

Offshore Power Curve Tests for Onshore Costs: A Real World Case Study

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References

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Abstract

Testing the power performance of offshore wind turbines reduces project risk by establishing the compliance of those turbines with the power curves used when deriving pre-construction estimates of production. In addition, power curve tests can provide useful diagnostic information when undertaking preventative or reliability centred maintenance to minimise the downtime of offshore wind turbines.

The key impediment to offshore power curve tests has been the cost. Hitherto, it has been necessary to install an expensive offshore met mast to obtain the measurements necessary to characterise the incident wind resource with which the observed power production of the test turbine is compared.

Method

A Galion G4000 Offshore wind lidar was installed on the transition piece of AV07 in Alpha Ventus Wind Farm on 18th February 2013, along with two others which were installed on the nacelle.

One of the tasks scheduled for the transition piece mounted lidar was the measurement of the wind turbine power curve using the scan geometry indicated below to acquire data characterising the incident wind resource.

The results exhibited lower scatter than power curves obtained using the nacelle cup anemometry or the nearby FINO1 reference met mast.

Conclusions

- 1. Transition piece mounted lidar acquires the wind speed data needed to undertake power curve tests offshore
- 2. Directions to other wind turbines in the array are constant on the transition piece, but change with wind direction on the nacelle. Transition piece mounting allows the power curve tests of multiple offshore turbines during a

The ability to install scanning lidar on the access walkway of the transition piece of an offshore wind farm provides a valuable opportunity to make highly cost-effective measurements. The lidar can be used to implement scan geometries that allow wind data to be acquired at hub height 2.5 rotor diameters upwind of the test turbine as recommended by the standard for power performance assessment of wind turbines, IEC 61400-12-1.

The resulting cost of the power curve test is *less than 1%* of the cost of the equivalent met mast based test

Galion G4000 Offshore lidar on the transition piece of wind turbine AV07



Transition piece lidar power curve compared with FINO1 power curve



single test campaign

- 3. The transition piece is in effect "ground based", so guidance, standards and recommendations for ground based lidar can be used to support confidence in the results, such as the draft 2nd edition of the power curve test standard IEC 61400-12-1. is not possible for nacelle This lidar which is explicitly mounted from the scope of this excluded standard.
- 4. The costs of this technique, compared to met masts based techniques, are so low (less than 1%) that power curve tests offshore should be routine.





The power curves obtained using the wind speed as measured by the Galion and the wind speed as measured by the nearby reference mast FINO1 both show excellent agreement with each other, within the uncertainty of the met mast measurements.

The Galion arc scan measurement methodology was verified against the FINO1 reference mast approximately 900m from AV07. The results showed excellent agreement, consistent with onshore tests, with both correlation coefficient R^2 and regression slope *m* exceeding 0.98% acceptance criteria.

Scan geometry plan view



Scan geometry side elevation





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