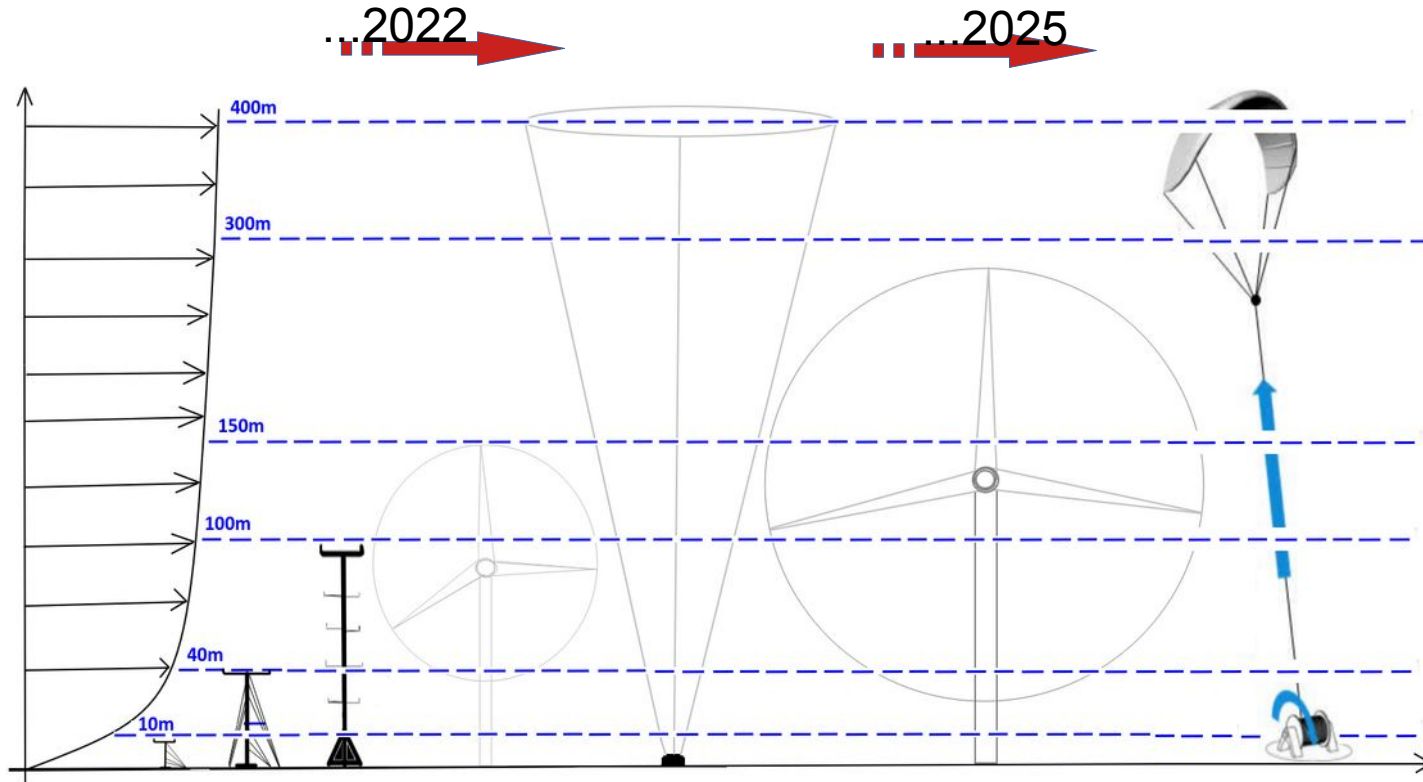
Redefinition

T51 Phase 1

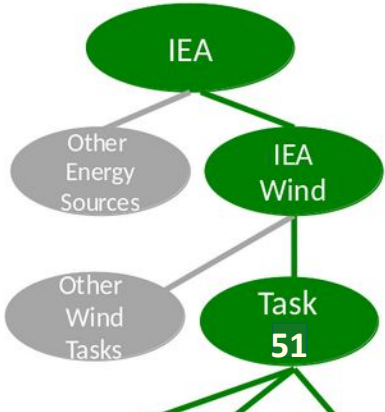
2022-2025

Forecasting for the
weather-driven
Energy System

From groups of single wind turbines to large-scale Wind Energy Systems



IEA Wind Task 51: Forecasting for the weather-driven Energy System



What is the IEA (International Energy Agency)? (www.iea.org)

- International organization within OECD with 30 members countries and 8 associates
- Promotes global dialogue on energy, providing authoritative analysis through a wide range of publications
- **One activity: convenes panels of experts to address specific topics**

Task 51: Forecasting for the weather-driven Energy System:

- One of 17 Tasks of IEA Wind: <https://iea-wind.org/>
- Task 36: Phase 1: 2016-2018; Phase 2: 2019-2021 **Task 51: Phase 3: 2022-2025**
- Operating Agent: Gregor Giebel of DTU Wind Energy
- Objective: facilitate int. collaboration to **improve wind energy forecasts**
- Participants: (1) research organization and projects, (2) forecast providers, (3) policy-makers and (4) end-users & stakeholders

Work Streams:	WP1 Weather	WP2 Power	WP3 Applications
Atmospheric physics and modelling (WP1)	★		
Airborne Wind Energy Systems (WP1)	★		
Seasonal forecasting (WP1)	★		
State of the Art for energy system forecasting (WP2)		★	
Forecasting for underserved areas (WP2)		★	
Minute scale forecasting (WP2)		★	
Uncertainty / probabilistic forecasting (WP3)			★
Decision making under uncertainty (WP3)			★
Extreme power system events (WP3)			★
Data science and artificial intelligence (WP3)			★
Privacy, data markets and sharing (WP3)			★
Value of forecasting (WP3)			★
Forecasting in the design phase (WP3)			★

Task 51 Scope: 3 “Work Packages” distributed over 13 “Workstreams”

- WP1: Global Coordination in Forecast Model Improvement
- WP2: Benchmarking, Predictability and Model Uncertainty
- WP3: Optimal Use of Forecasting Solutions

Task homepage: <https://iea-wind.org/task51>

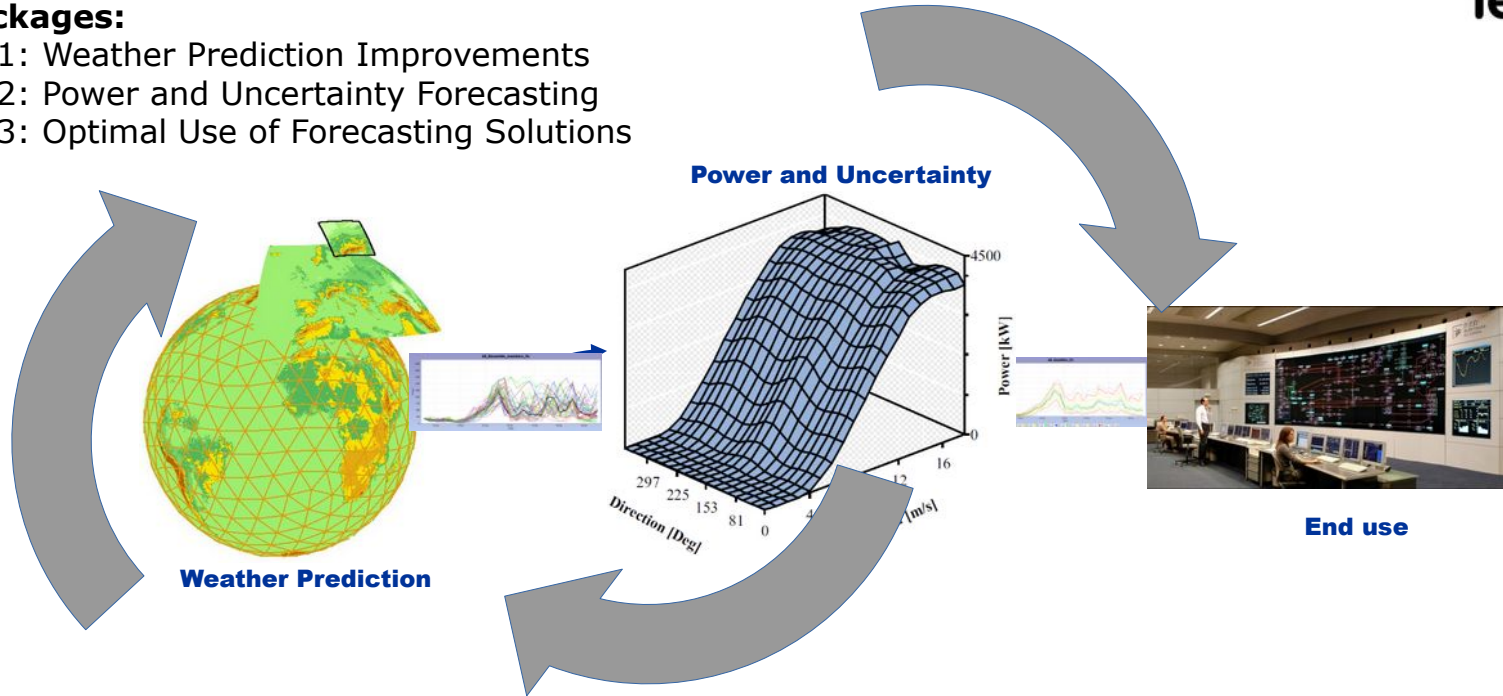
IEA Wind Task 51 Work distribution

Task Work is divided into 3 work packages:

WP1: Weather Prediction Improvements

WP2: Power and Uncertainty Forecasting

WP3: Optimal Use of Forecasting Solutions

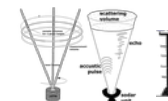




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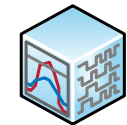
IEA Wind Task 51 Work distribution

Work Streams:	WP1 Weather	WP2 Power	WP3 Applications
Atmospheric physics and modelling (WP1)	★		
Airborne Wind Energy Systems (WP1)	★		
Seasonal forecasting (WP1)	★		
State of the Art for energy system forecasting (WP2)		★	
Minute scale forecasting (WP2)		★	
Data science and artificial intelligence (WP3)			★
Extreme power system events (WP3)			★
Uncertainty / probabilistic forecasting (WP3) & for underserved areas			★
Decision making under uncertainty (WP3)			★
Privacy, data markets and sharing (WP3)			★
Value of forecasting (WP3)			★



Modelling & data assimilation

Workshops



Verification Platform

Publications



Information Portal

The Task 51 Information Portal aims to be a useful resource for people in forecasting, especially providing links to publically available data for model development.

<https://iea-wind.org/task-51/t51-information-portal/>

The Task members identified several issues which might be useful in an information portal for wind power forecasting. Those are:

- [A list of meteorology masts](#) with online data over 100m height, useful for verification of wind speed predictions
- [A list of meteorological experiments](#) going on currently or recently, either to participate or to verify a flow model against
- [A list of publicly available wind power forecasting benchmarks](#), to test your model against
- [A list of current or finished research projects](#) in the field of wind power forecasting
- [A list of future research issues](#)
- [A list of open weather data](#)

For all of those, we would be happy to accept input, so head over to the site and see where you can help, or what you can use!

Please find the full text of the task description [here](#).

The task is led by [Gregor Giebel](#) from DTU Wind Energy.

Research projects

<https://iea-wind.org/task-51/project-list/>

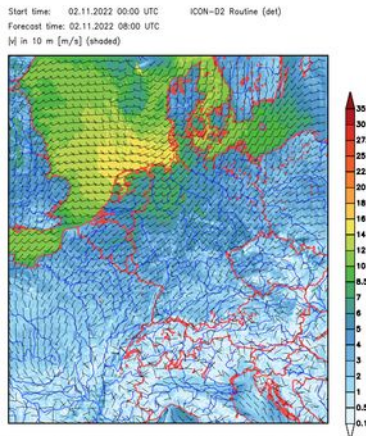
Here are some ongoing and finished projects towards short-term prediction of wind power throughout the last two decades. In total, the public (and partly private) spending on this list exceeds 150 million euro.

Country	Project acronym	Full title	Sponsor	Total / Funded budget	Start – end date	Participants incl. those from IEA Task 36/51
DE	WindStore	Optimized system integration of offshore wind energy through intelligent linking of various forecast concepts and forward-looking management of distributed cascade storage systems.	BMWK (German Federal Ministry for Economics and Climate Protection)	1.76 M€ / 1.47 M€	Jan 2024 – Dec 2026	Fraunhofer IEE, DLR, 4Cast, SETrade, WEPROG, EnBW, Stadtwerke Hassfurt und Wunsiedel
BE	BeFORECAST	Wake-effect included offshore wind power forecasting for smooth operation of the Belgian electricity grid based on advanced data handling and sensor technology, including airborne systems.	Energy Transition Funds of the Federal Public Service Economy of the Belgian Federal Government	3.25 M€ / 2.74 M€	Nov 23 – Oct 25	von Karman Institute for Fluid Dynamics, Vrije Universiteit Brussel, KU Leuven, 3E, SABCA, Royal Meteorological Institute of Belgium
UK		Multi-variate forecasting for wind power integration in electricity markets	Shell/ETP Scotland	90k€/120k€	Oct 22 – Mar26	University of Glasgow, Jethro Browell

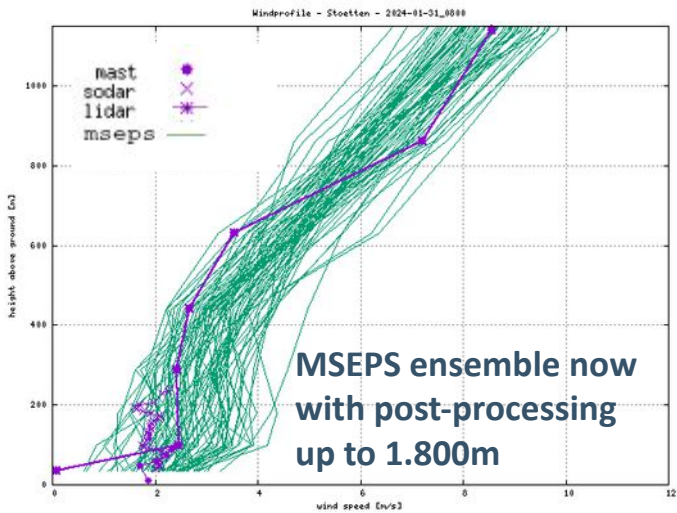
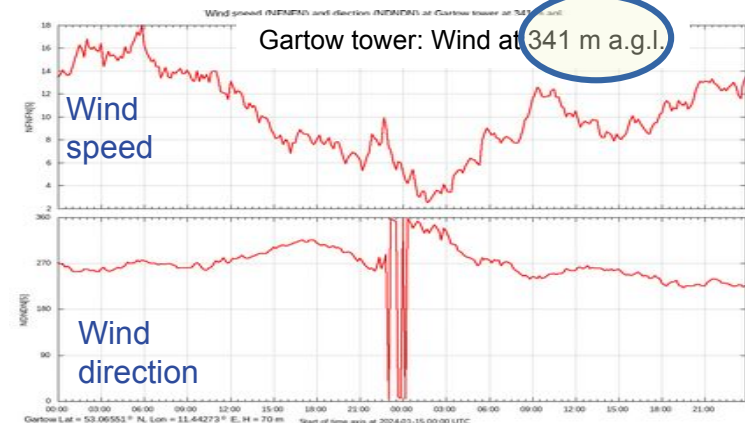
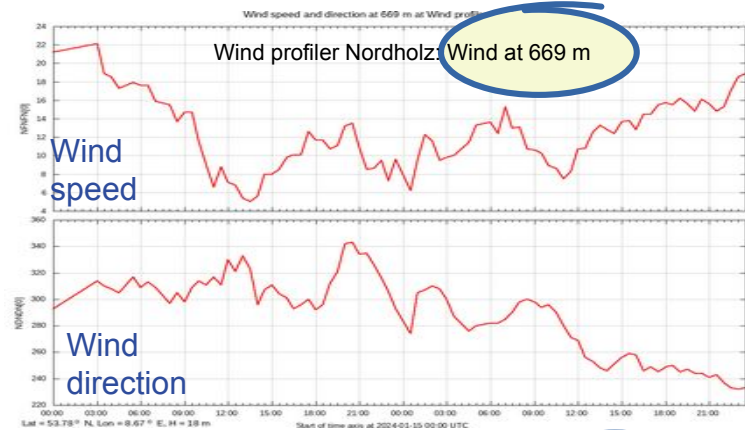
Workstream Atmospheric Modelling and Physics & first simulations for airborne wind



iea wind



ICON-DE model now in 15min resolution every hour





iea wind

Elsevier OpenAccess Book

ORDER or **DOWNLOAD for free NOW!**

ISBN: 978-0-443-18681-3

PUB DATE: November 2022

DISCOUNT: Non-serials

FORMAT: Paperback

Editors: Corinna Möhrle, John W. Zack, and Gregor Giebel

<https://www.elsevier.com/books/iea-wind-recommended-practice-for-the-implementation-of-renewable-energy-forecasting-solutions/mohrlen/978-0-443-18681-3>

Online OpenAccess:

<https://www.sciencedirect.com/book/9780443186813/iea-wind-recommended-practice-for-the-implementation-of-renewable-energy-forecasting-solutions>

IEA Wind Task 51 Information

iea-wind.org → Task 51 → Publications → [Recommended Practice](#)

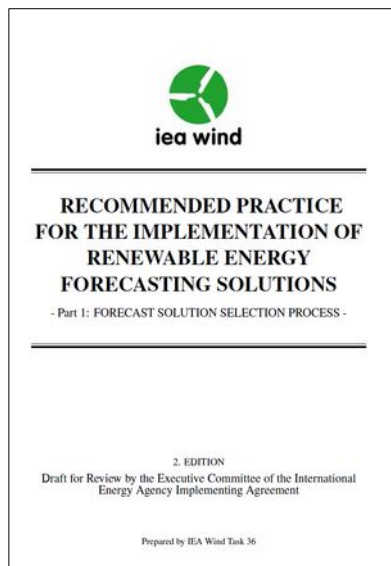


IEA Wind Recommended Practice for the Implementation of Renewable Energy Forecasting Solutions

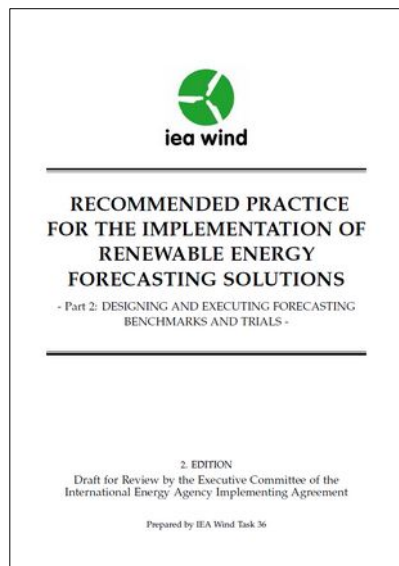


Corinna Möhrle
John W. Zack
Gregor Giebel

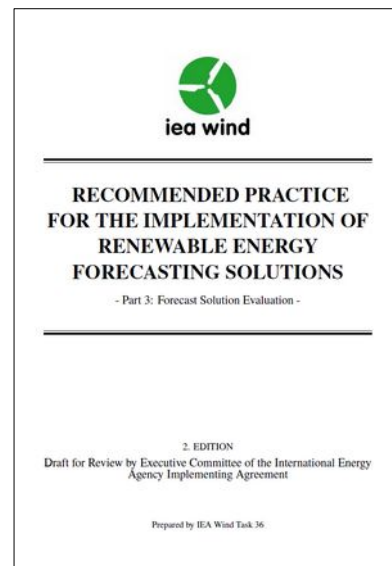
IEA Best Practice Recommendations for the Selection of a Wind Forecasting Solution v2: Set of 4 Documents



Part 1: Selection of an Optimal Forecast Solution



Part 2: Design and Execution of Benchmarks and Trials



Part 3: Evaluation of Forecasts and Forecast Solutions



Part 4: Data Requirements for Real-time Applications

Now as OpenAccess book!

Introduction: <https://www.youtube.com/watch?v=XVO37hLE03M>



Validation & Verification code examples



IEA Wind Recommended Practice for the Implementation of Renewable Energy Forecasting Solutions

Wind Energy Engineering

2023, Pages 321-322



Examples developed within the IEA Wind Task 36 and Task 51:

WE-validate

Available on GitHub: <https://github.com/joejoejoseph/WE-Validate>

Publication: <https://www.sciencedirect.com/science/article/pii/S0960148122014707>

Use Case: Demo Jupyter Notebook (U.S. Mountain Wave case):

https://nbviewer.jupyter.org/github/joejoejoseph/i-validate/blob/main/notebooks/demo_notebook.ipynb

Existing metrics: RMSE, cRMSE, mean bias, mean absolute error

Existing plots: time series, histogram, scatter plot

WE-verify-prob – R-package for probabilistic verification

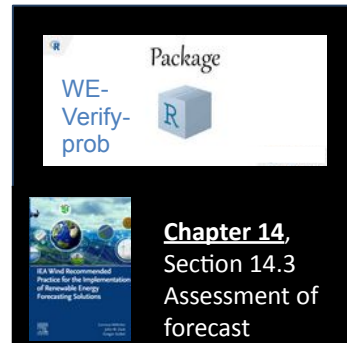
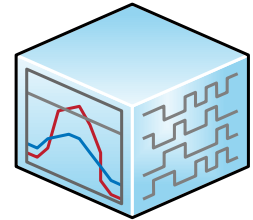
Existing metrics: CRPS, Brier Score, ROC curve, Histograms, Reliability Diagram, Contingency table

Existing plots: time series, histograms, ROC curve, CRPS

See also our workshops & conference page:

<https://iea-wind.org/task51/task51-publications/task51-workshops-and-special-sessions/>

Appendix G - Validation and verification code examples



Workstream Uncertainty :

Uncertainty Propagation throughout the model chain with real data

PHASE I

2022-2023

tool
1

tool
2

R-
verify
tool

tool
3

Uncertainty
Quantification
with test data
sets
according to
2022 UQ
publication*

PHASE II

2024

Online
Verification
Platform



Discussion & testing of
verification platform

PHASE III

2025

Publication



Discussion & writing of
publication with most
suitable test cases

* Uncovering wind power forecasting uncertainty sources and their propagation through the whole modelling chain
<https://www.sciencedirect.com/science/article/pii/S1364032122004221>

Review of uncertainty propagation

Work program Part I

- **Qualitative description** of the origins and propagation of uncertainty through the forecasting chain (D2.2)

→ Published in *Renewable and Sustainable Energy Reviews* in 2022

Work program Part II (2023-2025)

- **Quantification** of the origins and propagation of uncertainty through the forecasting chain

Uncovering wind power forecasting uncertainty origins and development through the whole modelling chain^{*,**}

Jie Yan^a, Corinna Möhrlein^b, Tuhe Göçmen^c, Mark Kelly^c, Arne Wessel^d and Gregor Giebel^{e,*}

^aNorth China Electric Power University, State Key Lab of Alternate Electrical Power System with Renewable Energy Sources, Beijing, P.R. China

^bWEPROG, Dreifjærvaenget 8, 5610 Assens, Denmark

^cTechnical University of Denmark, Department of Wind Energy, Frederiksborgvej 399, 4000 Roskilde, Denmark

^dFraunhofer Institute for Energy Economics and Energy System Technology IEE, Kassel, Germany

ARTICLE INFO

Keywords:
wind power
forecast uncertainty
modelling chain

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, endogenous 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 Möhrlein, Tuhe Göçmen, Mark Kelly and Gregor Giebel were funded by the Danish EU/DF project 'IEA Wind Task 36 Phase II Danish Consortium', Grant Number 64018-0515.

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ORCID(i): 0000-0002-9412-0999(0000-0002-9412-0999) (J. Yan); 0000-0002-8842-1533(0000-0002-8842-1533) (C. Möhrlein); 0000-0002-4453-8756(0000-0002-4453-8756) (G. Giebel)

Decision making under uncertainty

Forecast Game	Short Description	Link
		Forecast Game (choose "Play the Game" at top menu)
	IEA Wind Task 36/51 and MPH for Human Development have released a forecast game at the European Meteorological Society Annual Conference 2021.	Forecast Game Results Links to additional material:
Wind Power Trading decisions for a Wind Park in complex Terrain	The game investigates how ensemble forecasts showing forecast uncertainty can improve our ability to make informed decisions, also when the weather conditions are complex or extreme.	WGW2022: Key Note Presentation
	In the experimental game, the player is asked to make trading decisions for a wind farm in complex terrain in a number of situations based on deterministic and probabilistic power and wind forecasts.	AMS 2022: Presentation Electric-City 2021: Paper & award winning Poster EMS 2021: Presentation
		IEA Task 36 Webinar Youtube & Presentation
		Forecast Game (offline version to come soon) Forecast Game Results
Wind Power Trading decisions for an Offshore Wind Park	The game investigates how useful different forecasts are for wind power trading decisions in a simplified way in the game, the player is asked to make trading decisions for an offshore wind farm in the North Sea in a number of situations based on deterministic and probabilistic power and wind forecasts.	IEA Wind Task 36 Youtube channel at time 3:03:00 Presentation Download
		Publications: MetOceanologica, 2022 Jut Phys. Conf Series 2021
	In the game the player is managing a water supply reservoir!	Forecast Game
	Purpose of the Game is to train with forecast information and improve decision-making.	License conditions
Call for Water Game	The player is newly appointed water manager for a	Creative Commons CC

	In the game the player is managing a water supply reservoir!	
Call for Water Game	Purpose of the Game is to train with forecast information and improve decision-making.	Forecast Game License conditions Creative Commons CC BY-NC-ND 4.0
	The player is newly appointed water manager for a reservoir that serves water users for a town and is responsible to secure sufficient water for the town at a specific time.	
	The game is played in two rounds of 5 years each.	Forecast Game A blog post on the game was published in the Inpress review website
HEPEX Forecast Game "Pathways to running a flood forecasting centre: an adventure game"	The game simulates the responsibilities of a water management centre in charge of protecting a city against floods.	
	The game is investigating what kind of information is needed and how many days in advance the forecast information is good enough to make a decision that could save lives and money.	Reference: Arnal et al (EGU 2017 abstract)
Feuerwache (only available in German)	The game's aim is to well users understand and are able to make use of the uncertainty of weather forecasts	Forecast Game
	The task of the game is to decide on 16 days, whether or not to request more firefighters for the next 21 hours to handle additional missions in predicted storm events.	

Offline Games

HEPEX Forecast Games		
Water Management Game	The game experiment focuses on risk-based decision-making in water management using probabilistic forecasts of inflows to a reservoir	Download: English Spanish Reference: Couchman et al, 2019 HEPEX blog post
Peak Box Game	The "Peak Box" game supports interpretation and verification of operational ensemble peak flow forecasts, proposed by Zappo and colleagues, and encourages discussions of the use of ensemble predictions in operational hydrology.	Download: Peak Box Game Reference: Zappo et al, 2013 HEPEX blog post
	The Peak-Box defines the "best estimate" of a flood event's timing and magnitude by framing the discharge peaks of all members of an ensemble forecast and taking their median in timing and magnitude.	

Table and collection of forecasting Games:
iea-wind.org/taks 51
→ Workstreams → Decision Making under Uncertainty

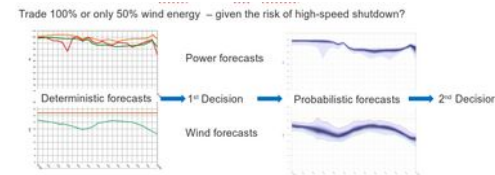
<https://iea-wind.org/task51/taks51-work-streams/ws-decision-making-under-uncertainty/>

“Probabilistic Forecasting Games & Experiments” initiative

1. Experiment (2020)

Game: 12 cases

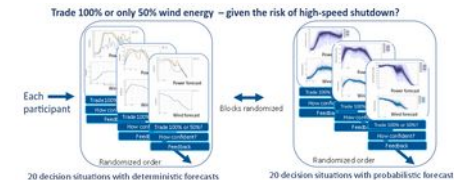
Decision structure: 12 deterministic Forecasts followed by a probabilistic forecast
After each decision, possible change of decision based on new information



2. Experiment (2021-2024*)

Game: 40 cases

Decision structure: 20 deterministic cases + decision confidence request
20 probabilistic cases + decision confidence request



* still open...: <https://meteorology.mpib.de/wind-power-decisions/about.html>

Workstream Data Science and AI



As the world's fastest-growing technology, **Artificial Intelligence (AI)** is rapidly shaping industries such as Energy and Meteorology.

To help address stakeholders' concerns about the impacts of increasingly incorporating AI and Machine Learning into weather and power prediction models, a webinar in Deep Learning for Weather-Based Power Prediction was held in January 2024

In this Webinar we brought to-gether the **Energy Meteorology and Machine Learning/Deep Learning (ML/DL) communities** to showcase the latest advancements in ML/DL for weather prediction.

Some Lessons Learned from the webinar:

Positive developments:

- ↑ The models start to show skill
- ↑ The models suggest a new approach to meteorological questions
- ↑ Fast hypothesis testing and scope narrowing for simulations with physics models
- ↑ The models develop fast due to large resources put into new features
- ↑ Huge ensembles (>1000 members) are on the horizon
- ↑ There is work underway to start the AI models from measurements alone

Challenges to be solved:

- ↓ Quality control of input data is not yet handled - outliers, missing or corrupt data
- ↓ High complexity and variety of data to train models is a challenge
- ↓ Feature engineering needs features – without physics this will be difficult
- ↓ Data-driven models require new look upon data sharing which has been a challenge until now



Webinar now available in our YouTube channel

IEAWindForecasting

<https://youtu.be/t6H7diavQdg>

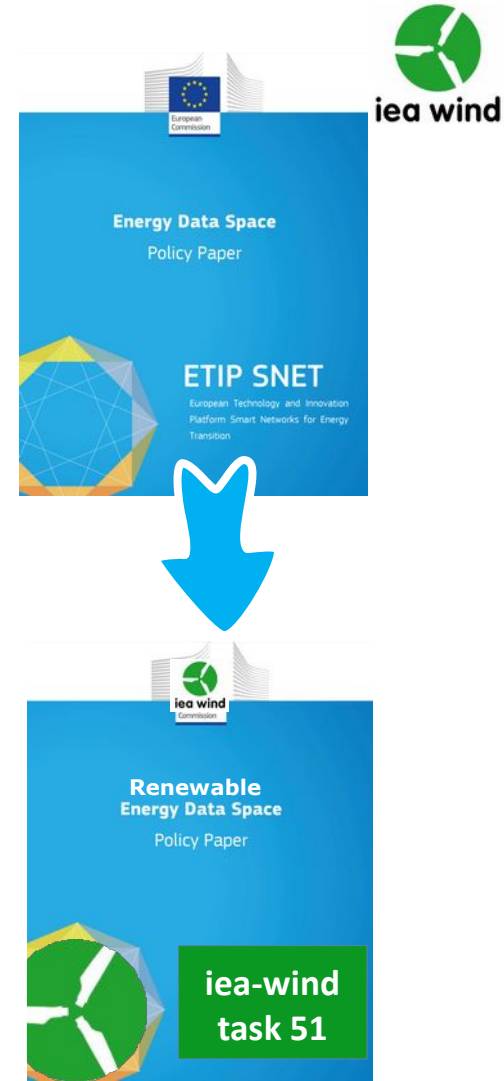
Workstream Data Sharing

Workplan

A recently [policy paper for the European Commission](#) about the transformation of the energy system covering digitilisation and data sharing was generally for the energy sector – covering RES only on the surface.

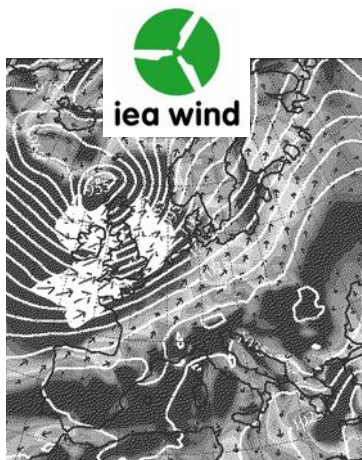
Status: Development of a position paper about data sharing for the renewable energy sector has been started

A group of contributors are covering different aspects of RES: resource assessment/site location, forecasting, trading, O&M, etc.



* <https://op.europa.eu/en/publication-detail/-/publication/21b0260e-a2d5-11ee-b164-01aa75ed71a1/language-en/format-PDF/source-300344208>

WS Extreme Power System Events



IEA Wind TCPTask 51
“Forecasting for the weather-driven
energy system”

Workshop on
Extreme Power System Events
Boulder, April 2025



**IEA Wind Task 51 Austria
Workshop at the NH Danube
City Hotel in Vienna on
November 6, 2024**

GeoSphere Austria, Austro Control Digital Services GmbH and WEB Windenergie AG are organizing the IEA Task 51 Austria Workshop on...

<https://iea-wind.org/2024/07/31/iea-wind-task-51-austria-workshop-in-vienna-on-6th-nov-2024/>

Collaboration



Collaboration with
Subtask: On-demand
digital twin extremes
forecasting system for
renewables - The
Destination Earth

<https://www.earthobservations.org/destinE-2024-07-31-international-partnership-wins-bid-to-develop-destination-earths-on-demand-extremes-digital-twin/>

WS Extreme Power System Events

THE IRISH TIMES

Storm Isha Live

Storm Isha: Second storm, Jocelyn, to hit on Tuesday as thousands remain without power and water

Some 93,000 properties still without electricity as Met Éireann issues further Orange warnings for Donegal, Mayo and Galway

Ireland

Storm Isha: Thousands without power and over 100,000 homes without water as wind causes damage across Ireland

Flights cancelled and diverted in Dublin Airport due to 'severe and dangerous' weather, with reports of fallen trees

Expand



Waves crash over the pier at Fenit, Co Kerry on Sunday as Storm Isha lashes the southwest. Photograph: Dornnack Walsh/Eye Focus

What is an extreme event ?

Ireland and UK experienced two storms in a row:

Isha on Jan, 21st 2024 and Jocelyn on Jan, 22nd 2024

THE IRISH TIMES

14:31



Main points:

- Follow live coverage of the [clean-up after Storm Isha in Monday with our live coverage](#).
- Over 170,000 homes and businesses are without power on Sunday evening
- A status red weather warning for wind is in effect in Co Donegal
- An orange weather warning is in effect for all of Ireland
- Earlier red wind warnings issued for counties Mayo and Galway have since expired
- Dublin Airport says Storm Isha is having an impact on flights
- Local authorities and fire and rescue services across the country are responding to reports of fallen trees

WS Value of Forecasting

Status is monitored by looking and discussing the use of wind power forecasts
+++ now in collaboration with Task 50 Hybrid Power Plants +++

User Cases presented at Meetings + Reports

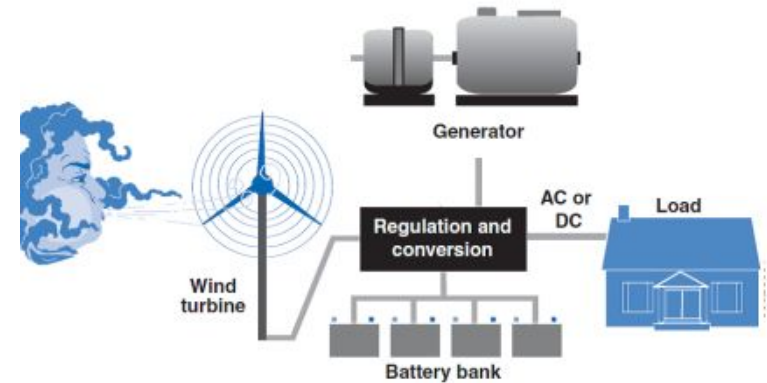
Dimitrios Eleftheriou, Ea Energianalyse: *use of wind power forecasts in scheduling a hybrid energy asset consisting of wind turbines, electrolyser and hydrogen storage*

Honglin Wen, Shanghai Jiao Tong University: *Value-oriented Renewable Energy Forecasting for Coordinated Energy Dispatch Problems at Two Stages*

Antonio Couto, LNEG, Portugal: *Addressing the challenges of wind power plants hybridised with solar power: A generation forecast perspective. (see also [publication](#))*

Rujie Zhu, Technical University of Denmark: *Value of forecasting for hybrid Energy Management*

See iea-wind.org/task51 → Publications
→ [Workshops & Special Sessions](#)



Collaboration and Liaison with IEC Scientific Committee 8A on *Grid Integration of Renewable Energy Generation*



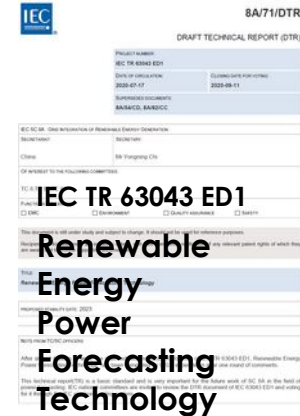
Common work: IEC Technical Report TR63043 - Renewable Energy Power Forecasting Technology

- Technical Report was released in 2020 by Sub-Committee 8A Grid Integration of Renewable Energy Generation, Working Group 2 Renewable energy power prediction

<https://webstore.iec.ch/publication/26529> - Link to IEC SC8A WG2

- New Work Item for the development of a IEC Standard in Oct. 2023

See Presentations from WIW2024 session 9D*



*<https://iea-wind.org/task51/task51-publications/task51-workshops-and-special-sessions/>

Task 51 Web Presence

Website

<https://iea-wind.org/task51>



Forecasting for the Weather Driven Energy System — Improving the value of renewable energy forecasts to the wind industry

The Task 51, under the *IEA Implementing Agreement for Co-operation in the Research, Development, and Deployment of Wind Energy Systems* (IEA Wind) focuses on improving the value of renewable energy forecasts.

There are three distinct areas of challenge in forecasting wind power. The first area is in the continuing effort to improve the representation of physical processes in weather forecast models through both new high performance initializations and tailored parameterizations. The second area is the heterogeneity of the forecasters and end users, the full understanding of the uncertainties throughout the modelling chain and the incorporation of novel data into power forecasting algorithms. A third area is representation, communication, and use of these uncertainties to industry in forms that readily support decision-making in plant operations and electricity markets.

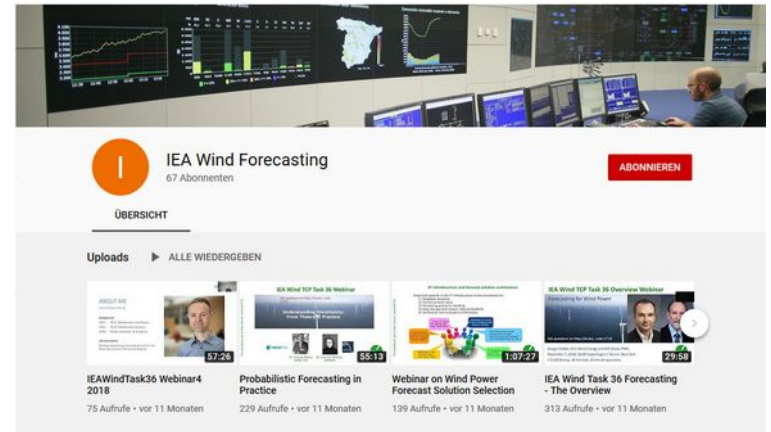
This Task will focus on facilitating communication and collaborations among international research groups engaged in the improvement of the accuracy and applicability of forecast models and their utility for the stakeholders in the wind industry, in the power sector and in the energy system.

This Task has the following specific objectives:

- To establish an active, open forum for sharing knowledge among the participants, related IEA Wind Tasks and other related TCPs through workshops, dissemination and communication measures
- To establish and communicate standards and frameworks for the operation and evaluation of forecast model performance
- To identify paths to increased application and utility of forecast information to the task stakeholders
- To advance the knowledge in the underlying atmospheric physics, in the mathematical models converting the transforming atmospheric quantities to energy system application variables, in the modelling of the uncertainty and in the applications and decision-making
- To identify most promising areas for new research to improve the quality and utility of forecasts
- To provide guidelines for the implementation of optimal forecasting solutions

 YouTube Channel

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



Handouts

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

<https://iea-wind.org/task51/task51-publications/task51-posters-and-handouts/>

IEA Wind Task 36
Forecasting for Wind Power

FORECASTING FOR YOU

Setup

Wind power forecasts have been used extensively for over 25 years. Despite this fact, there are still several possibilities to improve the forecasts, both from the weather prediction side and from the usage of the forecasts.

The IEA Wind Task is divided in three work packages. Firstly, a collaboration on the improvement of the scientific basis for the wind predictions themselves. This includes numerical weather prediction-model physics, but also, widely distributed information on accessible datasets. Secondly, we deal with the **conversion to power** and losses affecting the forecast vendors. Thirdly, we will be engaging real users aiming at dissemination of the best practice in the usage of wind power predictions. The Task is currently in its second phase, 2020-2022.

Results of phase 1 (2016-2018)

We developed an **information panel**, with links to data, projects and knowledge useful for wind power forecasting. This could be a list of all assets useful for online validation of NWP models, a list of field campaigns with open data for model verification, a selection of benchmarks for forecasts with established data sources and existing reference frameworks.

A major result was the IEA Wind Recommended Practice (RP) on **Forecast Solution Selection**, detailing out the necessary steps to get the best adapted forecasts for the individual use case. The RP starts with the initial deliberations which might or might not end up with the decision to do a forecast trial. The second document shows how to conduct such a trial in order to yield accurate and usable results for both the end user and the participating vendor. The last part shows how to evaluate the trial to get 1) representative, 2) representative and 3) reliable results.

For **probabilistic forecasts**, we published two papers with an overview (for a broader readership) and one with a long list of specific use cases (more technical oriented). We also classified methods for uncertainty forecasting, and tried to establish a common vocabulary. We also mapped the current use of probabilistic forecasts through a questionnaire.

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Task Overview

Impact

The Task sends out news a few times a year, is present on conferences and meetings, and has its own YouTube channel. There, alongside video transmissions of the public sessions, we also had a **webinars** of full an hour talks plus audience questions on the major results of phase 1. The fourth one was an additional one on forecast use in Denmark.

The Task members also try to get an **enhance relationship** between weather prediction providers and vendors, and between vendors and end users. One activity for the current phase of the Task (2020-2022) is a book into **standardization** of data, to make data exchange more fluent across the industry. Another activity is to **estimate the value** of better forecasting.

The Task also collaborates with other Wind Tasks, e.g. in the common workshop on minute scale forecasting we had together with Task 32 later. In the future, we will also collaborate with IEA PV Task 13 Solar resources, which also deals with forecasting and has some of the same issues.

Collaboration

Currently, some 750 people from 12 countries are collaborating on forecasts. There are meetings every half year, often in combination with relevant conferences. We also have special sessions at conferences for outreach, and usually an **executive position** if you are interested to collaborate, or just to be informed about new results, please contact Giorgio Gobbi.

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IEA Wind Task 36
Forecasting for Wind Power

RECOMMENDED PRACTICES FOR SELECTIVE RENEWABLE POWER FORECASTING SOLUTIONS

Challenge

The selection of practices to reduce the overall forecast error is a complex task. It involves understanding the specific requirements of the user, the capabilities of the available forecasting solutions, and the trade-offs between accuracy, cost, and reliability.

Solution

The solution involves a structured approach to the selection process. It starts with a clear definition of the user's needs and the available forecasting solutions. This is followed by a systematic evaluation of the solutions based on a set of criteria, leading to the selection of the most appropriate solution for the specific use case.

Forecast Solution Selection

The forecast solution selection process is a complex task that involves understanding the specific requirements of the user, the capabilities of the available forecasting solutions, and the trade-offs between accuracy, cost, and reliability.

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IEA Wind Task 36
Forecasting for Wind Power

Understanding Uncertainty: the difficult road from a deterministic to a probabilistic world

Challenge

Understanding forecasts as a mix of a prediction and a range of uncertainty is a complex task. It involves understanding the specific requirements of the user, the capabilities of the available forecasting solutions, and the trade-offs between accuracy, cost, and reliability.

Solution

The solution involves a structured approach to the selection process. It starts with a clear definition of the user's needs and the available forecasting solutions. This is followed by a systematic evaluation of the solutions based on a set of criteria, leading to the selection of the most appropriate solution for the specific use case.

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Forecast Solution Selection

The forecast solution selection process is a complex task that involves understanding the specific requirements of the user, the capabilities of the available forecasting solutions, and the trade-offs between accuracy, cost, and reliability.

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Uncertainty and Probabilistic Forecasting

The forecast solution selection process is a complex task that involves understanding the specific requirements of the user, the capabilities of the available forecasting solutions, and the trade-offs between accuracy, cost, and reliability.

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Summary

- Framework conditions changed since first phase of Task 36: **RES is no longer addition to system, but IS the system**; sector coupling to transport, heat, X...
- Has new challenges for **new forecast horizons** (seasonal forecasting...)
- Needs strong **collaboration with related TCPs** (solar, hydro, hydrogen, ...) and related Tasks (Integration, Lidar, Farm Flow Control, Hybrids, Airborne Wind ...), standardisation (IEC), data markets, data control & quality assessment (WMO)
- **Uncertainty**, probabilistic Forecasting & data-driven **AI** modelling is in focus
- **Workshops&Webinars**: State of the art Workshop (2022), Seasonal Forecasting (2023), Minute Scale Forecasting (2024), NAWEA Side-event IEA Wind Task51 (2024), IEA Wind Task 51 Austria Workshop (2024), Extreme Power System Events (2025) Webinar on AI in meteorology & energy



iea wind

Task 51 – “Forecasting for the weather-driven Energy System”

iea-wind.org/task51

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The IEA Wind TCP agreement, also known as the Implementing Agreement for Co-operation in the Research, Development, and Deployment of Wind Energy Systems, functions within a framework created by the International Energy Agency (IEA). Views, findings, and publications of IEA Wind do not necessarily represent the views or policies of the IEA Secretariat or of all its individual member countries.