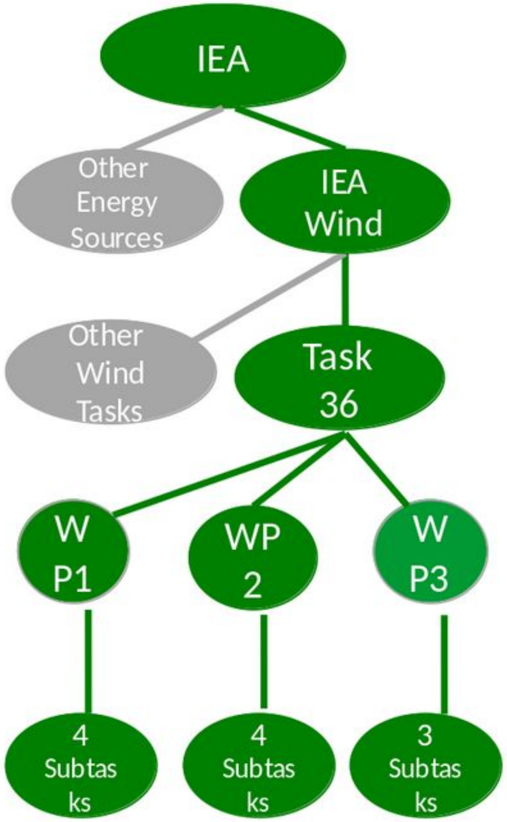
IEA Wind Task 36

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

Summary

February 3, 2020

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/

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

Summary of Subtask 3.3:

Meteorological Data Requirements to be provided in the grid codes for real-time forecasting models

Subtask 3.3: Data Requirements to be provided in the grid codes for real-time forecasting models

- BACKGROUND -

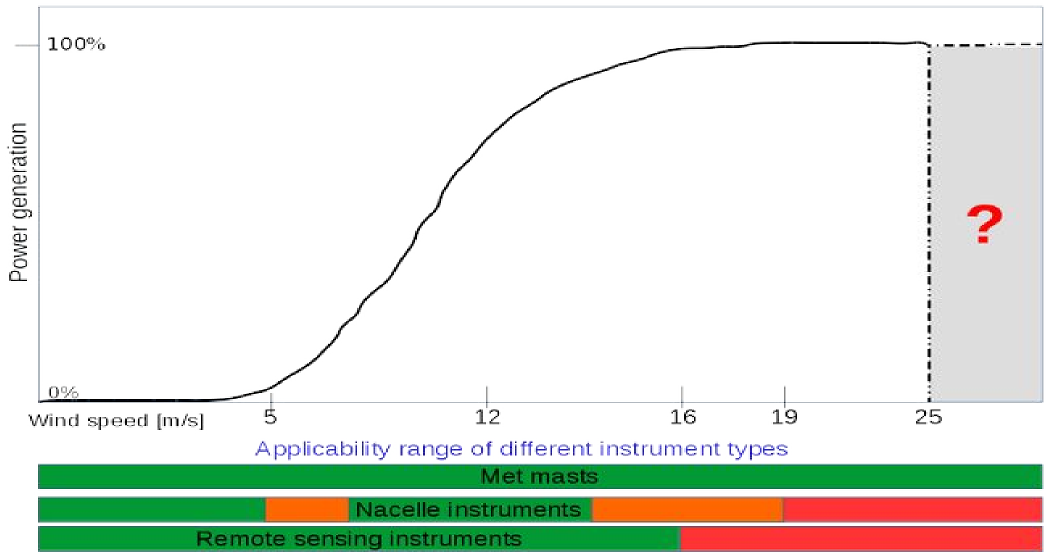
Combination of **actual wind measurements + trend from wind forecast** provide necessary input to a number of areas in grid operation: e.g.

- forecast of high-speed shut-down events
- strong ramping events
- potential power computation
- compensation for curtailments
- etc.

Currently every ISO/TSO has to develop their own requirements for the grid code
→ a industry guideline would make this process much more efficient!

Subtask 3.3: Data Requirements to be provided in the grid codes for real-time forecasting models

The most common instrumentation and their applicability



Met Masts
- cup/sonic anemometer

Nacelle instrumentation
- cup/sonic anemometer
- computation via pressure

Remote Sensing
- LiDAR
- SODAR
- RADAR

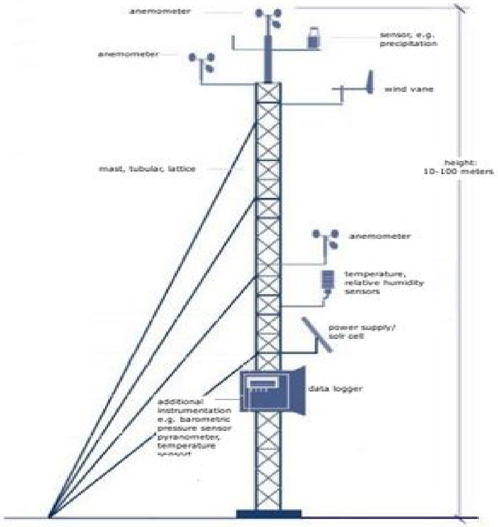
Status and plans for the next period

- Summarize types of instrumentation used today
- Creating Table of Contents for a RP and setup Writing Platform -→ Overleaf Template ready now...
- Studying and summarize existing standards
- Develop the recommendations
  -

--→ volunteers needed ...please contact me
@ <com@weprog.com>

Review of instrumentation and industry Best Practice

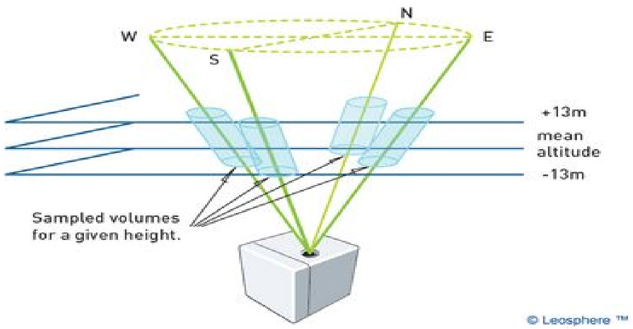
Meteorological Mast



Well known and tested

Standards for instruments

Remote Sensing Instruments

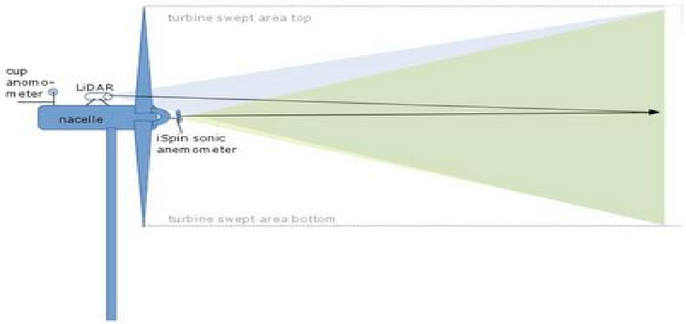


Less known in Wind Applications

Meteorologically interesting

Standards need to be adjusted for wind applications

Nacelle Instruments



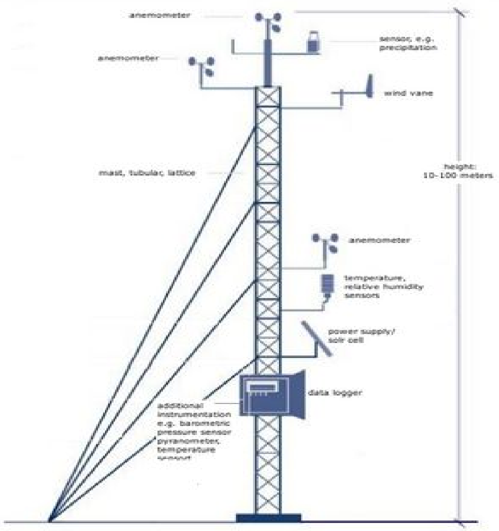
Relative new application

“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

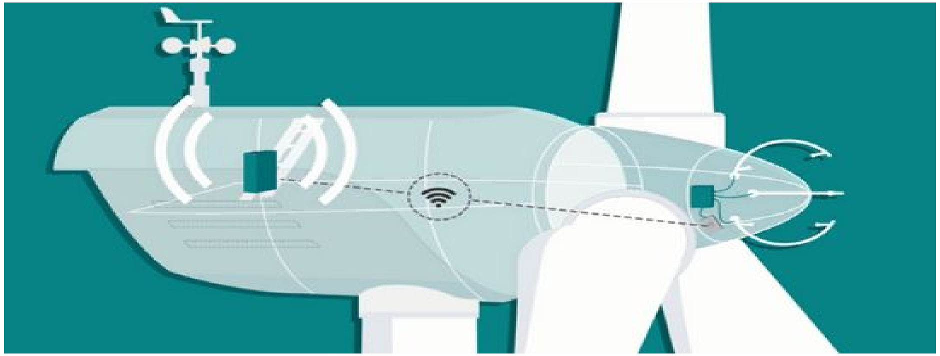
IEC 61400-12-1/2 and ISO/IEC 17025 standards describe how these instruments must be:

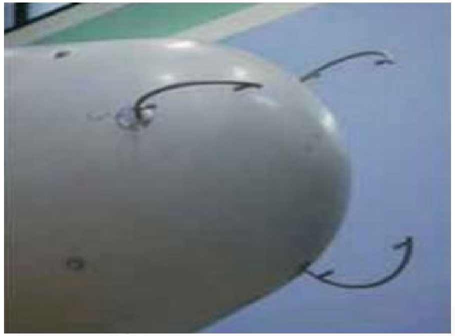
- calibrated
- mounted
- describe the process and the integrity of the measurement processes
- describe design of mast, instruments and measuring procedures.

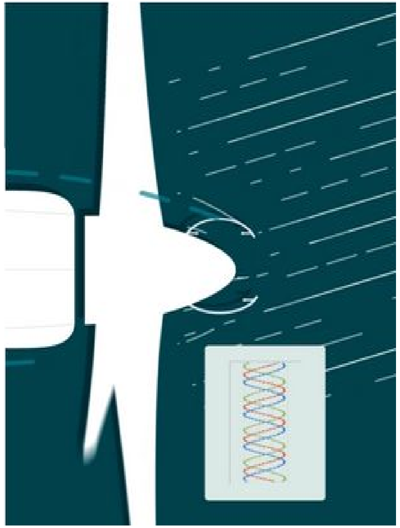
3D sonic anemometers have:
long tradition in atmospheric science and meteorology

- 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

Findings from analysis of measurement types

Identified issues with **nacelle mounted measurements**:

induction: nacelle measurement errors followed in large the angle of pitched blades (5% pitched blades equivalent 5% measurement error)

flow disturbances: changing direction gives changing inclination angles and wrong changes in wind speeds

wake effects from other turbines and of cup anemometers, where the turbine was subject to wake effects at certain directions

over-speeding of cup anemometer with errors > 10%

offsets in wind direction

snow and icing

Findings from analysis of remote sensing measurement types

Findings from analysis of **remote sensing instruments**:

ADVANTAGES

Availability of vertical wind profile information

Volume-averaged versus point measurement

Upstream scanning

DISADVANTAGES

Higher maintenance requirements

Variable data quality

Data outages correlated with active weather

Data frequency

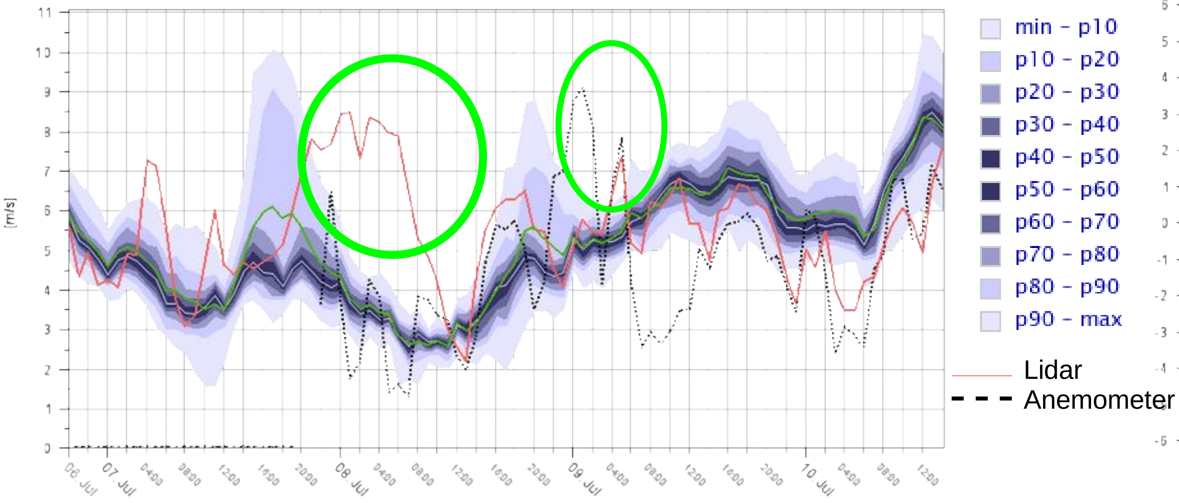
The instruments are interesting, especially for situational awareness, but show highest reliability issues under:

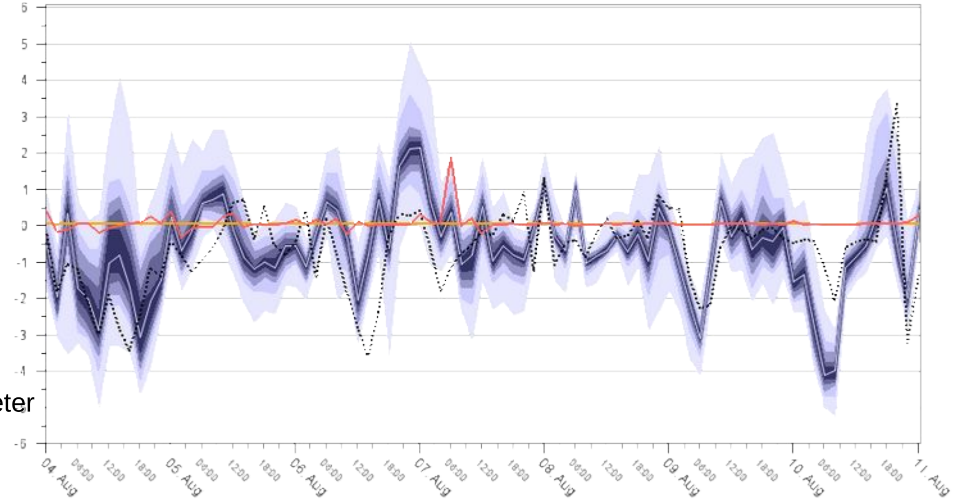
- active weather
- strong precipitation

Findings from analysis of different measurement types in real-time environments

Remote sensing instruments are about to be mature for real-time operation, but require more testing and pilots…

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





Outliers on both Metmast & Lidar...

Difference between anemometer and Lidar is == difference to forecast iea wind

Findings from analysis of measurement types


Remote sensing instruments are mature for real-time operation, but require further development for application in power grid operation:

- measurements must be raw or technical requirements must include delivery of maintenance and software updates
- lightning protection and recovery strategy after lightning
- measurements should be taken at several heights to take advantage of the instrument type
- instruments must be serviced and maintained by skilled staff
- version control must be maintained for signal processing
- wind characteristics data must be on wind turbine level
- LiDARs and SODARs in complex terrain require special consideration and testing

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.

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

Requirement suggestions for wind farm accuracy of measurement instrumentation

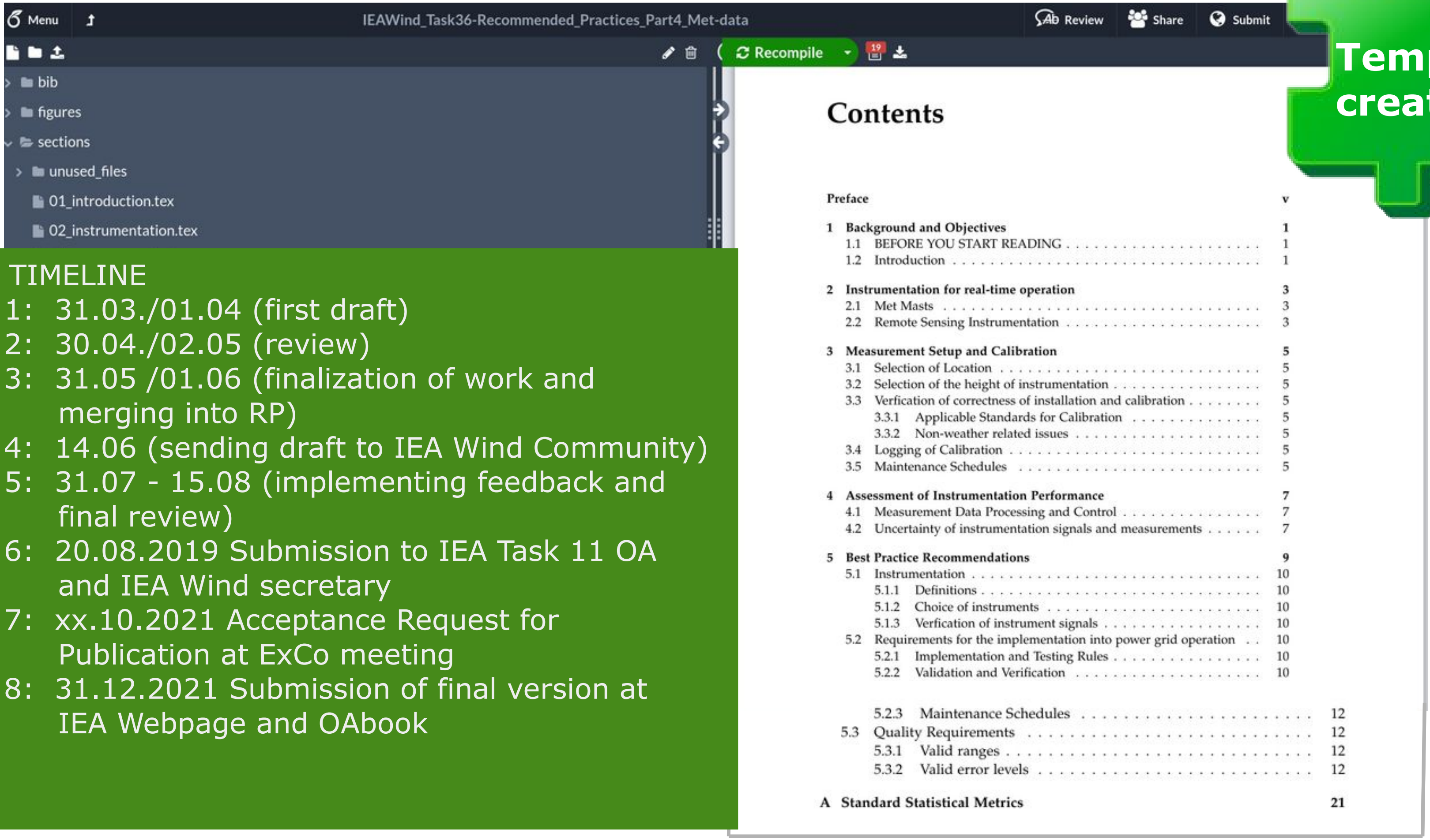
Measurement	Units	Precision for Instantaneous Measurements (to the nearest...)	Range	Accuracy	Required /Optional
Wind Speed	Meters/Second (m/s)	0.1 m/s	0 to 50	±1m/s	R
Wind Direction	Degrees from True North	1 degree	0 to 360	±5°	R
Surface Pressure	HectoPascals (HPa)	1 hPa	800-1100	± 1.0 hPa at -20 ... 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 wind direction	m/s deg	0.1 1°	0 to 50 0 to 360	±1m/s ±5°	R R	Wind speed and direction anemometer at the avr array height
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**

Next Step: Development of the Recommended Practice Guideline in Overleaf



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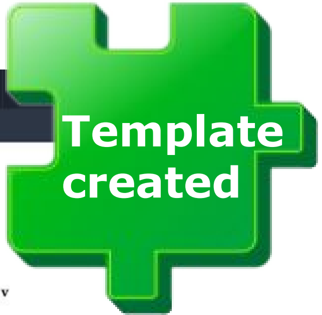

Tentative TIMELINE

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

THANK YOU FOR YOUR ATTENTION

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Project webpage

http://www.ieawindforecasting.dk/

Task-page:

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Contact WP Leaders:
Dr. Corinna Möhrlen, WEPROG
com@weprog.com

Dr. Ricardo J. Bessa, INESC TEC
ricardo.j.bessa@inesctec.pt