Understanding Lidar availability in the context of wind turbine control

Julien Tissot, Paul Mazoyer, Matthieu Boquet

To cite this version:


HAL Id: hal-03647975
https://hal.science/hal-03647975

Submitted on 21 Apr 2022

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L’archive ouverte pluridisciplinaire HAL, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d’enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.
Understanding Lidar availability in the context of wind turbine control

Julien Tissot, Paul Mazoyer, Matthieu Boquet
Leosphere

Lidar-assisted control spreading out

One critical-to-success factor of Lidar-assisted control is the availability of Lidar data, especially when wind turbine design and size relies on the preview of critical wind condition from the Lidar. We analyze here Lidar availability in a variety of atmospheric conditions.

Rotor Averaged Wind Speed definitions

**RAWS**: Rotor Averaged Wind Speed is a measure of the average longitudinal wind speed over the rotor area.
(Provided at 10 distances simultaneously ahead the wind turbine, from 50 to 200m, at a 4Hz frequency).

**RAWS availability**: is the percentage quantity of accepted RAWS for a complete data set.
(based on embedded quality control. Provided for each measurement distance independently).

**Global RAWS availability**: for the sake of clarity of this analysis, we define the Global RAWS availability as a representative indicator of RAWS availability over all measurement distances.
(its status is ok if at least 50% of distances have a RAWS status ok. Alternative definitions could be used, accordingly to the control algorithms involved. The conclusions of the atmospheric sensitivity analysis are expected to remain similar).

Results based on SmartEole project

The analysis is based on SmartEole research project which involves a Leosphere nacelle-mounted turbine control lidar deployed on a MM82 Senvion wind turbine. The entire 4 months data set collected during the field test totalizes over 360 000 000 measurements.

Global RAWS availability is analyzed as a function of different environmental conditions to characterize sensitivities:

- **Sensitivity to wind speed**
  (it is critical to assess availability for different wind turbine regimes)

- **Sensitivity to atmospheric visibility**
  (the atmospheric visibility is the most useful indicator of the aerosol load in the atmosphere (which impacts Lidar signal-to-noise). It also indicates conditions of fog, haze, clear sky. It is given in km)

- **Sensitivity to precipitations**
  (the impact of rain and snow is evaluated, defined in mm/h.)

Availability increases with wind speed

![Availability increases with wind speed](image)

- Lower availability at lower wind speed is explained by the blocking effect of blades.
- High availability from moderate to high wind speeds can be due to the aerosols dragging effect from wind.

Atmospheric visibility drives availability

![Atmospheric visibility drives availability](image)

- A very clear sky (high visibility) decreases availability because of reduced particles load.
- No fog data was registered during the field test.

Precipitations do not reduce availability

![Precipitations do not reduce availability](image)

- Precipitation droplets increase the Lidar signal-to-noise.
- No higher precipitation levels have been recorded.

Conclusions

The evaluation of Lidar measurement availability enables the implementation of correct wind turbine control strategies, while understanding its limitation led to developing performant mitigation strategies and get a trustworthy evaluation of the overall benefits of Lidar-assisted control.

Wind Iris TC (Turbine Control) Lidar is designed to maximize the availability of measurements. In this study, it is particularly promising to see increasingly high Lidar availability for wind speeds above 7m/s, a wind regime for which the Lidar-Assisted Control is key for mitigating wind turbine loads and safety.

Meet us at A1.150

[windeurope.org/summit2018](http://windeurope.org/summit2018)

#GlobalWind2018