IEA Wind Task 36

Workpackage 3.3: Develop data requirements for real-time forecasting models for use in grid codes

Kickoff

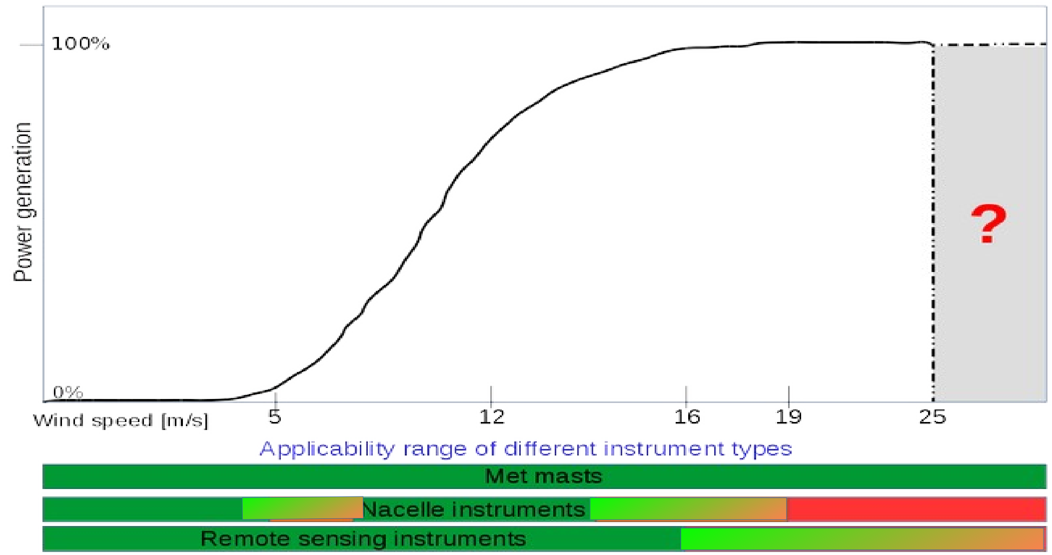
March 2021

Task 36 Phase 2: Work Package Scope

- WP 1: **Global Coordination in Forecast Model Improvement**
  - 1.1 Compile list of available wind data sets suitable for model evaluation
  - 1.2 Annually document field measurement programs & availability of data
  - 1.3 Verify and validate NWP improvements with common data sets
  - 1.4 Work with the NWP centers to include energy forecast metrics in evaluation of model upgrades
- WP 2: **Benchmarking, Predictability and Model Uncertainty**
  - 2.1 Update the IEA Recommended Practice on Forecast Solution Selection
  - 2.2 Uncover uncertainty origins & development through the whole modelling chain
  - 2.3 Set-up and disseminate benchmark test cases and data sets
  - 2.4 Collaborate with IEC on standardisation for forecast vendor-user interaction
- WP 3: **Optimal Use of Forecasting Solutions**
  - 3.1 Use of forecast uncertainties in the business practices
  - 3.2 Review existing/propose new best practices to quantify value of probabilistic forecasts.
  - 3.3 Develop data requirements for real-time forecasting models for use in grid codes

Subtask 3.3: Met data requirements for real-time forecasting models for use in grid codes

The most common instrumentation and their applicability in **wind forecasting**



Met Masts
- cup/sonic anemometer

Nacelle instrumentation
- cup/sonic anemometer
- computation via “pressure method”

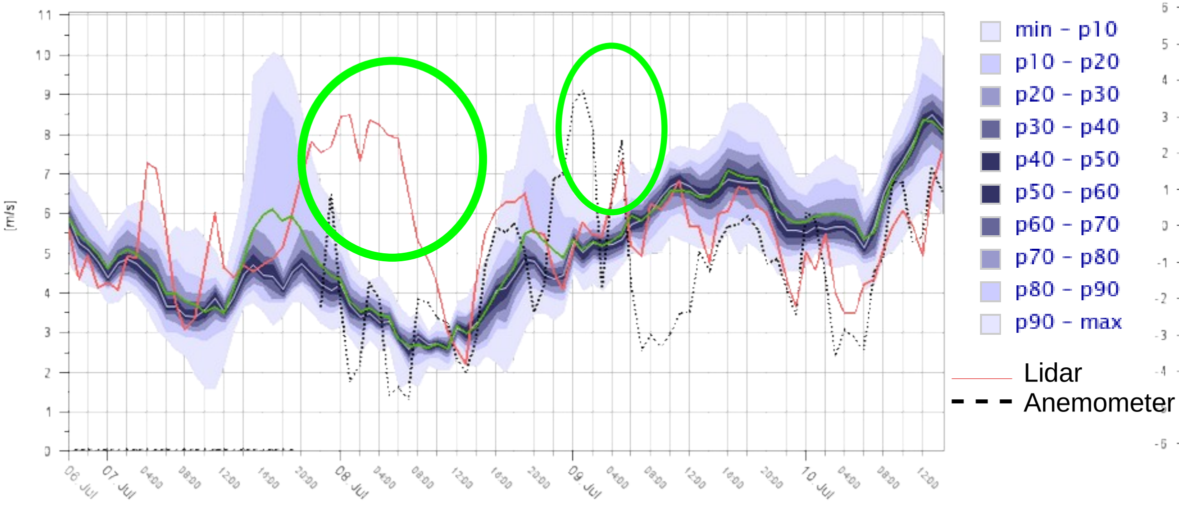
Remote Sensing
- LiDAR
- SODAR
- RADAR

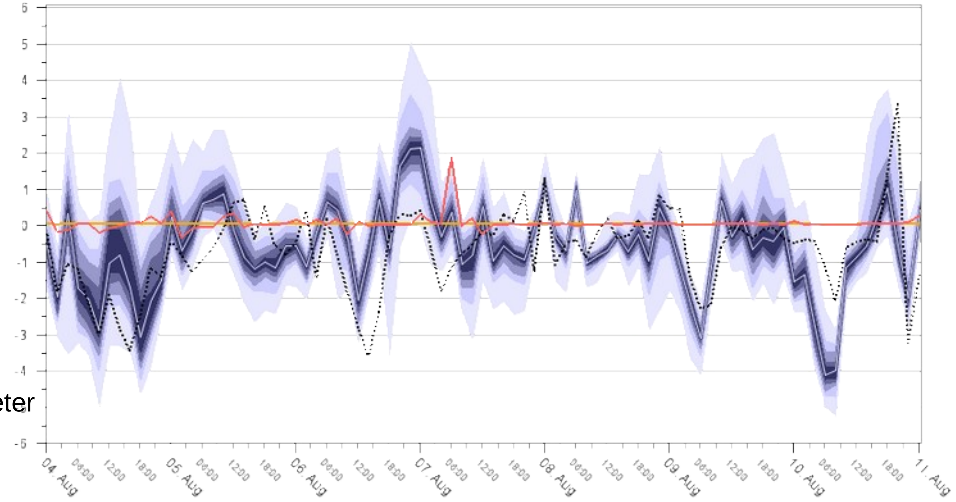
Q1: Do we have a similar measurement application challenge in PV forecasting ?

Calibration challenge of different measurement types in real-time environments

Remote sensing instruments are about to be mature
for real-time operation, but need guidelines for performance...

Just 2 typical challenging situations in a quality analysis...





Outliers on both Metmast & Lidar...

Difference between anemometer and
Lidar is == difference to forecast

Subtask 3.3: Met Data Requirements for real-time wind and solar forecasting

Requirement suggestions for wind farm accuracy of measurement instrumentation

Measurement	Units	Precision for Instantaneous Measurements (to the nearest...)	Range	Accuracy	Required /Optional
Wind Speed	Meters/Second (m/s)	0.1 m/s	0 to 50	±1m/s	R
Wind Direction	Degrees from True North	1 degree	0 to 360	±5°	R
Surface Pressure	HectoPascals (HPa)	1 hPa	800-1100	± 1.0 hPa at -20 ... 45 °C	R
Temperature	Degree Celsius	0.1° C	-50 to +50	±0.2 K in the range -27 ... +50°C	R
Dewpoint	Degrees Celsius (°C)	0.1° C	-50 to +50	±0.2 K in the range -27 ... +50°C	O
Relative Humidity	Percentage (%)	1.00%	0 to 100 %	±2% RH in the range 5- 95% RH at 10-40°C	O
Ice-up Parameter	Scale 0.0 to1.0	0.1	0 to 1	n/a	O/R
Precipitation	mm/min	0.1	0-11	2% until 25 mm/h 3% over 25 mm/h	O

Requirement suggestions for Solar/PV plant measurement instrumentation based on ISO 9060

Type	Variable	Unit	Precision	Range	Accuracy	Required/ Optional	Description
Thermopile Pyranometer**	GHI	W/m2	0.1	0-4000	±3%* *Secondary Standard	R	Global Horizontal Irradiance (GHI)
	DHI	W/m2	0.1	0-4000	±3%* *Secondary Standard	R	Diffused Horizontal Irradiance (DHI)
	GHIPOA	W/m2	0.1	0-4000	±3%* *Secondary Standard	O	Global Horizontal Irradiance Plane-of-Array (GHIPOA)
	DHIPOA	W/m2	0.1	0-4000	±3%* *Secondary Standard	O	Diffused Horizontal Irradiance Plane of Array (DHIPOA)
Pyreheliometer**	DNI	W/m2	0.1	0-2000	±3%* *Secondary Standard	R	Direct Normal Irradiance (DNI)
Sunshine Duration Sensor	SSD	V	0.1	0/1	90.00%	R	Sunshine Duration
Temperature Sensor	Ambient Temperature	•C	0.1	-50 to +50	±0.2 K in the range -27 ... +70°C	R	Ambient temperature at the array average height
	Backpanel Temperature	•C	0.1	-50 to +50	±1°	R	Back panel temperature for PV type arrays at the array average height
Wind vane	wind speed	m/s	0.1	0 to 50	±1m/s	R	Wind speed and direction anemometer at the avr array height
	wind direction	deg	1°	0 to 360	±5°	R	
Precipitation sensor	precipitation	mm/min	0.1	0-11	2% until 25 mm/h 3% over 25 mm/h	R	Rain gauge or tipping bucket following WMO standard
Relative Humidity Sensor	RH	%	1%	0-100	±2% RH in the range 5- 95% RH at 10-40°C	R	Relative humidity sensor following WMO standard
Barometric Pressure Sensor	Ps	hPa	0.1	600-1100	± 1.0 hPa at -20 ... 45 °C	R	Barometric Pressure sensor following WMO standard

** DHI and DNI instrumentation should be from same manufacturer

* **ISO9060 Definitions**

Recommended instrumentation and industry Best Practice for Solar Systems

Standards and Guidelines for Wind Energy Assessment

IEC 61400-12 "Power performance measurements of electricity producing wind turbines" Annexes A to K - guidelines around the setup of meteorological measurements and the respective measurement campaigns.

IEA Wind "Task 11: Best Technology Information Exchange Recommended Practices" – implementation guide for IEC 61400-12.

MEASNET guideline on cup anemometer calibration

Standards and Guidelines for Solar Energy Assessment

NREL "Best Practice Handbook for the Collection and Use of Solar Resource Data for Solar Energy Applications" (3rd Edition 18. Feb 2021)

ISO 9060 Solar energy – Specification and classification of instruments for measuring hemispherical/direct solar radiation

IEC 61724-1:2017 Photovoltaic system performance – Guideline for measurement, data exchange and analysis

Meteorological Standards and Guidelines

WMO Guide No.8 to Instruments and Methods of Observation,

Manuals on the WMO Integrated Global Observing System (WMO-No. 1160) and WIGOS Metadata Standard (WMONo. 1192)

EPA "Meteorological Monitoring Guidance for Regulatory modelling Applications"

...

Q2: how can/should we make use of these standards and guidelines for Real-time Operation f for Wind and Solar/PV projects

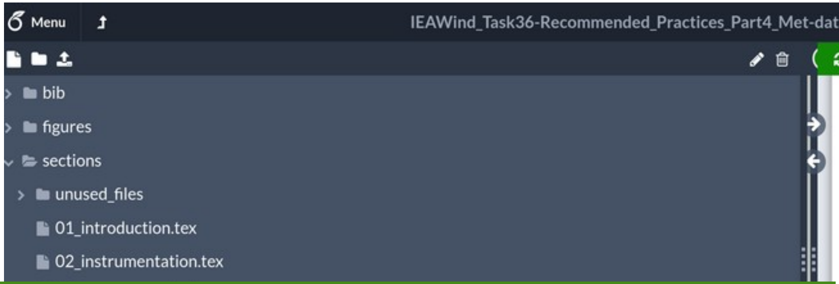
Table of contents suggestion for the Recommended Practice

Questions to answer...:

Q1: Do we have a similar measurement application challenge in PV forecasting as in wind (power curve..) ?

Q2: how can/should we make use of these standards and guidelines for Real-time operation for Wind and Solar/PV projects

Next Step: Development of the Recommended Practice Guideline in Overleaf



Template created

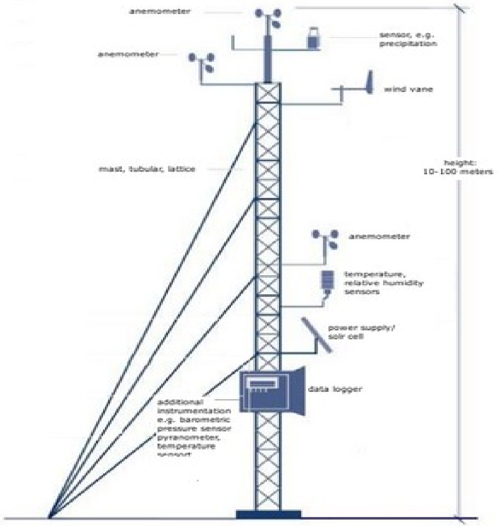
Tentative TIMELINE

Milestone 1: 31.03./01.04 (first draft)
Milestone 2: 30.04./02.05 (review)
Milestone 3: 31.05 /01.06 (finalization of work and merging into RP)
Milestone 4: 14.06 (sending draft to IEA Wind Community)
Milestone 5: 31.07 - 15.08 (implementing feedback and final review)
Milestone 6: 20.08.2019 Submission to IEA Task 11 OA and IEA Wind secretary
Milestone 7: xx.10.2021 Acceptance Request for Publication at ExCo meeting
Milestone 8: 31.12.2021 Submission of final version at IEA Webpage and OAbook

Contents

Review of instrumentation and industry Best Practice

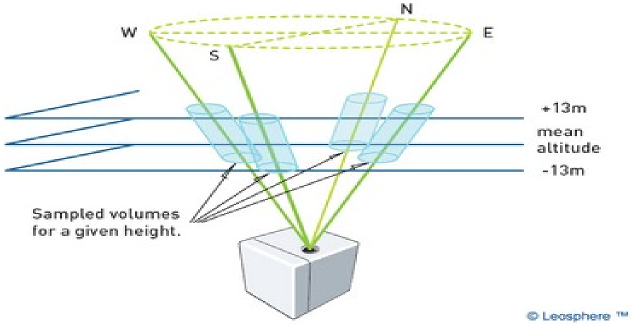
Meteorological Mast



Well known and tested

Standards for instruments

Remote Sensing Instruments

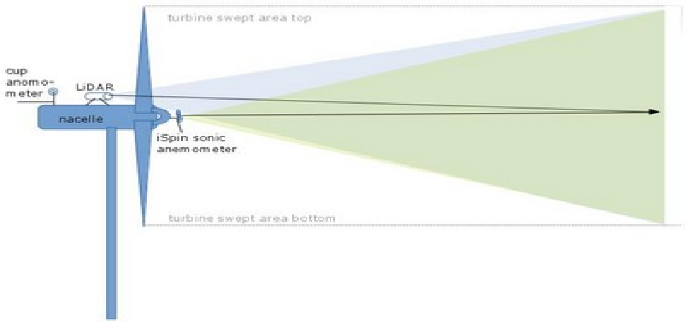


Less known in Wind Applications

Meteorologically interesting

Standards need to be adjusted for wind applications

Nacelle Instruments



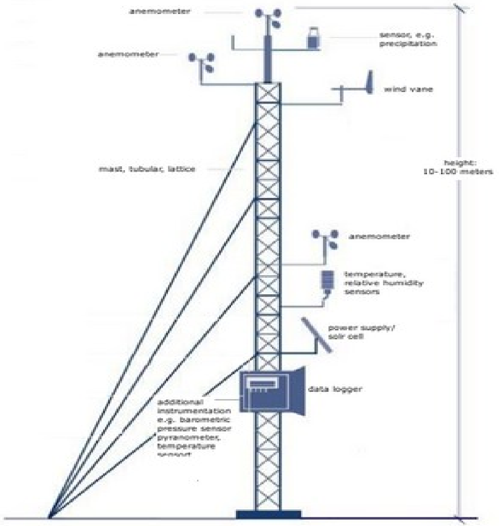
Relative new application

“old” technology (cup anemometer) insufficient

advantages not tested for forecasting/grid security

Review of instrumentation and industry Best Practice

Meteorological Mast



simple,
realiable,
less
information

more information, but
also more complex and
more expensive….

Cup anemometers
well tested and standardised

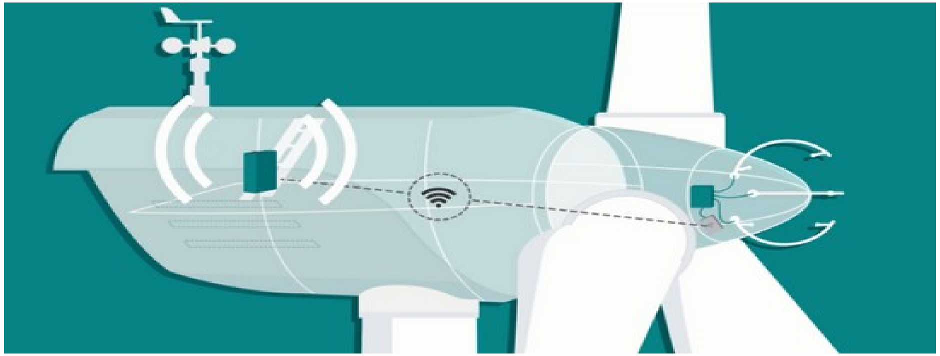
IEC 61400-12-1/2 and ISO/IEC 17025 standards describe how these instruments must be:

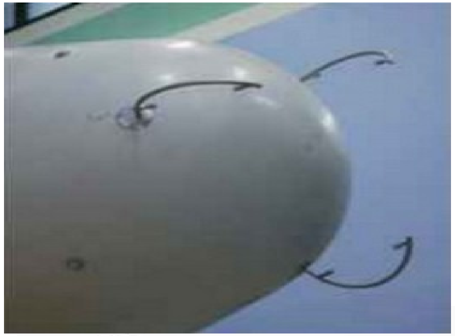
- calibrated
- mounted
- describe the process and the integrity of the measurement processes
- describe design of mast, instruments and measuring procedures.

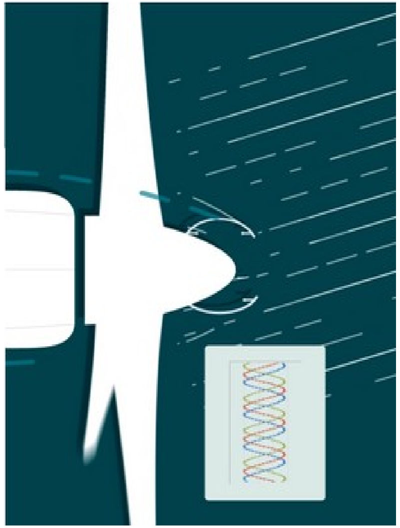
3D sonic anemometers have:
long tradition in atmospheric science and meteorology

- boundary layer studies of turbulence intensity
- phenomena like low level jets

Review of instrumentation and industry Best Practice







The iSpin technology claims to solve the following issues:

- monitor the air density corrected power curve
- monitor and correct yaw misalignments
- Observe turbulence intensity allowing you to make informed choices between power production and

Most critical for forecasting application:

- computation of flow
- not proven in real-time yet

Recommended instrumentation and industry Best Practice for Solar Systems

Standards and Guidelines for Solar Energy Assessment

NREL "Best Practice Handbook for the Collection and Use of Solar Resource Data for Solar Energy Applications" (1st Edition 2015 /63112, 2nd Edition 2017/6886, **3rd Edition 18. Feb 2021**)
The NREL handbook is a comprehensive report, which summarizes important information for all steps of a solar energy project - reaching from required measurements and the design of measurement stations to forecasting the potential solar radiation. Additionally, NREL informs about measurement instruments and its application as well as sources for solar measurement data.
Download: NREL Best Practice Handbook for the Collection and Use of Solar Resource Data for Solar Energy Applications

ISO 9060 Solar energy – Specification and classification of instruments for measuring hemispherical solar and direct solar radiation
In the ISO 9060 standard pyranometers are classified in three classes: Secondary Standard for scientific measurement quality, First Class for good measurement quality and Second Class for medium measurement quality. The ISO 9060 is accepted by the WMO (World Meteorological Organisation). See also Pyranometer.

IEC 61724-1:2017 Photovoltaic system performance – Guideline for measurement, data exchange and analysis
This standard decribes measurement system components and processes. It focuses on measurement uncertainties and defines accuracy classes. Additionally, the standard defines cleaning and calibration intervals for pyranometers.

THANK YOU FOR YOUR ATTENTION

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Project webpage

http://www.ieawindforecasting.dk/

Task-page:

https://www.ieawindforecasting.dk/work-packages/workpackage-3

Publications:

http://www.ieawindforecasting.dk/publications.html

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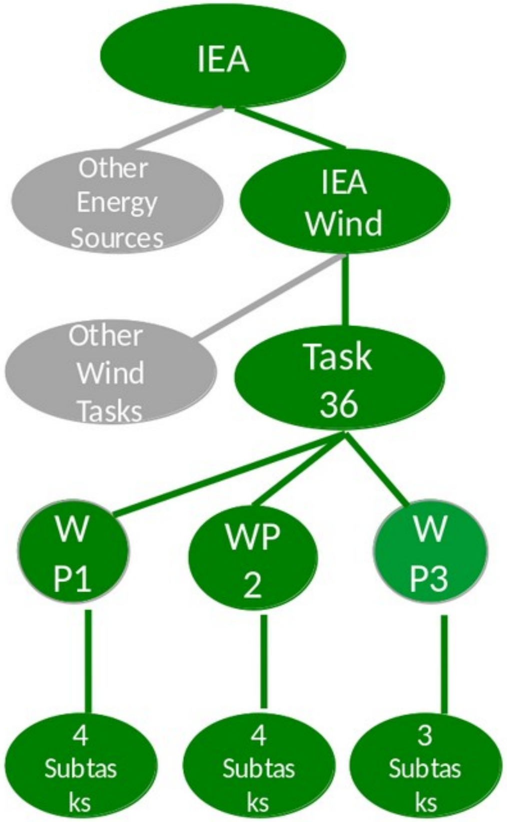
IEA Task 36 - Forecasting for Wind Energy



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/issues**

Task 36: Forecasting for Wind Energy: (www.ieawindforecasting.dk)

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

Task 36 Scope: Three "Work Packages"

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

Task homepage: http://www.ieawindforecasting.dk/