Robust Low Cost Offshore Power Curve Tests with Lidar

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Testing the power performance of offshore wind turbines is an important part of operating an offshore wind farm. The key impediment to offshore power curve tests so far has been the high cost. Hitherto, it has been necessary to install an expensive offshore met mast to obtain the necessary measurements. The ability to install scanning lidar on the transition piece of an offshore wind turbine provides a valuable opportunity to eliminate the cost of the offshore met tower and make highly cost-effective measurements.

The set up needed to be compliant with the draft 2nd edition of the power curve test standard IEC 61400-12-1 [2]. This requires “ground based” lidar methods. Nacelle mounting is not compliant, but, mounting on the transition piece satisfies this requirement. A further IEC requirement is measurement at hub height 2.5 rotor diameters upwind of the test turbine.

IEC Requirements

IEC 61400-12-1 2nd edition (draft) [2], Annex L, describes the requirements remote sensing devices must fulfil to be considered for power curve tests. Section L.1 (General) states:

- “Only ground based remote sensing devices are used (e.g. nacelle mountings are not included)”

So floating and nacelle mounted Lidars are explicitly excluded from the relevant standard. Power production is compared to wind speed at hub height 2.5 rotor diameters upwind.

In situ comparison of Galion Lidar and mast

Accuracy is verified against reference cup anemometry both onshore and offshore. Measurements are suitable "where a horizontal distance between the location of the measurement device and its measurements is necessary" and "may be recommended [...] for a power performance assessment offshore with the Galion Lidar installed on the transition piece of the test turbine.” [5]

Conclusions

The methodology described for installing lidar on the transition piece of an offshore wind turbine complies with the draft 2nd edition of the power curve test standard IEC 61400-12-1 to the fullest extent possible without a met mast.

The results of measurements performed at Alpha Ventus and Sheringham Shoal confirm the suitability of this method.

The measurements showed excellent agreement with reference anemometry, with both correlation coefficient $R^2$ and regression slope $m$ exceeding 0.98% acceptance criteria.

The cost of the power curve test undertaken using this lidar method is less than 1% of the cost of the equivalent met mast based test.

Independent validations of the VAD scanning, the remote mast and the long term measurement campaigns have been provided by:

References

1. IEC 61400-12-1 1st edition, 2005
2. IEC 61400-12-1 2nd edition (draft)
5. Gottschall, J., Galion Lidar Performance Verification, Fraunhofer IWES, 2013

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