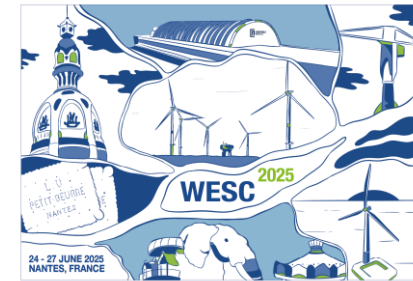




# AIRE measurement campaigns and data analysis

*Charlotte Bay Hassager (DTU) and Beatriz Méndez (CENER)*  
*WESC Conference Nantes 26th June 2025*



Funded by  
the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them.



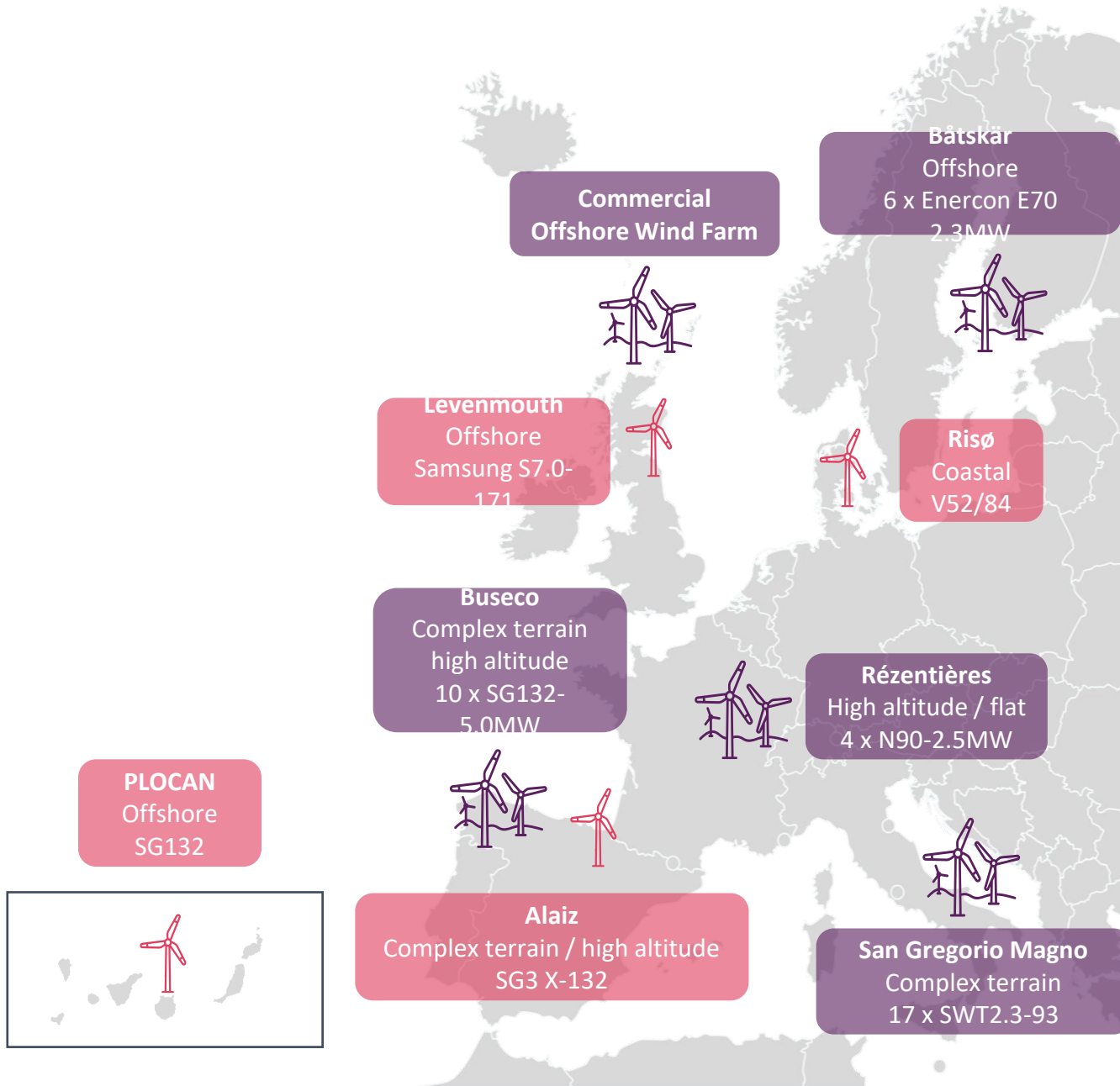
Horizon Europe Project (2023-2026)

How **site location** and **climate conditions** affect wind turbine and wind farm operation and design?

AIRE makes a **holistic approach** to:

- Study the effect that variables such as **precipitation** and **dust** have on wind turbines and wind farms operation.
- Improve wind turbine and wind farm design and control.
- **Increase** wind energy efficiency.





# AiRE

## Sites & Partners



Experimental wind turbine



Wind farm



| Owner                 | Name of site                            | EQUIPMENT                                                                                                                                                                       |
|-----------------------|-----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>CENER</b>          | Alaiz Experimental Wind farm            | Micro Rain Radar, V2 lidar<br>4 met mast 118m<br>Wind vanes, cup anemometers, sonic anemometers<br>Parsivel                                                                     |
| <b>DTU</b>            | Risø Campus experimental site           | Meteorological mast up to 123m<br>Disdrometers Parsivel and Thies<br>Micro Rain Radar and V2 lidar                                                                              |
| <b>OREC</b>           | Levenmouth Demonstrator Turbine         | Parsivel<br>Lidar, KIPP & ZONEN UVS Radiometer<br>NOAH Offshore Anemometry Hub (Blyth)                                                                                          |
| <b>PLOCAN</b>         | Oceanic offshore platform and test site | Vaisala meteorological station (WXT530)<br>Solar radiation sensor (Apogee Instruments model SQ-215)<br>UV sensor (SGLUX model UV-Cosine)<br>LIDAR ZX300M<br>Air quality station |
| <b>CAPITAL ENERGY</b> | Buseco wind farm                        | Rain sensor and V2 lidar                                                                                                                                                        |
| <b>ENGIE</b>          | Rézentières wind farm                   | Meteorological mast (data from 2018 to 2020)<br>Micro Rain Radar, disdrometer and V2 lidar                                                                                      |
| <b>ENGIE</b>          | San Gregorio Magno wind farm            | Meteorological mast, precipitation sensors                                                                                                                                      |
| <b>VTT</b>            | Båtskär wind farm                       | Nacelle weather sensor<br>Disdrometer (nacelle mounted)<br>Precipitation holographic imaging sensor (ICEMET)<br>Ceilometer (ground/substation mounted)                          |





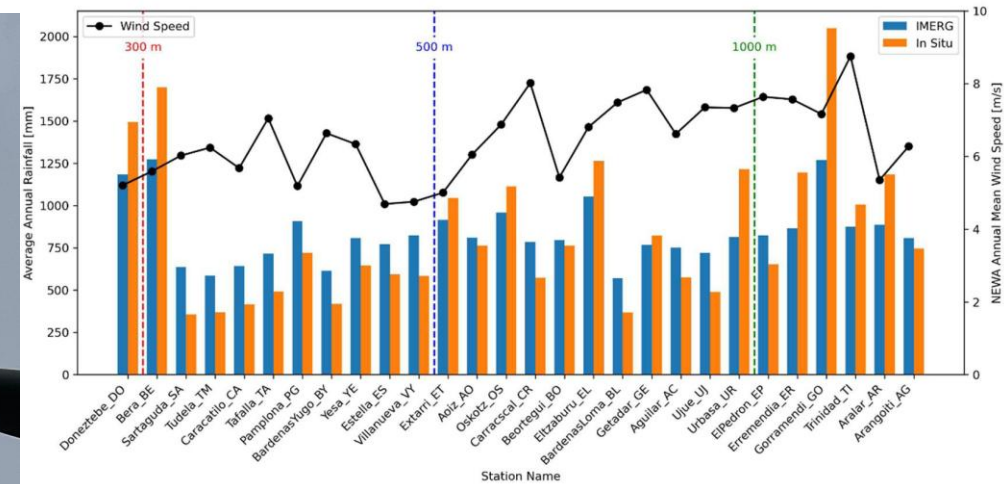
# Knowledge hub



Wind + precipitation + sand  
Different sites (onshore/offshore/altitude effect/complex terrain)  
Satellite data analysis

## Equipment & Data:

- Micro Rain Radar, Disdrometers, Lidar
- Radiometer, Particle aerosols (with high volume collector), Meteorological stations
- Solar radiation sensor
- Blade Status & Wind Turbine Scada
- Satellite data calibration



Funded by  
the European Union



# 1. Alaiz



# 1. Alaiz



## General Description

**Location:** Spain

**Type of site:** High altitude & Complex Terrain

**Wind turbine model:**



**Experimental wind turbine**

## Equipment

**Wind:** anemometers, lidar

**Precipitation:** MRR PRO, disdrometer, pluviometer

**Other:** Blade inspections

## Results

Calibration of the precipitation equipment

Study of the wind-precipitation dependence

Publication on MRR data (Torque 2024)



# Alaiz (CENER's experimental wind farm)

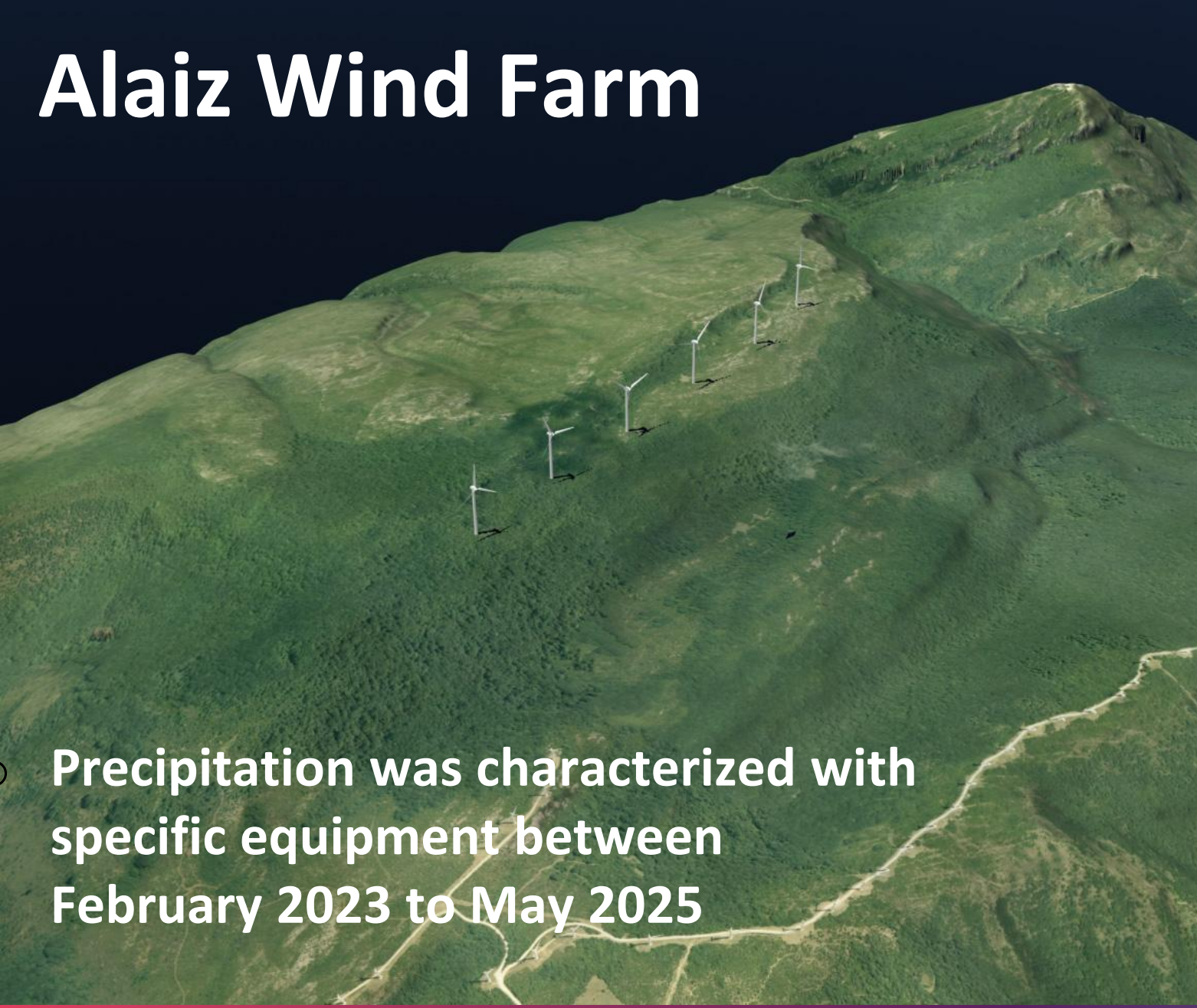


September 2023



# Alaiz Wind Farm

Precipitation was characterized with specific equipment between February 2023 to May 2025



Funded by  
the European Union





# 2024-2025 precipitation and wind campaign at Alaiz



*DTU Lidar installed with the precipitation measurement equipment*

# Equipment



## Micro Rain Radar

Metek MRR-PRO

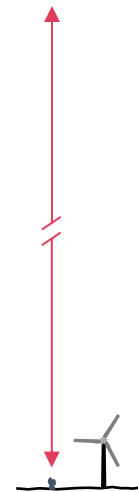
- Raindrop size distribution
- Precipitation fall speed
- Rain intensity
- Type of precipitation

Data at 0.2 Hz

Measures at different heights

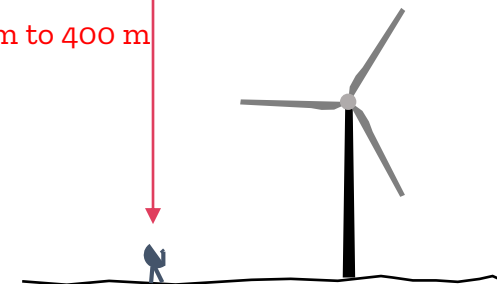
### Micro Rain Radar range

50 m to 3200 m



### AIRE range of interest

50 m to 400 m



## Disdrometer

OTT Parsivel<sup>2</sup>

- Raindrop size distribution
- Precipitation fall speed
- Rain intensity
- Type of precipitation

Measures at ground level

Data at 0.02 Hz (1 per minute)

## Pluviometer

R M YOUNG 52203

- Average rainfall intensity

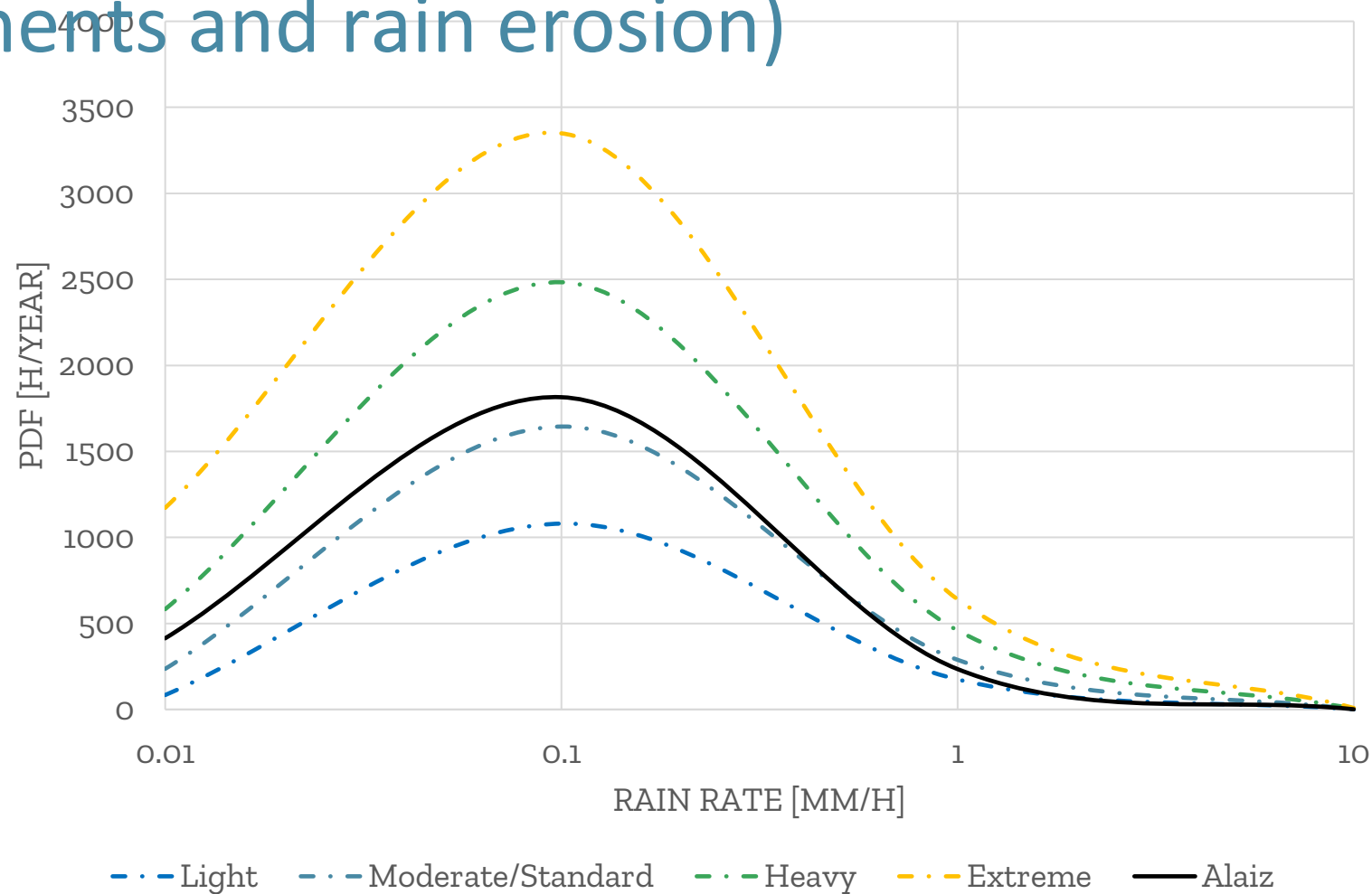
Measures at ground level

Data averaged 1min and 10min





# Annual Rain Rate Distributions (DNV-st-0376 rain environments and rain erosion)



# Case Study 1

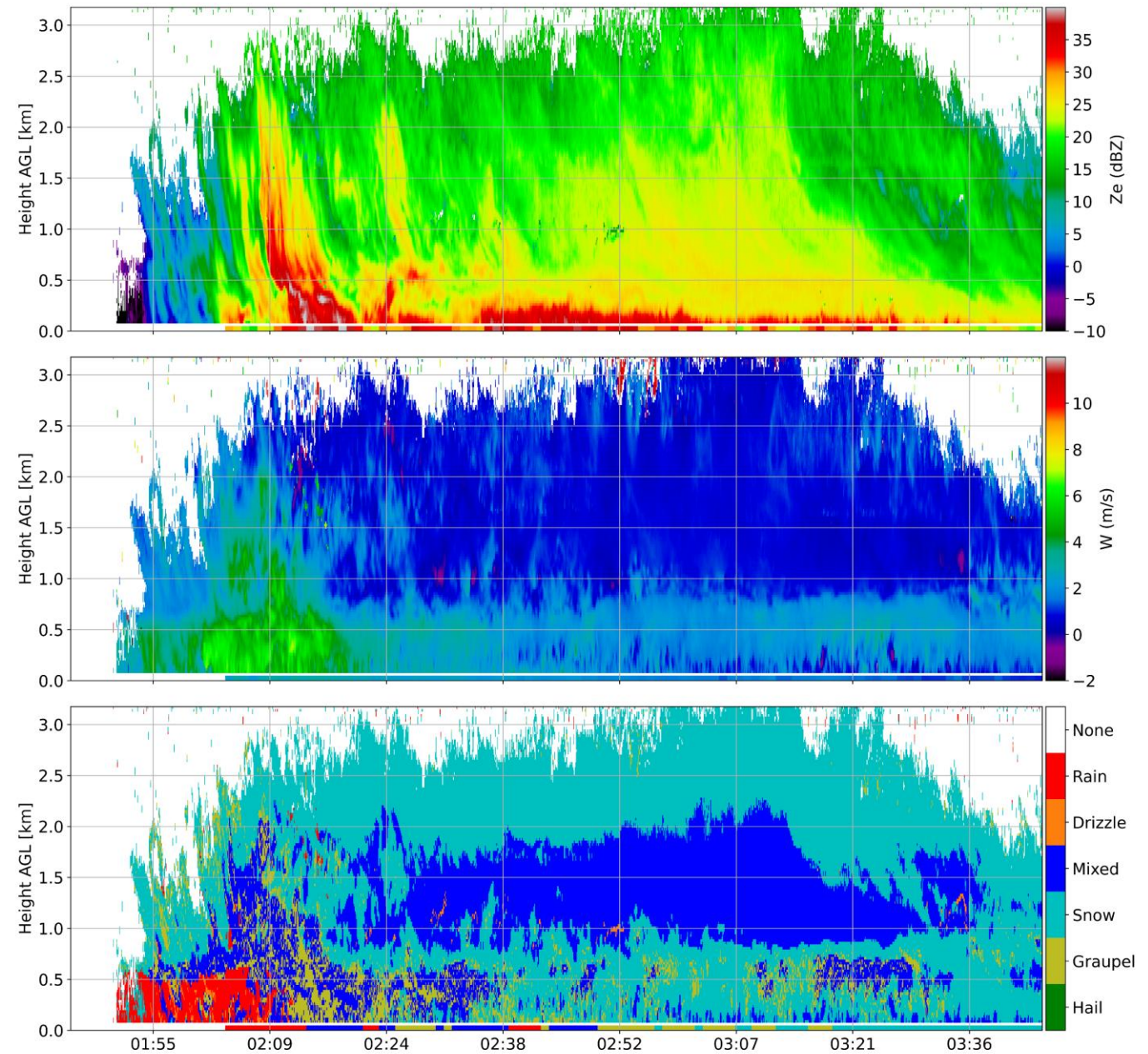
23<sup>rd</sup> February 2023 from 1:45 to 3:45 UTC

Equivalent radar reflectivity  $Z_e$

Vertical fall velocity  $W$

Estimated precipitation type

*\*\*Parsivel observations are shown at the lowest level of each panel using the same color scale as MRR data.*

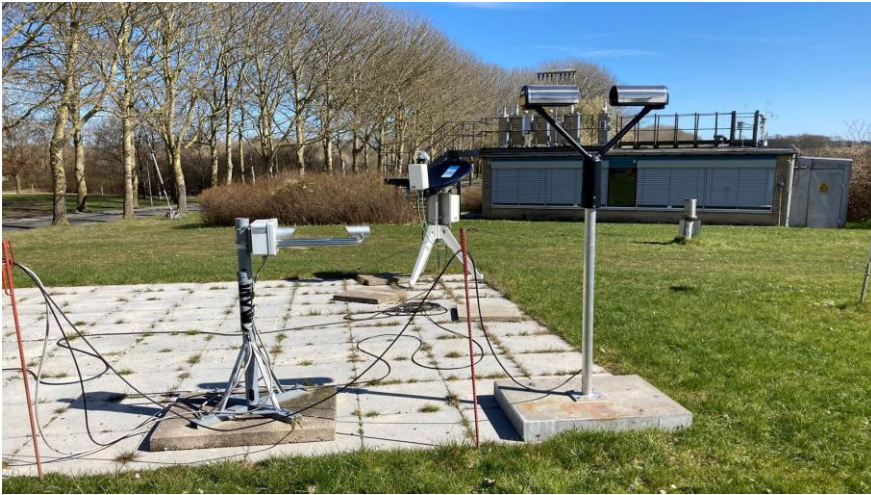




# 2. RISØ



## 2. RISØ



### General Description

**Location:** Denmark

**Type of site:** Coastal

**Wind turbine model:** V52



**Experimental wind turbine**

### Equipment

**Wind:** cup anemometers, sonics, wind lidar

**Precipitation:** Disdrometers, MRR PRO, rain gauge

### Results

**Investigation of the effect of rain on wind lidar data quality**

**Testing accuracy of disdrometer and rain gauge with droplet experiment**

**Calibrating MRR and compare to rain gauge**



# 3. Rézentières Wind Farm



### 3. Rézentières Wind Farm



# 3. Rézentières Wind Farm

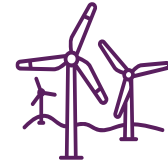


## General Description

**Location:** France

**Type of site:** High altitude

**Wind turbine model:** Nordex



Wind farm

## Equipment

**Wind:** anemometers

**Precipitation:** MRR PRO, disdrometer

**Other:** SCADA, blade inspections

## Results

Detailed study of the influence of precipitation on power performance and wake evolution



Funded by  
the European Union





# 4. Levenmouth



# 4. Levenmouth



## General Description

**Location:** UK  
**Type of site:** Offshore  
**Wind turbine model:**



**Experimental wind turbine**

## Equipment

**Wind:** anemometers, lidar  
**Precipitation:** MRR, disdrometer, pluviometer  
**Other:** Blade inspection, testing of LEP, pyranometer

## Results

Comparison of disdrometer and weather station rain gauge  
Wind lidar and met-mast and turbine wind speed comparison  
Comparison pyranometer vs. weather station data

# 4. PLOCAN





# 4. PLOCAN



## General Description

**Location:** Spain- Canary Islands

**Type of site:** Subtropical Climate & Offshore Terrain

**Wind turbine model:** Gamesa



**Experimental wind turbine**

## Equipment

**Wind:** anemometers, lidar

**Precipitation:** None

**Other:** Air quality (aerosol dust), blade inspections

## Results

Air quality and damage at blades (in progress)

Influence of dust on wind profile



Funded by  
the European Union





# WindLab

Knowledge & Data Hub

<https://windlab.hlrs.de/>

**WindLab**  
Knowledge & Data Hub

[Datasets](#) [Organizations](#) **[Groups](#)** [About](#)

Search 

[Home](#) / **Groups**

 **What are Groups?**

You can use CKAN Groups to create and manage collections of datasets. This could be to catalogue datasets for a particular project or team, or on a particular theme, or as a very simple way to help people find and search your own published datasets.

Search groups... 

**3 groups found** Order by: Name Ascending 

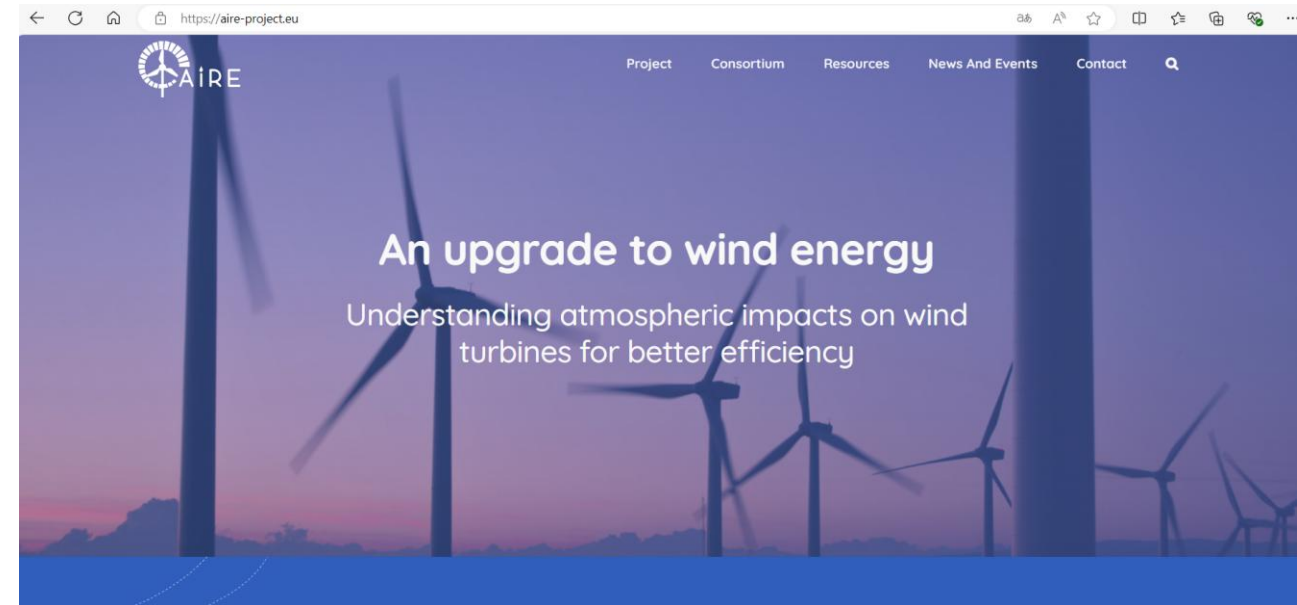
**AIRE**  
9 Datasets

**FLOW**  
6 Datasets

**MERIDIONAL**  
7 Datasets

# AIRE: the Newsletter & the Webpage

aire-project.eu





A lot of information can be extracted from **MRR and disdrometers** that is very useful for improving wind turbine design and operation (specially for blade erosion).

**Calibration** is needed regarding traditional equipment (that could be installed in the commercial sites).

The understanding the **mutual influence of precipitation and wind** is crucial to increase power production and reliability

Investigation of the influence of dust on blade erosion and power performance.





# Thank you.

@ProjectAire

@Aire Project

[AIREproject@cener.com](mailto:AIREproject@cener.com)

[bmendez@cener.com](mailto:bmendez@cener.com)

