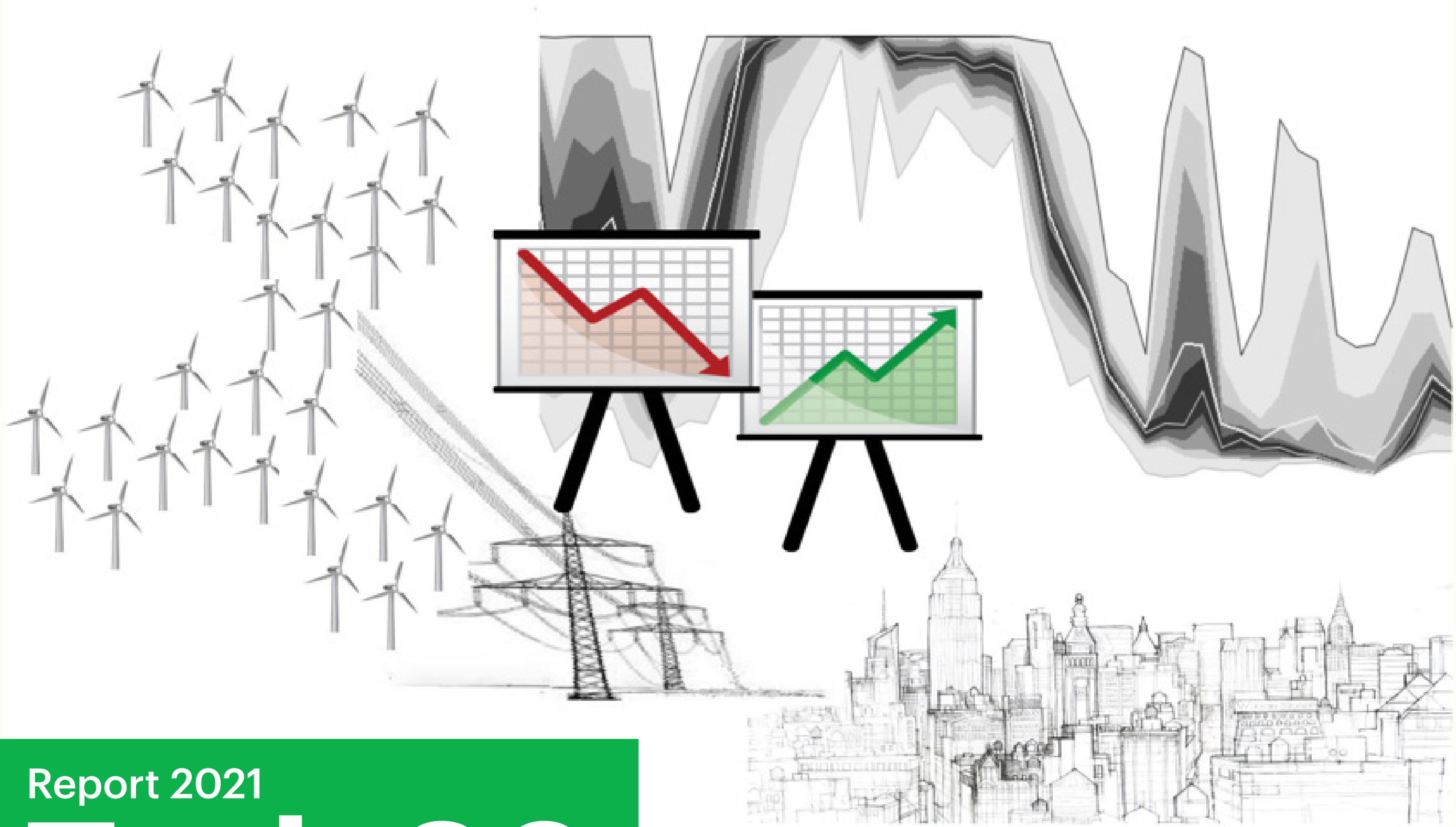

Report 2021
Task 36

Figure 1: Wind Power Forecasting for Grid Integration. *Source: Corinna Möhrlen, WEPROG*

Forecasting for Wind Energy

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Task 36, *Forecasting for Wind Energy*, is the collaborative work of meteorologists, forecast vendors, academia, and end users to investigate and identify significant advances in wind power forecasting and make them more visible to the user community, including demonstrating the value of probabilistic forecasts.

The main effort of 2021 was to finish the work of the outgoing Task 36 and to prepare the new Task 51, "Forecasting for the Weather Dependent Energy System". For the latter, the two Task meetings this year were used to discuss the future Task layout. The new Task will also have a much broader outlook, connecting to several other TCPs and other Tasks of the Wind TCP.

The main outcomes of Task 36 were the second edition of the IEA Recommended Practice (RP) for the Implementation of Renewable Energy Forecasting Solutions, the collaboration with cognitive scientists on games for the promotion of probabilistic forecasts, a report on the value of forecasting, and a journal paper on the sources and propagation of uncertainty.

Version 2 of the RP expands the scope with solar forecasts (for which we collaborated with IEA PVPS Task

Table 1. Countries Participating in Task 36

	COUNTRY	INSTITUTION(S)
1	**Austria**	Zentralanstalt für Meteorologie und Geodynamik
2	**CWEA**	China Electric Power Research Institute; China Meteorological Administration; Envision; North China Electric Power University; Xinjiang Goldwind; Zhejiang Windey
3	**Denmark**	Technical University of Denmark (DTU); Denmarks Meteorological Institute; DNV; ENFOR; WEPROG; Energinet; ConWX; Ea Energianalyse.
4	**Germany**	Deutscher Wetterdienst; Fraunhofer Institute for Energy Economics and Energy System Technology; ForWind; Zentrum für Sonnenenergie und Wasserstoff-Forschung; WindForS; EWC; 4cast; Stuttgart University; Enercon; Tennet
5	France	MINES ParisTech; MeteoSwift; MetEolien; Electricité de France; Compagnie Nationale du Rhône; Engie Green; Réseau de transport d'électricité
6	Finland	VTT Technical Research Centre of Finland; FMI
7	Ireland	Technological University of Dublin; University College Dublin
8	Portugal	INESC TEC; Laboratorio Nacional de Energia e Geologia
9	Spain	Iberdrola Renovables; Electricidade do Portugal Renovaveis; Red Electrica de España
10	United Kingdom	UK National Grid; Glasgow University; Reading University; Strathclyde University;
11	United States	Pacific Northwest National Laboratory; National Renewable Energy Laboratory; National Oceanic and Atmospheric Administration; National Center for Atmospheric Research; Electric Power Research Institute; UL Renewables; MESO, Inc.

16), probabilistic forecasts, and a fourth part on how to use real-time measurements, providing recommendations for the design, set-up, maintenance of meteorological and power generation data gathering systems to optimally support the production of generation forecasts. This last part also contains a description of useful data transfer standards and classifies those according to complexity.

Introduction

Wind power forecasting is an essential part of the energy transition. High penetration of wind power in the grid is only possible with accurate wind power forecasts for the next minutes, hours, and days. IEA Wind Task 36 combined some 250 people from forecast vendors, end users, and academia to advance the field, increase the value of forecasts, and to provide advice on streamlining related business processes. The Task was composed of three threads: Work Package (WP) 1 is focused on the Numerical Weather Prediction (NWP) improvements necessary to improve the overall forecasting accuracy. The collaboration of global NWP centres and other weather modelling groups improves the NWP models and gives better access to the input and output data. WP 2 is focused on the weather to wind power conversion step of the forecast process and the calculation of the uncertainty and to a large extent, is populated by wind forecast service providers (vendors). The mission of WP 3 is the assessment of how to improve the business practices of end users in order to realise the maximum value from probabilistic wind power forecasts. Academics are active in all three WPs.

IEA Wind Task 36 Forecasting collaborated with IEA PV Task 16 on Solar Resource on both the RP and the uncertainty propagation paper.

Progress and Achievements

Last year, WEPROG presented in collaboration with the German Max-Planck Institute on Human Development (MPIB) an initiative on "probabilistic forecasting games and experiments". The first "game" was setup by the team of forecast providers (WEPROG) and cognitive scientists from the MPIB and ran as a iea wind

Recommended practice for the implementation of renewable energy forecasting solutions

Part 1: Forecast solution selection process

3. Edition
Draft for Review by the Executive Commitee of the International Energy Agency Implementing Agreement

Prepared by IEA Wind Task 36

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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 Commitee of the International Energy Agency Implementing Agreement

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Part 3: Forecast solution Evaluation

2. Edition
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Prepared by IEA Wind Task 36

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

1. Edition
Draft for Review by the Executive Commitee of the International Energy Agency Implementing Agreement

Prepared by IEA Wind Task 36

``decision game'' to demonstrate the potential benefits of uncertainty forecasts in a realistic - although simplified – problem. Here, 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. Although the experiment was simplified, it still provided a realistic scenario for many decision makers in the industry and for this reason, was well received by the participants as an exemplary application for the use and application of probabilistic forecasts from a physical-based ensemble weather prediction system, and considered a useful tool for training purposes.

The second experiment [1] followed the structure of behavioural decision experiments in social science in order to also study communication and knowledge gaps by simulating a real-time problem for specific user groups. This experiment not only requests to make a decision, but also investigates the confidence participants have in each decision. Participants are presented with 20 randomised cases to make decisions based on deterministic or on probabilistic ensemble forecasts, inclusive a confidence choice between 50 and 100% for each decision. With this split and randomisation of probabilistic and deterministic cases, the team studies the differences in decision making in difficult and less difficult situations and how the confidence changes among participants by using probabilistic or deterministic information. This setup allows the team to investigate the behavioural effects from failures and successes. In other words, from the new experiment, the psychological aspects of decision-making can be studied. A poster on the science won a poster award on the WindEurope Electric-City in November 2021 [2,3]. Please play the game and give us more data to analyse!

Ea Energianalyse did an analysis of the value of forecasting [4]. The analysis studies imbalance settlement ac-cording to the "one-price" model in day-ahead and balancing markets, as this will be the future default model to prevail in Europe. This report focuses on the value of wind power forecasts for a wind power plant owner. The value is assessed for different bidding strategies in the day-ahead and balancing market.

Highlight

The largest effort went into the update and expansion of the IEA Recommended Practice for the Implementation of Renewable Energy Forecasting Solutions [5]. The update expands the scope with solar forecasts (for which we collaborated with IEA PVPS Task 16), probabilistic forecasts, and a fourth part on how to use real-time measurements.

The first part of the series, "Forecast Solution Selection Process", deals with the design of the selection process and the background information necessary to collect and evaluate when developing or renewing a forecasting solution. The second part, "Benchmarks and Trials", offers recommendations on how to best conduct benchmarks and trials in order to evaluate the relative performance and the "fit-for-purpose" of forecasting solutions. The third part, "Forecast Evaluation", provides information and guidelines for the effective evaluation of the performance of forecasts and forecast solutions. The fourth part, which has been added in the second version, provides recommendations for the design, set-up, and maintenance of meteorological and power generation data gathering systems to optimally support the production of generation forecasts.

The work developed two different levels of data definitions, one for novice users (essentially a glossary of terms and a simple spreadsheet) and one for advanced users based on the IEC and ENTSO-E Common Information Model with a JSON schema, which, e.g. has also been used in the US Department of Energy

All Work Streams	WP1 Weather	WP2 Weather	WP3 Applications	Deliverable	#, Due	Collaboration
Atmospheric physics and modelling	★			List of experiments and data	D1.1, Ongoing	WMO, PVPS T16
Airborne Wind Energy Systems	★			Presentation on workshops	Part of D2.1	Task 48 Airborne Wind Energy
Seasonal forecasting	★			Workshop / Paper	D1.6 / M19	Hdro TCP, Hydrogen TCP, Biomass TCP
State of the art energy system forecasting		★		Workshop RecPract on forecast Solution Selection v3	D2.1 / M7, M12 M2.1 / M36	PVPS, TAsk 16, Hydro TCP, Hydrogen TCP, ...
Forecasting for underserved areas		★		Public datasheet	D2.4 / M24	WMO
Minute scale forecasting		★		Workshop / Paper	D2.5 / M31, M36	Wind Tasks 32 Lidar, 44 Farm Flow Control and 50 Hybbrids
Uncertainly / proballistic forecasting			★	Uncertainly progration paper with data RecPract v3	D2.6 / M42 M48	PVPS T16
Decision making under uncertainty			★	Training course Games	M12 M18	
Extreme poser system events			★	Workshop	D3,6 / M42	Task 25, ESIG, IEA IS-GAN, PVPS T16, GPST
Data science and artificial Intelligence			★	Report	D2.3 / M30	
Privacy, data markets and sharing			★	Workshop / Paper Data format standard	D3.5 / M15	ESIG IEEE WG Energy Forecasting
Value og forecasting			★	Paper	D3.4 / M33	
Forecasting in the design phase	★					Task 50 (hybrids), PV T16, hydrogen TCP

(DOE) funded Solar Forecast Arbiter project. The Recommended Practice was also the subject of several dissemination activities [6].

Next Steps

Task 36, "Forecasting for Wind Energy", closed after two phases at the end of 2021. The new Task 51, "Forecasting for the Weather Dependent Energy System", enlarges the scope and collaborates with many other groups within IEA Wind, with other IEA TCPs, and outside. The 13 Work Streams are spanning several work packages. One workshop each summer will address 4 of the work streams. The one in 2022 will be held in September in Dublin on the State of the Art and Research Gaps.

References

[1] https://arc-vlab.mpib-berlin.mpg.de/wind-power/experiment/

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Poster
Award Winner!

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Value of Forecast for a wind power plant Owner.
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13th Conference on Weather, Climate, and the New Energy Economy
John Zack and Corinna Möhrlen:
Best Practices for the Selection of Optimal Forecast Solutions for Renewable Electricity Generation Applications
(Core Science Keynote)

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