IEA Wind Task 36 Benchmark Exercise 2021

Overview

This benchmark exercise provides an opportunity for stakeholders to evaluate the performance of different configurations of numerical models at both intra- and inter-organizational levels. This exercise also serves as a platform for stakeholders to share and compare wind forecast evaluation metrics between organizations.

The primary goal of this benchmark exercise is to demonstrate the importance of reproducible, metrics-based model assessments, which should be part of every organization's validation strategy. Setting up a rigorous validation framework also aligns with the verification and validation framework proposed in the Second Wind Forecast Improvement Project (WFIP2) (Draxl et al. 2019) as well as the IEA Wind task 36 Recommended Practice for Forecasting Solution Selection (Möhrlen et al. 2019).

Forecast providers in the wind energy industry as well as wind energy researchers are invited to participate in this exercise. A team of researchers from the National Renewable Energy Laboratory and the Pacific Northwest National Laboratory in the U.S. ("we" in this document) are organizing and coordinating this benchmark exercise.

After we collect data from the participants, we will anonymously evaluate the submitted data using an open-source, Python-based validation tool we developed, which is also publicly available at https://github.com/joejoeyjoseph/i-validate. In the data analysis, we will use statistics such as root-mean-square error and mean absolute error, as well as more sophisticated skill scores for wind ramp events. We welcome suggestions and contributions to the codebase of the validation tool, and we invite stakeholders to extend the tool with their own modules and functionalities. In the long run, we hope that the validation tool will become a consistent reference forecast evaluation framework for the wind energy community.

If you have any questions or comments about this benchmark exercise, please contact IEA.Forecasting.Benchmark@groups.nrel.gov.

Benchmark exercise timeline

The following is the proposed timeline for 2021:

April – May	NREL and PNNL invite participation in the benchmark (via email and on the IEA Wind Task 36 website) and continue to develop the open-source validation tool
June – July	Participants will run their cases and submit their results by 31 July
August – September	NREL and PNNL analyze the submitted results
October – December	NREL and PNNL share the findings and publish a technical report summarizing the results

Case description

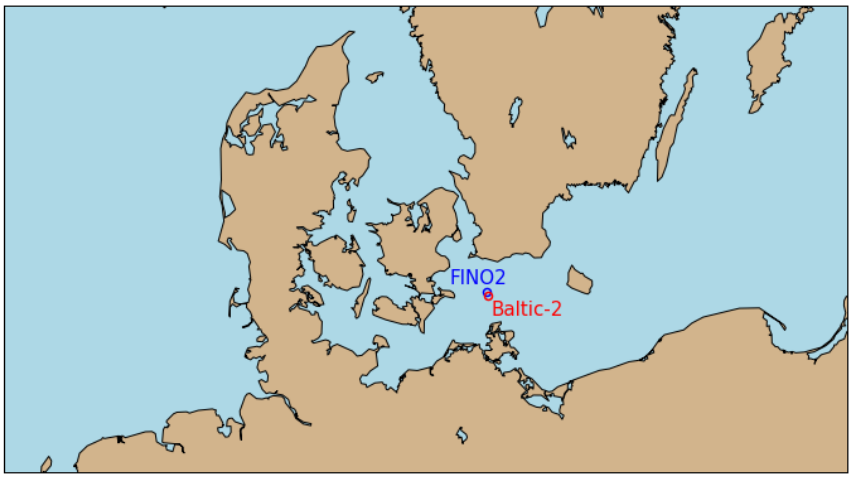
The following table lists the details of the two case studies for this exercise. Please kindly submit data for either or both cases. We ask the participants to provide forecasts that only initialize once at the start of a forecast period.

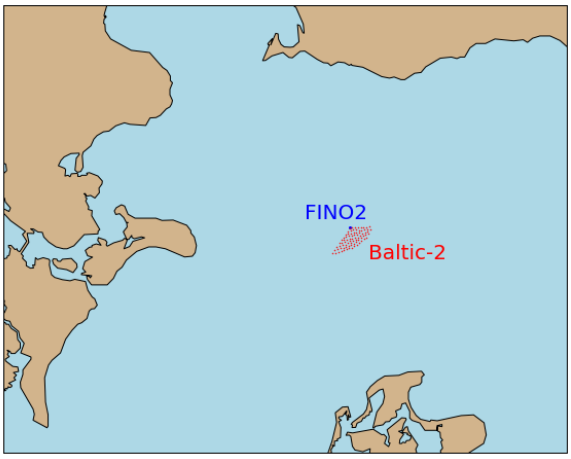
	U.S. case: WFIP2 campaign	**European case: Baltic-2 wind farm**
Site description	Complex terrain, onshore. The WFIP2 project was a meteorological measurement field campaign targeting the Pacific Northwest of the U.S.	Offshore, 80 Siemens SWT-3.6-120 wind turbines, with hub height of 78.25 m, rotor diameter of 120 m, and rated power of 3.6 MW. The plant capacity is 288 MW.
Latitude and Longitude (WGS84) of measurements	Sodar: 45.57451N, 120.74734W	FINO2 tower: 55.006928N, 13.154189E Baltic-2 wind farm: 54.9733N, 13.1778E FINO2 is about 4 km northwest of Baltic-2
Evaluation period (One initialization at the start of the forecast)	Start: 2016-09-23, 12 UTC End: 2016-09-25, 12 UTC A 48-hour forecast	Start: 2020-10-03, 23 UTC End: 2020-10-10, 23 UTC A 168-hour forecast
Measurement type	Temporal averages from sodar (Vaisala Triton wind profiler)	FINO2: Temporal averages from cup anemometers and wind vanes Baltic-2: Wind-farm-average power and nacelle wind speed
Data frequency	Averaged at an interval of 10 minutes at the end of the bin, e.g. data labeled at 00:10 UTC represent averages from 00:00 to 00:10 UTC.	FINO2: Averaged at an interval of 10 minutes at the midpoint of the interval, which starts at 00:05 of the hour, e.g. data labeled at 00:05 represents averages from 00:00 to 00:10. Baltic-2: Averaged at an interval of 15 minutes at the end of the bin, e.g. data labeled at 00:15 represent averages from 00:00 to 00:15.
Benchmark variables [units] available at heights (m above ground level)	Wind speed [m s^{-1}] and wind direction [degrees] at 40, 80, 120 m	FINO2: Wind speed [m s^{-1}] at 62, 72, 82, 92 m and wind direction [degrees] at 51, 71, 91 m above mean sea level Baltic-2: Power [MW] and nacelle wind speed [m s^{-1}]
Notes	Wind farms exist and operate	Wind turbine availability was 100%.

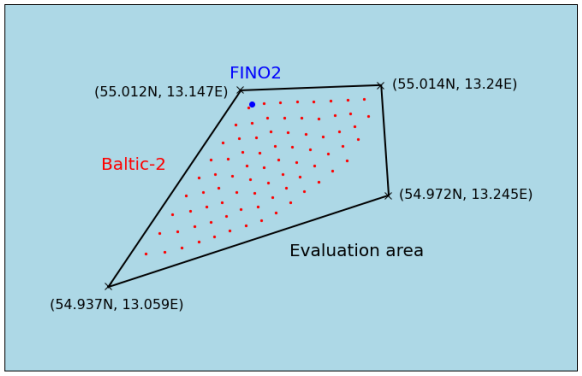
	in the area, but no wind power data are available. Mountain waves were observed.	
Reference links to data	https://a2e.energy.gov/data/wfip2/sodar.z06.b0 https://github.com/joejoeyjoseph/i-validate/tree/main/data	https://www.bsh.de/DE/THEMEN/Beobachtungssysteme/Messnetz-MARNET/FINO/fino_node.html https://www.fino2.de/en/ Participants need to request an account to access FINO data. We are working on publicizing the FINO2 meteorological data of the evaluation period.

The following map projections display the geographical location of the WFIP2 sodar.

The following map projections display the geographical locations of the FINO2 tower and the Baltic-2 wind farm layout.







Data submission

We ask the participants to submit their forecasts for the locations in the table above to IEA.Forecasting.Benchmark@groups.nrel.gov. Please find the details of data submission in the table below.

Data format	We encourage the participants to submit data following the format illustrated in the sample submission csv data files in https://github.com/joejoeyjoseph/i-validate/tree/main/data/submission_sample. However, we also accept any commonly used data formats, e.g. .txt, .nc, .hdf.
Data frequency	Every 30 minutes
Data - U.S. case	For the U.S. case, we ask you to submit either wind velocity (in u and v components [m s^{-1}]), or horizontal wind speed [m s^{-1}] and wind direction [degrees] at 40, 80, 120 m above ground level. Please submit 30-minute data, starting at 2016-09-23 12 UTC.

Data - European case	For the European case, we ask you to submit the following: 1. Wind velocity (in u and v components [m s^{-1}]), or Horizontal wind speed [m s^{-1}] and wind direction [degrees] Please submit wind forecasts at 62, 72, 82, 92 m above mean sea level, which will be compared to the point measurement at FINO2 tower (55.006928N, 13.154189E). 2. Plant-level power [MW] and plant-average wind speed [m s^{-1}] Please submit area-averaged data of the wind farm at 78.25 m above mean sea level, which will be compared to the area-averaged data at the hub height of the Baltic-2 wind farm. The recommended averaging area is bounded by these latitude and longitude pairs: (54.9375N, 13.0589E), (55.0122N, 13.146E), (55.014N, 13.2395E), (54.972N, 13.2445), displayed in the black polygon in the map above. Please submit 30-minute data starting at 2020-10-03 23 UTC.
Data post-processing	If your organization performs data post-processing (e.g. using statistical corrections or machine learning methods) in your operational products or in your research, we kindly ask the participants to submit both the raw and the post-processed versions of the time series.

When the participants submit the data to IEA.Forecasting.Benchmark@groups.nrel.gov, we kindly ask you to fill out and attach the following metadata form. Please fill out one metadata form for each case.

Location	Which location are the data for
Nature of forecast	Deterministic, ensemble mean, or specific ensemble member, or others
Numerical model details	• Numerical model used • Initial and boundary conditions/dataset(s) used • Horizontal and vertical resolutions • Brief description of special setups used in the model runs • If additional data assimilation was done, please indicate the type of additional data assimilated and the methodology
Temporal averages or instances	Whether the data represent 30-minute temporal averages or instances/snapshots every 30 minutes
Averaging interval	If not specified, based on our validation datasets, we would assume the temporal averages represent the previous period, e.g.

	a data point labeled as 00:30 UTC (12:30 am) represents the arithmetic mean of the data between 00:00 and 00:30 UTC. If the above interpretation differs from your metadata, please specify whether a data point labeled as 00:30 UTC represent: ● Data between 00:15 and 00:45 UTC ● Data between 00:30 and 01:00 UTC ● Data of other period(s)
Spatial averaging (for the European case)	Number of model grid cells that are used to generate the area-average results
Post-processing	If data post-processing is applied, please briefly describe your methodology with a couple sentences.
Units (if necessary)	If you use units different from the ones we listed, please kindly label the units of the variables in your data submission or in this table.

Data policy

We value data privacy, and we will not share participants' data without seeking their approval. Data submitted will be anonymized in any public dissemination in order to protect the privacy of participants. If possible, we kindly ask our participants not to consult historical data when they conduct the simulations (i.e., hindcasting), even if reference data may be publicly available.

Moreover, in contrast to the forecast competition described in the Recommended Practices for Selecting Renewable Power Forecasting Solutions (published by IEA Wind Task 36 in 2018), we will not determine "winning forecasts". The objective of this exercise is not to determine the most accurate forecasts, but to demonstrate the value of a common, standardized forecast evaluation process.

References

Draxl, C., and Coauthors, 2019: *The Verification and Validation Strategy Within the Second Wind Forecast Improvement Project (WFIP 2)*. 19 pp.

Möhrlen, C., J. Zack, and J. Lerner, 2019: *Export Group Report on Recommended Practices For Selecting Renewable Power Forecasting Solutions Part 2: Designing and Executing Forecasting Benchmarks and Trials*. 29 pp.