NOVEL TECHNIQUES TO DETERMINE RELIABILITY AND PERFORMANCE OF WIND TURBINES

DNV·GL

Introduction

Owners and operators continuously seek ways to improve turbine performance. Typical inefficiencies include:
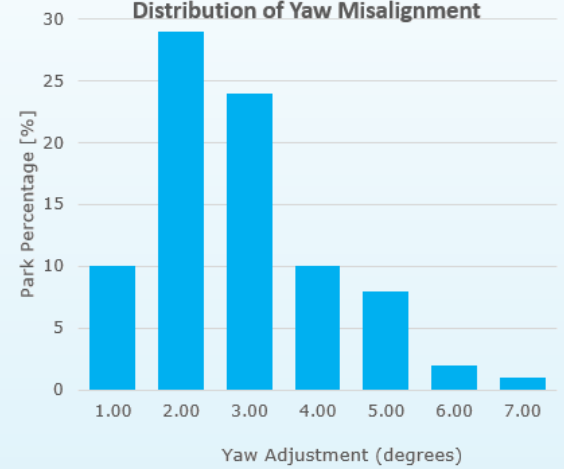
- Yaw misalignment and
- Pitch misalignment

Data resolution of 10 minutes is typical. Because turbine pitch and yaw controllers' response time is ~1 second, the analysis of 1 Hz data may prove to be valuable.

Power Ratio vs. Off Yaw

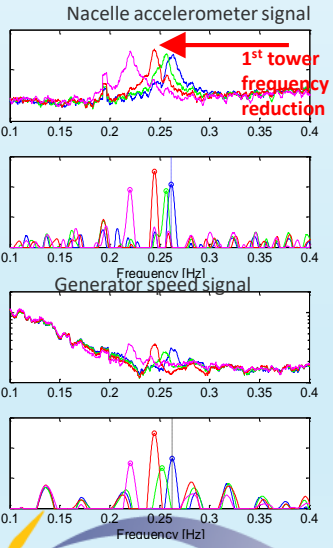- Avg(T1_pwr/T2_pwr) — Cos-squared — # of Datapoints
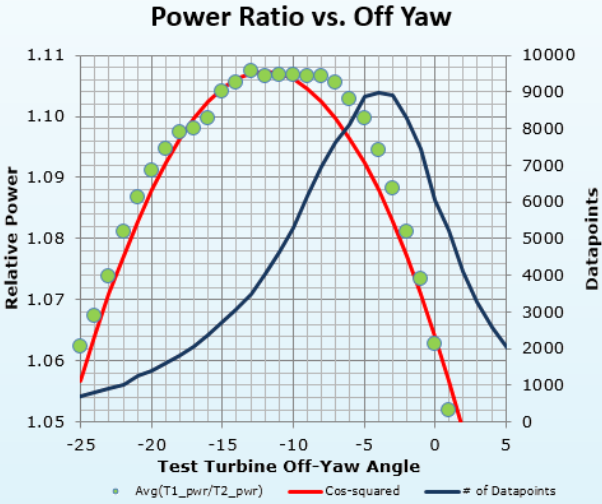
Results

- A 2° pitch misalignment was detected; it was later corrected.

- This leads to a reduction in loads, but also a material ~2% annual energy production (AEP) gain.

- Yaw misalignment analysis shows that ~10% of turbines were > 5° yaw misalignment, which can lead to a >~1% AEP gain.

Distribution of Yaw Misalignment

Pitch Misalignment

Frequency analysis of 1-s data

Filtering

Identification of tower frequency

Nominal stiffness
40% stiffness reduction
60% stiffness reduction
80% stiffness reduction

Nacelle accelerometer signal

1st tower frequency reduction

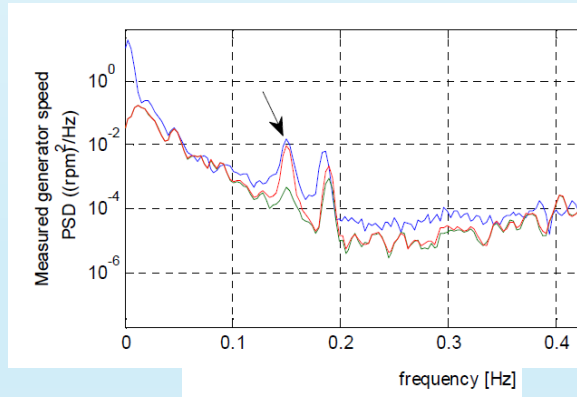Generator speed signal

Methodology

Pitch Misalignment

- Calculate and track the peak frequency for all periods and for all turbines.

Yaw Misalignment

- Calculate and track the power ratios between "side-by-side" turbines as a function of "yaw error".

Pitch Misalignment

Summary

1. Our results show that 1 Hz data can be used to detect both yaw and pitch misalignment.

2. ~10% of turbines exceeded >5° yaw misalignment which can lead to >~1% AEP gains when corrected.

3. Using data analytics can be an extremely powerful way to monitor all turbines throughout the life of the project to ensure maximum efficiency.

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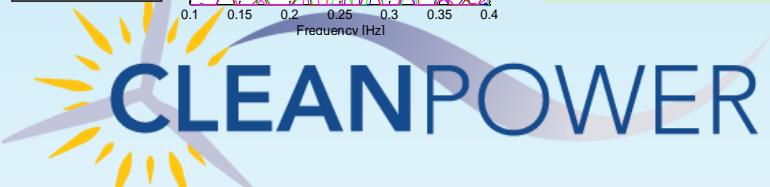
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