Power Performance Assessment using Sodar in Complex Terrain

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Abstract

Wind turbines constructed in complex terrain present significant challenges in assessing their performance against the warranted power curve. A key challenge in assessing turbine performance is the measurement of the wind conditions with sufficient accuracy and at sufficient locations to be representative of the wind farm.

A potential solution for obtaining measurements is the use of remote sensing technology to undertake the site calibration and power performance assessment. To investigate this Meridian Energy conducted several power performance assessments at one of our complex terrain sites.

We found it was more cost effective to utilise two sodars at multiple test locations than to erect two masts at each test location. As met masts have high installation costs the portable sodars can easily be used for other project work once performance testing is complete.

The results provided useful insights into both the use of this technology in complex terrain and also its use in power performance assessment.

Objectives

- Understanding how remote sensing can be used for cost effective power performance measurement in simple and complex terrain.
- Recognise key steps in the assessing wind turbine performance using remote sensing.
- Determine requirements for the use of sodars in complex terrain and wind farms.
- Investigate areas of higher uncertainty or test failure from the use of remote sensing in complex terrain and wind farm construction/operation.

Method

Pre-construction site calibrations were undertaken for the proposed wind farm using a pair of sodar remote sensing devices at six turbine sites. A sodar modification with a line-of-sight radio link was incorporated, synchronising the pair of sodars to enable operation in close proximity to each other.

Complex terrain bias correction was included in the sodar analysis. Data was collected at the turbine location sodar concurrently with the upwind reference sodar, approximately two turbine rotor diameters from the turbine location, to define the site calibration relationship.

Post installation of the wind turbines a single sodar was returned to the location upwind of each turbine for a data collection period.

Overall combined results were evaluated and the individual turbine results compared with the warranty power curve and the nacelle wind speed derived power curve.

Results (cont.)

The test results showed similar trends to the nacelle wind speed derived results with a lower overall wind farm test uncertainty calculated from the multiple sodar tests (3.7%), compared to the nacelle tests (5.2%) at the same turbines.

In general a lower deviation from warranty power curves was found with the sodar results than the nacelle wind speed derived results in line with the estimated wind farm performance.

Conclusions

The process undertaken in this investigation has shown promise in the use of remote sensing devices to assess the performance of wind turbines with a cost effective approach, even in complex terrain.

Further investigation is required into the best use of the equipment, optimum length of monitoring period, contributions to uncertainty, applicability of IEC standards, potential for utilising lidar and also pitfalls in the test process.

Selection of turbines for testing and the placement of the sodars is a key aspect. Multiple tests better represent the wind farm and reduce uncertainty.

In summary, remote sensing is a cost effective method with clear benefits for performance measurements at multiple wind turbine locations.

References

5. Rovers T. Correction of sodar wind speed bias in complex terrain situations, Poster at EWEA2012, April 2012, Wellington, New Zealand

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