Roussas-Claves wind farm optimisation through rotor balancing

PO.163

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Abstract

Results from an optimisation campaign performed by RES on the Roussas-Claves wind farm using Sereema's Windfit® are presented. The six Vestas V66 wind turbines of the farm have been equipped with Windfit® since November 2016.

Windfit® is based on both smart sensors and IoT technologies. It is composed of a sensing box, installed on the wind turbines, that communicates acquired data to a cloud server. Data is then analysed and results are made available through an online dashboard. Each Windfit® box contains multiple sensors, such as accelerometers, a magnetic compass and environmental sensors. A continuous acquisition from these sensors combined with specific data analysis allows a monitoring of the operation of wind turbines, namely in terms of their rotor balance.

Windfit's® rotor balance diagnosis is based on the analysis of high frequency acceleration data. From the data analysis, two out of the six wind turbines were identified as presenting an aerodynamic imbalance of the rotor.

The on-site verification of the TC Marks confirmed both diagnosis and showed that both imbalances were caused by pitch shifts of one of the blades.

Due to manufacturer's limitations, only a partial correction of the shifts was possible. Nonetheless, the analysis after the correction shows a reduction in the acceleration levels caused by the imbalance and an increase of the wind turbine's performance through a power curve improvement.

Figure 1: Windfit box set on the met mast of a Vestas V66 of the Roussas-Claves wind farm by RES

Objectives

Present a new way to optimise wind turbines performance and life expectancy through the use of smart sensors and IoT.

Demonstrate the application of these technologies for an operating wind farm in terms of rotor imbalance diagnosis and correction.

Compare the wind turbine's behavior before and after the corrective actions in order to demonstrate the importance of wind turbine optimisation.

Methods

The wind farm optimisation campaign resulted from the following actions:

- RES identified a loss of production on the wind farm;
- The wind turbines were equipped with Windfit®;
- Windfit® identified the defective wind turbines and pinpointed the source of underperformance, in this case the rotor aerodynamic imbalances;
- On-site verification of the diagnosis and correction of the rotor imbalances;
- Analysis of the wind turbines behaviour after corrections to validate the gain in terms of energy production and life expectancy.

Results

The rotor balance analysis identified 2 out of the 6 wind turbines on the farm presenting an aerodynamic imbalance. These diagnoses were confirmed on-site by RES by who verified the TC Marks of the individual blades on both wind turbines: a shift on the pitch of one blade of 1.6 degrees and 1.7 degrees was identified, respectively.

The correction was done by screwing/unscrewing the rod of the hydraulic cylinder of the pitch of the affected blade. Due to mechanical limits on the stroke of the hydraulic cylinder, only a partial correction (final shift of 0.7 degrees) was done on the first wind turbine and the complete correction is scheduled for the second wind turbine. The results after correction show a significant reduction in the 1p acceleration levels as shown in figure 2: the accelerations caused by the rotor imbalance were reduced by 50% with the partial pitch shift correction. In addition, an improvement of the power curve for the first wind turbine was attained, the gain in production is estimated at 2% AEP. To illustrate this gain, the average normalised power curves before and after correction are presented in the figure 3.

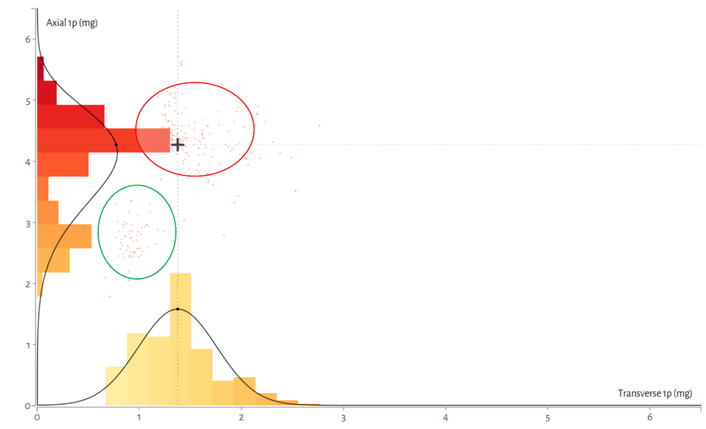

Figure 2: Comparison of the acceleration levels at the 1p frequency in both axial and transverse axis before and after pitch shift correction. The individual values before and after correction are encircled by the red and green circle respectively

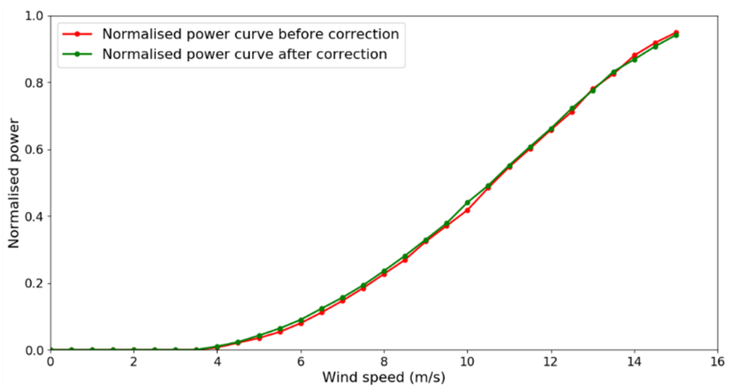

Figure 3: Average normalised power curves before and after the partial pitch offset correction. The improvement after correction is estimated at 2 % AEP

Conclusions

Wind farms present an important margin of optimisation. The results obtained with Windfit® for the Roussas-Claves wind farm are presented and they show the potential in the improvement of currently operating wind turbines by rotor balancing.

Aerodynamic imbalances of the rotor were diagnosed, confirmed on-site and corrected. A comparison before and after the correction shows a reduction in the efforts on the structure, increasing its life expectancy, and an improvement in the power curve, increasing the power production.

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