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Guidelines for the usage of scanning lidars for power curve verification

Motivation

Image: researchgate.net

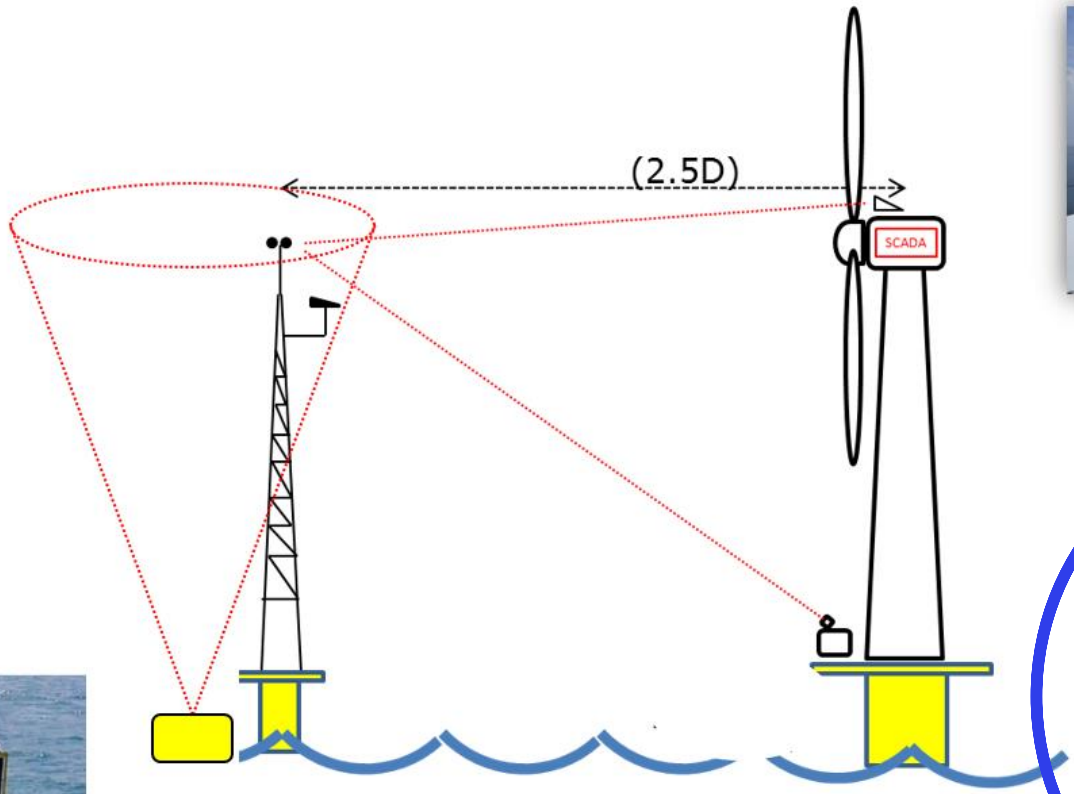
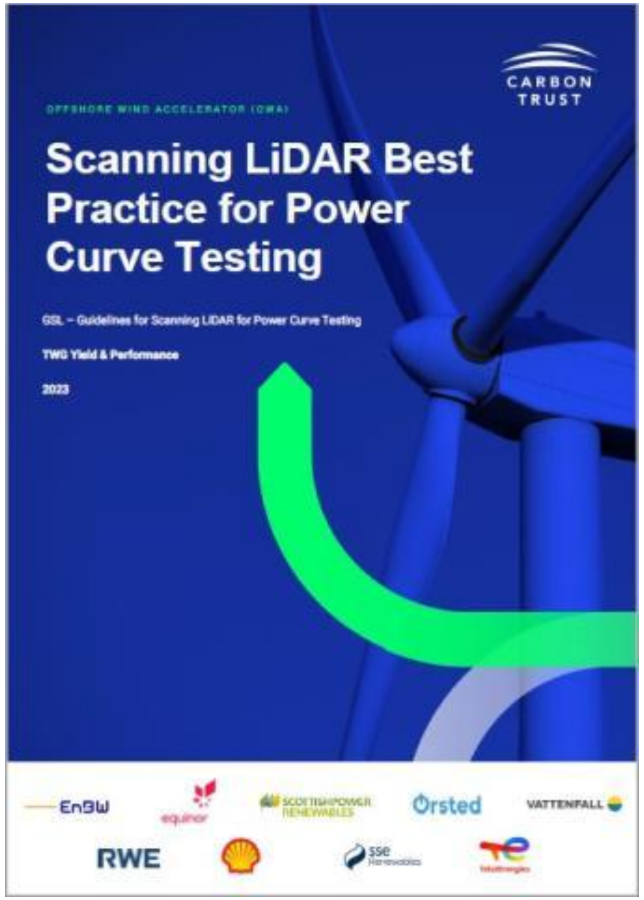


Image: zxmeasurements.com

Contents



https://www.carbontrust.com/our-work-and-impact/guides-reports-and-tools/guidelines-for-scanning-lidars-for-power-curve-testing

Lidar requirements

- **Physical** – footprint, transport, craning, water+salt, power
- **Performance** – ppi and hard target, ranges, angles, speeds
- **Accuracy** – indicative standard uncertainties – 1.5% speed, 10m range, 0.1° angles
- **Operational** – lens cleaning(!), network, auto-start, logging of important things
- **Optional** – remote power cycle, data transfer, flat surface on the scan head, lock

Wind Field Reconstruction (WFR) – keep things the same!

- Scanning lidars are really not very suitable for standardisation!
- Need to keep things as constant as possible between **calibration** and **application**, especially:
  - External processing software
  - Scanning trajectory
  - Pulse configuration
  - Acquisition time
  - Beam focus position
  - Measurement range
  - Beam elevation angle

Recommendations for scanning parameters

- Measure preferably at **one height,** and **never more than 3**
- Use an **arc-scan sector size between 40° and 90°**
- Scan at **1-2°/sec** in **one direction only**
- Aim for **at least one completed ppi scan per minute**
- Set the **beam focus** at the **target measurement range** (if you can)
- Use a **medium pulse length/duration** (100m/300ns)
- Try to make **radial speed measurements for every 1° of arc**

Calibration

Beam position quantities

- Pitch and roll inclinometers
- Scanning head homing position
- Measurement range check

Horizontal wind speed calibration

- Site requirements
- Setup requirements
- Lidar installation and configuration
- Data processing, filtering and results.
- Uncertainty

LOS speed check

- (valuable) additional check
- Similar to IEC 61400-50-3
- If significant deviation → investigate before continuing

PCV:

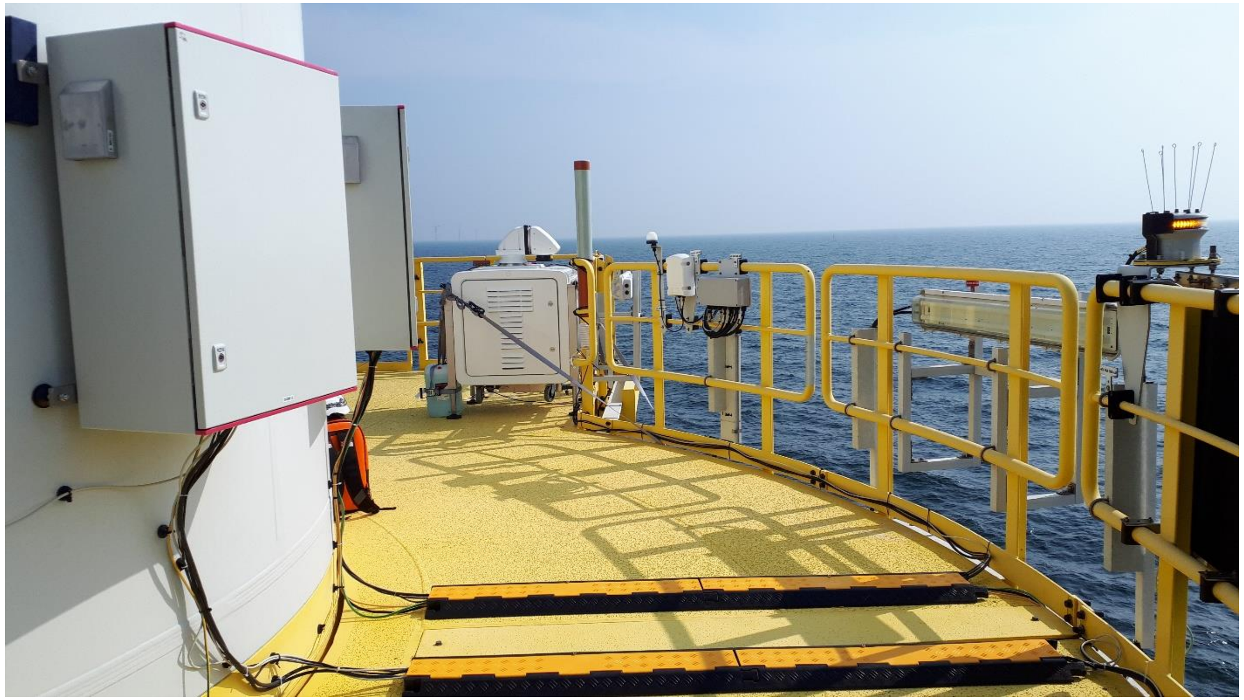
- Correct levelling and installation
- Inputs to PCV uncertainties

- Basis for PCV uncertainties

Campaign preparations

- Identify suitable position on transition piece:
  - Unobstructed view, stable position, hatch access, cable routing, personnel movement
- Prepare (assemble, calibrate, pre-configure):
  - Lidar, data logger, power & network infrastructure, camera, mounting hardware, survey equipment
- Obtain permissions for site work
- Setup time-sync, remote access & data pipeline
- Take pictures!

- After installation
  - Level the lidar using the zero-tilt inclinometer calibration values
  - Measure the instrument and hard target positions
  - CNRmap hard target to determine North-aligned azimuth offset



Measurement campaign

- Wind measurements can begin once the system is levelled & aligned
- Closely match the setup used in the onshore calibration
- Configure scan trajectory based on our suggested parameters
- Repeat lens wipe, hard target, and sea surface scans throughout campaign

- Monitor the devices and data collection daily (also automate checks)
  – Power & comms, humidity, range, scan config, disk usage, time-sync, tilt values, etc.
- Perform routine data checks (i.e. gaps, signal quality, beam angles, reconstruction result)
- Keep campaign logbook to document operational issues

- Plan decommissioning & post-campaign activities from the start
- Before removing equipment, check alignment and take pictures of everything
- Ideally, repeat the onshore work, i.e. post-campaign calibrations

When does it make sense to use SL for PCV?

- When the required measurement distance (2.5D) is close to or greater than a nacelle lidar range.
- In cases where nacelle access is difficult or roof space is small.
- When there are other measurement goals in the campaign besides PCV.

DTU