

# IEA Wind Task 36

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

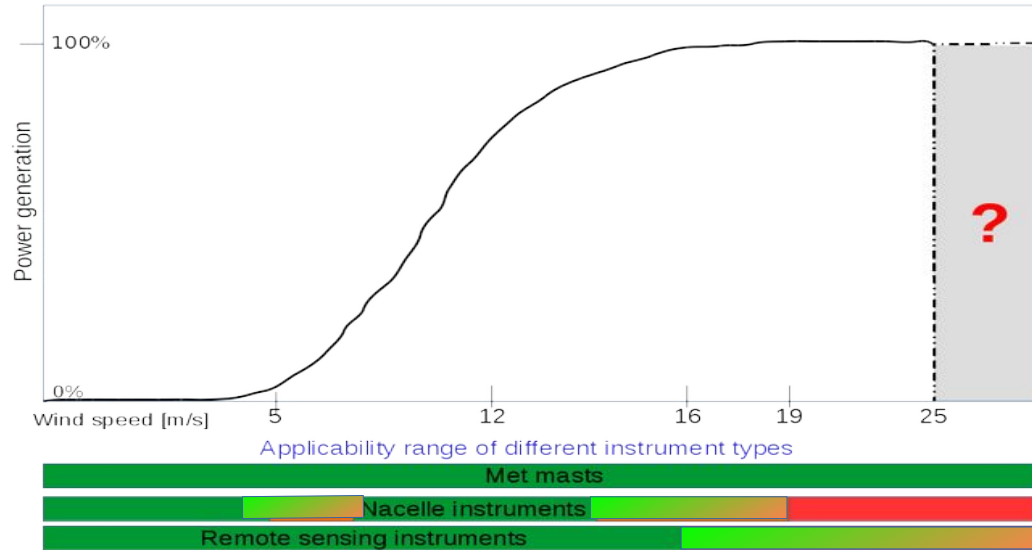


## Status Meeting

June, 14 2021

## 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

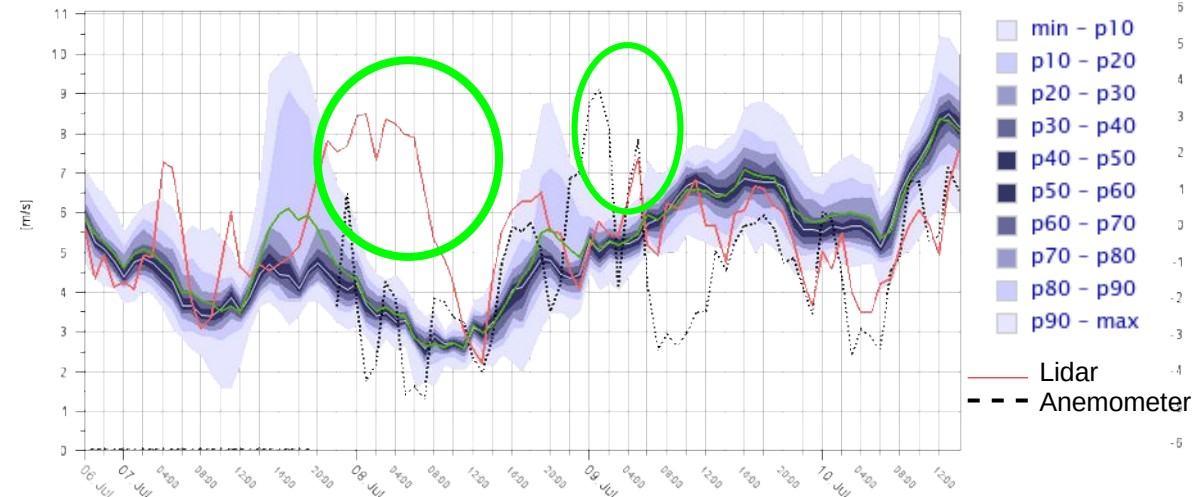
Q1: Do we have a similar measurement application challenge in **PV** forecasting ?

# Calibration challenge of different measurement types in real-time environments

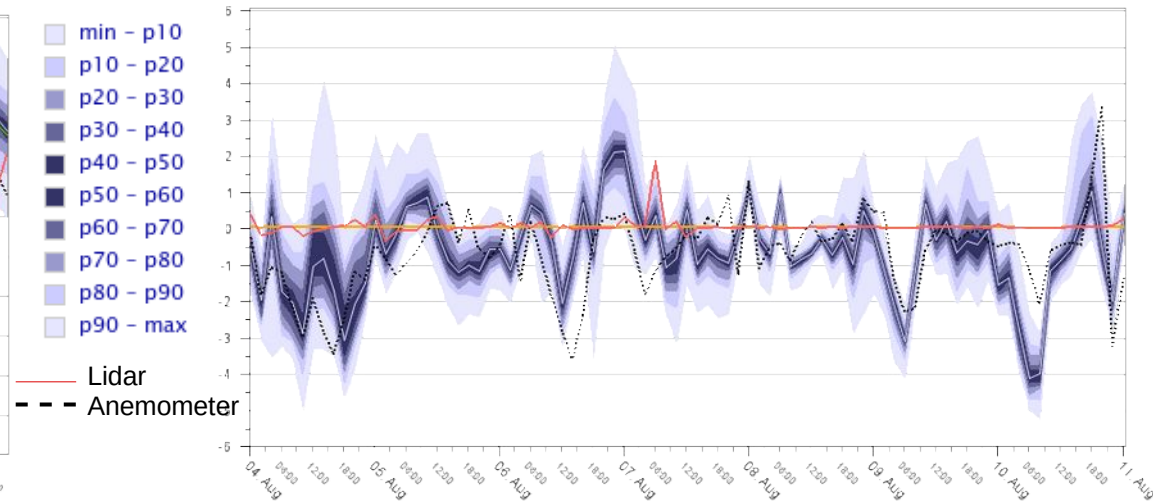
**Remote sensing instruments** are about to be mature for real-time operation, but need guidelines for performance...



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

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

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

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 Solar Energy Assessment

### **NREL "Best Practice Handbook for the Collection and Use of Solar Resource Data for Solar Energy Applications"** (1<sup>st</sup> Edition 2015 /63112, 2<sup>nd</sup> 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](#)

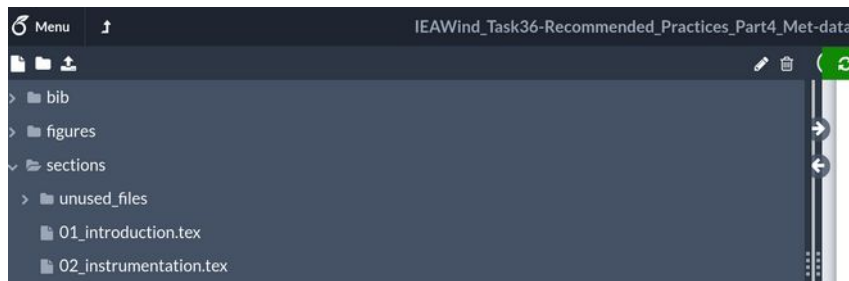
### **ISO 9060 Solar energy – Specification and classification of instruments for measuring hemispherical solar and direct solar radiation**

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 describes measurement system components and processes. It focuses on measurement uncertainties and defines accuracy classes. Additionally, the standard defines cleaning and calibration intervals for pyranometers.



# Next Step: Development of the Recommended Practice Guideline in Overleaf



## Contents

Preface	v
<b>1 Background and Objectives</b>	<b>1</b>
1.1 BEFORE YOU START READING	1
1.2 Introduction	1
<b>2 Instrumentation for real-time operation</b>	<b>3</b>
2.1 Met Masts	3
2.2 Remote Sensing Instrumentation	3
<b>3 Measurement Setup and Calibration</b>	<b>5</b>
3.1 Selection of Location	5
3.2 Selection of the height of instrumentation	5
3.3 Verification of correctness of installation and calibration	5
3.3.1 Applicable Standards for Calibration	5
3.3.2 Non-weather related issues	5
3.4 Logging of Calibration	5
3.5 Maintenance Schedules	5
<b>4 Assessment of Instrumentation Performance</b>	<b>7</b>
4.1 Measurement Data Processing and Control	7
4.2 Uncertainty of instrumentation signals and measurements	7
<b>5 Best Practice Recommendations</b>	<b>9</b>
5.1 Instrumentation	10
5.1.1 Definitions	10
5.1.2 Choice of instruments	10
5.1.3 Verification of instrument signals	10
5.2 Requirements for the implementation into power grid operation	10
5.2.1 Implementation and Testing Rules	10
5.2.2 Validation and Verification	10
5.2.3 Maintenance Schedules	12
5.3 Quality Requirements	12
5.3.1 Valid ranges	12
5.3.2 Valid error levels	12
<b>A Standard Statistical Metrics</b>	<b>21</b>

## Tentative TIMELINE

Milestone 1: 31.03./01.04- **31.7** (first draft)

Milestone 2: 30.04./02.05 **31.8** (review)

Milestone 3: 31.05./01.06 **01.09**  
(finalization of work, merging into RP)

Milestone 4: 14.06 **14.09**  
(sending draft to IEA Wind Community)

Milestone 5: 31.07—15.08 **31.10-15.11**  
(implementing feedback and final review)

Milestone 6: 20.08.2021 **15.11.2021**  
Submission to IEA Task 11 OA/Wind secretary

Milestone 7: 12.2021/01.2022 Acceptance Request for  
Publication at ExCo meeting

Milestone 8: **31.12.2021** Submission of final version  
for Publication at Springer Books



# Table of contents

Preface	vii	
<b>1 Background and Objectives Contributing author: COM, JY</b>	<b>1</b>	
1.1 BEFORE YOU START READING	1	
1.2 Introduction Contributing author: COM	1	
1.3 Use and Application of real-time Meteorological Measurements Contributing author: JY, JZ, COM	2	
1.3.1 Resource Assessment versus Forecasting Measurements	2	
1.3.2 System Operation	4	
1.3.3 Power plant operation Contributing author: IW/AC ?	4	
1.3.4 Power trading in electricity markets Contributing author: ES	6	
1.4 Available applicable Standards Contributing author: COMneeds attention	6	
1.4.1 Standards and Guidelines for Wind Measurements	6	
1.4.2 Standards and Guidelines for Solar/PV Measurements	8	
1.5 Data Communication Aspects Contributing author: JB, RPneeds attention	8	
<b>2 Meteorological Instrumentation for real-time operation Contributing author: COM, ES, JB</b>	<b>9</b>	
2.1 Meteorological masts	11	
2.2 Remote Sensing Instrumentation Contributing author: ESmore authors: IW/AC ?	14	
2.3 Nacelle instrumentation and measurementsneeds attention	20	
2.3.1 Cup anemometers	21	
2.3.2 Sonic and ultra-sonic anemometers	22	
2.3.3 Horizontally mounted nacelle LiDARneeds attention - more authors: IW/AC ?	24	
2.4 Solar Radiation Sensors needs attention/authors ?	25	
2.4.1 Sky-imaging	25	
2.5 Emerging Intrumentation	25	
2.5.1 Satellite images for fog and clouds	25	
<b>Power Measurements for real-time operation Contributing author: JB, RP?</b>	<b>27</b>	
3.1 Live power and related measurements	27	
3.2 Power available signals	28	
3.3 Measurement systems	29	
3.3.1 Connection-point Meters	29	
3.3.2 Wind Power SCADA Systems Contributing author: JBneeds attention - more authors ?	29	
3.3.3 Solar Power SCADA Systems Contributing author: ?	29	
3.4 Live Power Data in Forecasting	30	
3.4.1 Specifics for power plant operation	30	
3.4.2 Specifics for power system operation	30	
<b>Measurement Setup and Calibration Contributing author: JZ, COMmore authors needed for PV/Wind-Lidar</b>	<b>31</b>	
4.1 Selection of instrumentation	31	
4.1.1 Selection of instrumentation for wind projects	31	
4.1.2 Selection of instrumentation of PV projects	33	
4.1.3 Measurement Characteristics of Different Technologies	34	
4.2 Representativeness of Measurements	35	
4.2.1 Location of Instrumentation	36	
4.2.2 Positioning of Instrumentation	36	
4.3 Verification of correctness of installation and calibration needs attention	36	
4.3.1 Applicable Standards for Calibration	37	
4.3.2 Non-weather related issues	37	
4.4 Logging of Calibration	37	
4.5 Maintenance Schedules	37	
<b>Assessment of Instrumentation Performance Contributing author: COM, AK needs attention - more authors</b>	<b>39</b>	
5.1 Measurement Data Processing Quality and Control needs attention	39	
5.1.1 Known issues of nacelle wind speeds and mitigation methods	39	
5.1.2 Application of nacelle wind speeds in Real-time NWP Data Assimilation	40	
5.2 Uncertainty of instrumentation Signals	42	
5.3 Uncertainty of Measurements	42	
5.4 Quality control of measurements for real-time useAuthor: COM - needs more authors/discussion	42	
5.4.1 Quality control in real-time mode	42	
5.4.2 Quality control in historic mode	43	
<b>6 Best Practice Recommendations Contributing author:</b>	<b>49</b>	
6.1 Instrumentation Contributing author:	51	
6.1.1 Definitions	51	
6.1.2 Choice of instruments	51	
6.1.3 Verification of instrument signals	51	
6.1.4 Quality Requirements	51	
6.2 Requirements for the implementation into power grid operation Contributing author: COM	51	
6.2.1 Implementation and Testing Rules	51	
6.2.2 Validation and Verification	51	
6.2.3 Maintenance Schedules	51	
6.2.4 Quality Requirements	51	
6.3 Requirements for the implementation into power plant operation Contributing author: JY	51	
6.3.1 Implementation and Testing Rules	51	
6.3.2 Validation and Verification	51	
6.3.3 Maintenance Schedules	51	
6.3.4 Quality Requirements	51	
6.4 Requirements for the implementation for power trading in electricity markets Contributing author: ES, COM	51	
6.4.1 Implementation and Testing Rules	51	
6.4.2 Validation and Verification	51	
6.4.3 Maintenance Schedules	51	
6.4.4 Quality Requirements	51	
<b>A Examples of System Operator Met Measurement Requirements</b>	<b>61</b>	
A.1 Comparison of Requirements in various jurisdictions	61	
A.2 Met Measurement Example from Californina Independent System Operator in USA	61	
A.3 Met Measurement Example from Irish System Operator EIRGRID Group	61	