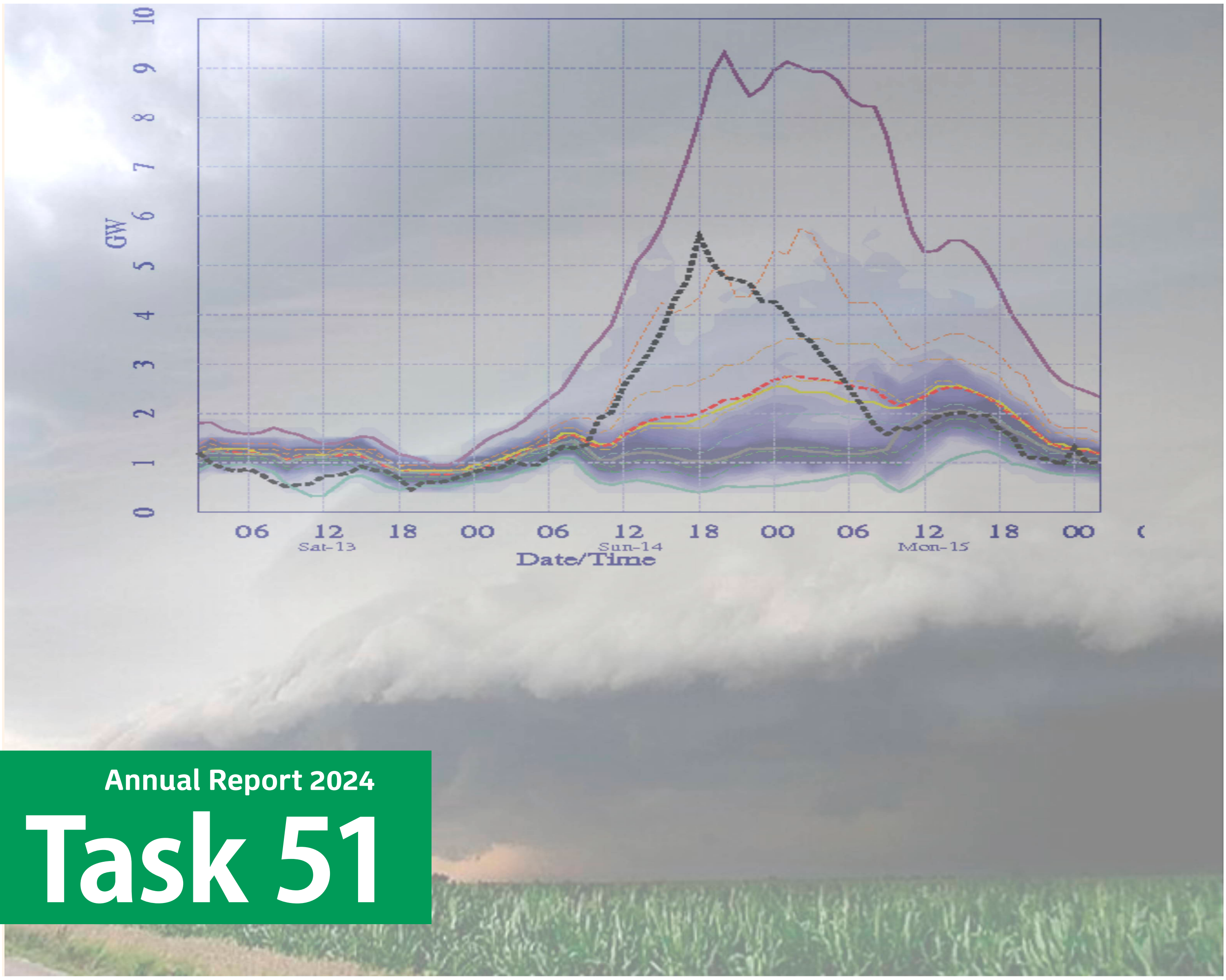

Annual Report 2024

Task 51

Photo: *Storm forecast. (Photo credit: Corinna Möhrlen)*

Forecasting for the Weather Driven Energy System

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Our focus in Task 51 is to reach out to other Tasks, TCPs and organisations to discuss and improve forecasting on all aspects of the weather-driven energy system.

The aim is to improve the forecast performance from minute-scale to seasonal scale, and increase the value obtained from the forecasts by improving and optimising their usage.

The work is organized across 3 work packages: Atmospheric Physics, Conversion to User Variables, and End Use spanning 11 work streams.

In 2024, our dissemination was focused on presenting important results and use cases for the recommended practice at various workshops and conference. Also, Task 51 held a public workshop on Minute-Scale Forecasting at Risø, Denmark, together with our colleagues from IEA Wind Task 52 Lidars and from IEA PVPS Task 16.

The industry partners of Task 51 collaborate as end users by for example testing the software tools developed in the task, especially those operating renewable generation facilities, trading renewable power or receiving forecasts for a control area as Transmission System Operators.

The active forecast providers in the task also collaborate, mostly by making use of new findings or results from weather prediction advancements provided by national weather institutes, or by adjusting their own models with results from the task.

Introduction

A decade ago, the idea of "wind integration" discussed how to integrate 10% or more of wind energy in an otherwise unchanged power system. A decade from now, wind and solar will be the backbone of the energy system, at least in some areas of the world and most of the time. Task 51 identified the need to collaborate not only across work packages and hence stakeholders, but also across other IEA TCP tasks and other organisations such as the IEC, the WMO, etc.

The work is structured in three work packages, partitioned according to stakeholders: meteorologists, forecast vendors, and end users. Academics populate all three work packages. There are 12 countries participating in Task 51 (Table 1) and the participants' list counts around 350 people, making Task 51 the largest global discussion group on forecasting of renewables.

The topical activities are designed across the three work packages as work streams. The 11 work streams span minute-scale forecasting, seasonal forecasting, data sharing, the value of forecasting, decision-making under uncertainty, uncertainty quantification throughout the entire modelling chain, AI and security, and extreme events in the power system-meteorology, data, uncertainty, decision making, several specialized time horizons and the value of forecasting.

Task 51 seeks to collaborate both within the IEA Wind TCP (i.e., Task 25 Large-Scale Integration, Task 44 Wind Farm Flow Control, Task 48 Airborne Wind Energy, Task 50 Hybrid Power Plants, Task 52 Large-Scale Deployment of Wind Lidar and Task 61 Variable

COUNTRY/SPONSOR	INSTITUTIONS
Austria	Geosphere Austria, Austrocontrol Digital Services
CWEA	China Electric Power Research Institute; China Meteorological Administration; Envision; North China Electric Power University; Xinjiang Goldwind
Denmark	Technical University of Denmark (DTU); Denmarks Meteorological Institute; DNV; ENFOR; WEPROG; ConWX; Ea Energianalyse.
France	MINES ParisTech; MeteoSwift; MetEolien; Electricité de France; Compagnie Nationale du Rhône; Engie Green; Réseau de transport d'électricité
Germany	Deutscher Wetterdienst; Fraunhofer Institute for Energy Economics and Energy System Technology; Enercon; ForWind; Zentrum für Sonnenenergie und Wasser stoff-Forschung; WindForS; EWC; 4cast; Stuttgart University; DLR Vernetzte Energiesysteme; MPI Bildungsforschung; enercast, Overspeed; Uni. Tübingen
Ireland	Technological University of Dublin; University College Dublin
Netherlands	Windpoint; TU Delft; Whiffle; KNMI
Portugal	INESC TEC; Laboratorio Nacional de Energia e Geologia
Spain	Iberdrola Renovables; Electricidade do Portugal Renovaveis; Red Electrica de España; Scirocco; Vortex FDC
Sweden	Uppsala University; Uni Halmstad; SVK
United Kingdom	UK National Grid ESO; Glasgow University; Reading University; Strathclyde University;
United States	Electric Power Research Institute; Pacific Northwest National Laboratory; National Renewable Energy Laboratory; National Oceanic and Atmospheric Administration; National Center for Atmospheric Research; ERCOT; SUNY Albany; MESO, Inc.

Table 1. *Countries Participating in Task 51*

Renewable Energy to Hydrogen), and with the broader renewables and generate a natural bridge to the meteorological sector.

It has established a collaboration with IEA PVPS Task 16 "Solar Resource for High Penetration and Large-Scale Applications" for solar forecasting and data handling and organized a common workshop on minute-scale forecasting in 2024.

Additionally, guests from the IEA Hydro Annex IX "Valuing Hydropower Services" have participated in some Task 51 meetings. Furthermore, Task 51 has established a collaboration with the WMO (World Meteorological Organisation) Study Group on Integrated Energy Services and the IEC (International Electrotechnical Commission) Sub-Committee 8A Working Group 2 on Forecasting Renewable Energy Power.

Progress and Achievements

2024 showed us that the use of forecasting methods on all time scales in the energy industry requires continuous education and dissemination efforts in the form of guidelines, recommendations and standards to serve an industry in transformation, as the gap between academic knowledge and industry adaptation is still large.

It also showed us that the work on testing the recommendations provided in the IEA Wind Recommended Practice [1] with real-data and use cases is a necessary step for the industry to be able to progress and adopt these recommendations.

In this vein, Task 51 started work on a new Technical Specification in IEC SC8A WG2 on forecast error determination and data quality.

The work of Task 51 also focused on a common Task meeting with IEA PVPS Task 16. The meeting included a *public workshop on Minute Scale Forecasting* held at Risø, Denmark, that had about 70 participants and several more online (see figure 1).

The workshop highlighted the current capabilities and challenges of Minute-Scale forecasts, which cover the period between a few seconds and several hours ahead. Martin Stensdal from the Danish system operator Energinet delivered a keynote on the application of these forecasts in Denmark.

In the first workshop on Minute Scale Forecasting in 2018, lidars were discussed as the main source of data. In 2024, sky cameras and satellite observations were in the focus, partly because they are much cheaper, and partly because we co-organized the meeting with task 16 of IEA PVPS, which brought a new perspective into the topic.

Some high-resolution numerical weather prediction models can also be useful to forecast, especially when coupled with 3D AI methods for downscaling the weather forecast to the local site. Assimilation in very short horizons without NWP forecasts as well as combination methods were discussed for both wind and solar power forecasts.

The usefulness of observational data for solely data-driven algorithms also depends on the time of availability. E.g. satellite data are often time lagged and can only be used to adjust NWP forecasts, especially where advection of cloud fields is predominant. Presentations from the workshop are available on *Task 51 homepage*.

Figure 1. *The participants of the Minute Scale Forecasting Workshop in Risø, Denmark, in April 2024.* (Photo credit: DTU.)

The second focus area was the dissemination of the IEA Wind Recommended Practice [1] and the verification tools to quantify uncertainty [2] as well as the Part 3 and 4 of the Recommended Practice tool evalprob4cast, a verification tool for probabilistic forecast evaluation according to the recommended evaluation methods written in R [1, 3].

In addition, the use of Recommended Practice guidelines for evaluation of probabilistic forecasts and measurement data quality assessment were demonstrated at three workshops [4, 5, 6].

The third highlight of 2024 was the start of a collaborative effort to develop a Technical Specification (standard) for renewable energy forecast evaluation with the IEC SC8A Workgroup 2 [7]. We leverage the existing Liaison between IEA and IEC Technical Committee 8 (TC8, the parent of Sub-Committee 8A) to allow the experts from IEA Wind Task 51 to work on the standard.

The primary objective of this standard is to establish a comprehensive framework for evaluating forecast results of renewable energy generation (such as wind and solar). This includes defining methods for data collection, processing, and deviation assessment, enabling cross-comparison of forecast deviations across different countries and forecast service providers. It also provides guidance for the scientifically grounded application of forecast results.

Also, members of Task 51 have published more than 10 articles in international journals and magazines [10].

Highlights

- In April 2024, a workshop on Minute Scale Forecasting was held at Risø, Denmark. This event brought together around 70 participants in-person and several more online. The workshop highlighted the current capabilities and challenges of Minute-Scale forecasts.

- The use of Recommended Practice guidelines for evaluation of probabilistic forecasts and measurement data quality assessment were demonstrated at three workshops [4, 5, 6].

- Task 51 started a collaborative effort to develop a Technical Specification (standard) for renewable energy forecast evaluation with the IEC SC8A Workgroup 2.

Outcomes and Significance

Task 51 is the largest global forum for discussing renewable power forecasting issues and challenges. The Task has prepared a Recommended Practice on forecast choice and evaluation and the dissemination of the recommendations into the industry with use-cases is a work-in-progress to close the gap between academic knowledge and industry adaptation.

Moreover, the Task has begun to create open software libraries for data exchange and forecast evaluation. Some of these error evaluation guidelines are now being incorporated into IEC standards.

Task 51 increased its dissemination efforts substantially, including one public workshop per year, and posters, talks and special sessions at several conferences such as WindEurope's Annual Event, EGU, ICEM, WESC, and the Wind & Solar Integration Workshop, among others.

Next Steps

In 2025, Task 51 organizes an open workshop on Extreme Events in the Power System, on Sept. 30/Oct. 1 at the German Meteorological Service in Offenbach [9]. Extreme weather conditions, such as heatwaves, severe storms, floods, and cold snaps, can significantly impact electricity grids and energy supply by disrupting power generation, transmission, and distribution systems.

Forecasting for such extremes and implementing effective mitigation strategies are critical for enabling system operators to prepare for these events well in advance. By improving weather prediction models, utilizing advanced analytics, and reinforcing grid infrastructure, operators can better anticipate extreme events and minimize their impact. Mitigation methods such as the development of more resilient infrastructure, smart grid technologies, and early warning systems can help ensure the grid's reliability and sustainability during extreme weather events.

The Task's Information Portal on the website is kept up to date, and the work streams are discussing their respective deliverables, working to update the Recommended Practices and providing inputs to the IEC SC8A WG2 new standard development.

A series of four webinars will disseminate the results in November 2025.

An extension for another four years has been approved, so Task 51 will begin its second phase from 2026-2029.

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