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Optimised management of blade erosion Understanding the cost of energy impact

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Abstract

Erosion of leading edges of wind turbine blades is a widespread issue, with potential for significant cost and revenue impacts, particularly offshore. The ORE Catapult has developed the blade leading edge erosion programme (BLEEP) focussing in this area.

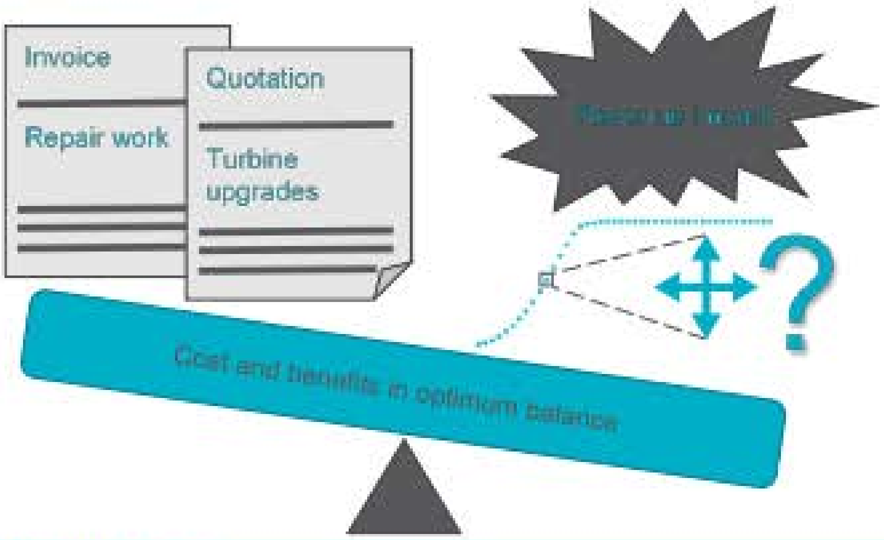
We present the results of a field study completed as part of BLEEP to measure impact on turbine performance of leading edge erosion at a commercial offshore wind farm. We describe the methodology used to quantify the performance impact of leading edge erosion and how improved understanding can be applied to improve financial yield by optimising the timing of maintenance interventions.

Objectives

To quantify the impact of blade erosion on cost of energy because:

- Cost of inspection and repair is known
- Cost of lost yield is **not known**
- There is limited robust evidence in the public domain on the real world effects of blade erosion

The motivation behind the campaign design was to accurately quantify the impact of erosion on AEP



Methodology

Lidar based power performance assessment was used to measure power performance of a test turbine exhibiting leading edge erosion on all blades.

By establishing an understanding of turbine power performance before and after blade repair it is possible to quantify the effect of erosion on performance. A key assumption of this methodology was that repair restored blades to as good as new.

It was essential to ensure that influences of factors with the potential to impact power performance such as turbulence intensity and air density were reduced as far as possible. This was achieved using a sensitivity analysis[1].

Methodology

Results

The turbine under test could be described as exhibiting moderate erosion on all blades. Full inspection reports along with a blade inspection on initiation of measurements were available to the project team.

The results of this measurement campaign at a UK offshore wind farm showed that an uplift of between **1.5** and **2** percent of Annual Energy Production (AEP) was credibly attributable to repair of blade leading edge erosion. This varied dependent on the wind speed distribution and mean wind speed used when transforming a measured shift in the power curve to an AEP value.

Following on from this pioneering work the ORE Catapult has convened a Joint Industry Project with 7 industry partners which will repeat this methodology in different test conditions. The JIP will shed light on the grey area of the cost of energy impact of leading edge erosion for the benefit of the whole industry.

Conclusions

Erosion remains a significant issue for the wind power industry. Whilst many potential research projects, innovations, test methodologies and technology improvements may be able to help the industry better deal with the phenomena in time, a benefit available in the short term is the optimisation of blade maintenance informed by an understanding of both the cost and the benefit of repair work.

It has been demonstrated that using turbine mounted lidar for power performance assessment can provide valuable insight into turbines in the operations and maintenance phase of the project lifecycle.

However this measurement represents only a single result from a single turbine type, site, and level of erosion. As such it is extremely important that further studies are performed to build a more complete picture of how the level of erosion, site, turbine and atmospheric variables influence the impact of erosion on performance. It would be particularly interesting to repeat this methodology on a turbine with more severe levels of erosion.

The methodology developed and executed as part of this campaign may also be usefully applied to assessment of proactive turbine upgrades such as aerodynamic or control improvements as well as to assessment of the impact of leading edge protection products on power performance.

Acknowledgements

It would not have been possible to establish this valuable initial result without the positive and pro-active engagement of our partner and site host; Centrica.

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References

1. Results from the Offshore Wind Accelerator (OWA) Power Curve Validation using LIDAR Project Alex Clerc, Peter Stuart, Lee Cameron, Simon Feeney, Ian Couchman (FNC) 14 April 2016 WindEurope Workshop, Bilbao