

Delfos¹

**Impact of pitch system
underperformance on wind turbine
production:
a scada data-based approach**

Samuel Lima - CTO

samuel.lima@delfos.energy

➤ Energy in maximum performance



Foundation: **2016**



Employees: **53**



Intellectual Property: **05**
Registered Softwares



Patents under review: **02**

Delfos Headquarters



Barcelona,
Espanha

Delfos Latam



Fortaleza, Brasil



Rio de Janeiro, Brasil



Technology company focused on
**predictive maintenance and
digitalization solutions** for renewable
energy plant optimization

+12 GW

+12 GW of **monitored** power
Wind, solar, and hydro energy
sources

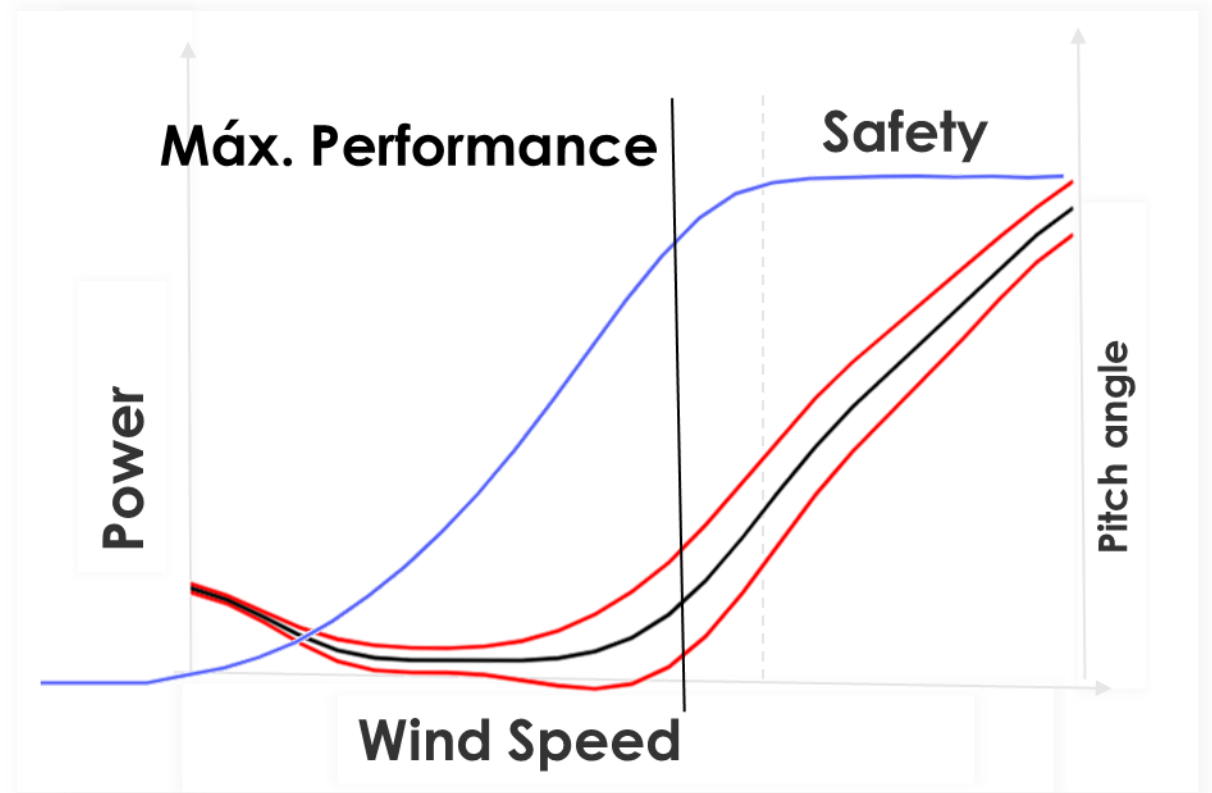
+1950 WTG monitored



100+ performance and fault
prediction algorithms

Introduction and Objective

What is the function of the pitch system in a variable-speed turbine?



Monitoring Pipeline for identify pitch-related underperformance



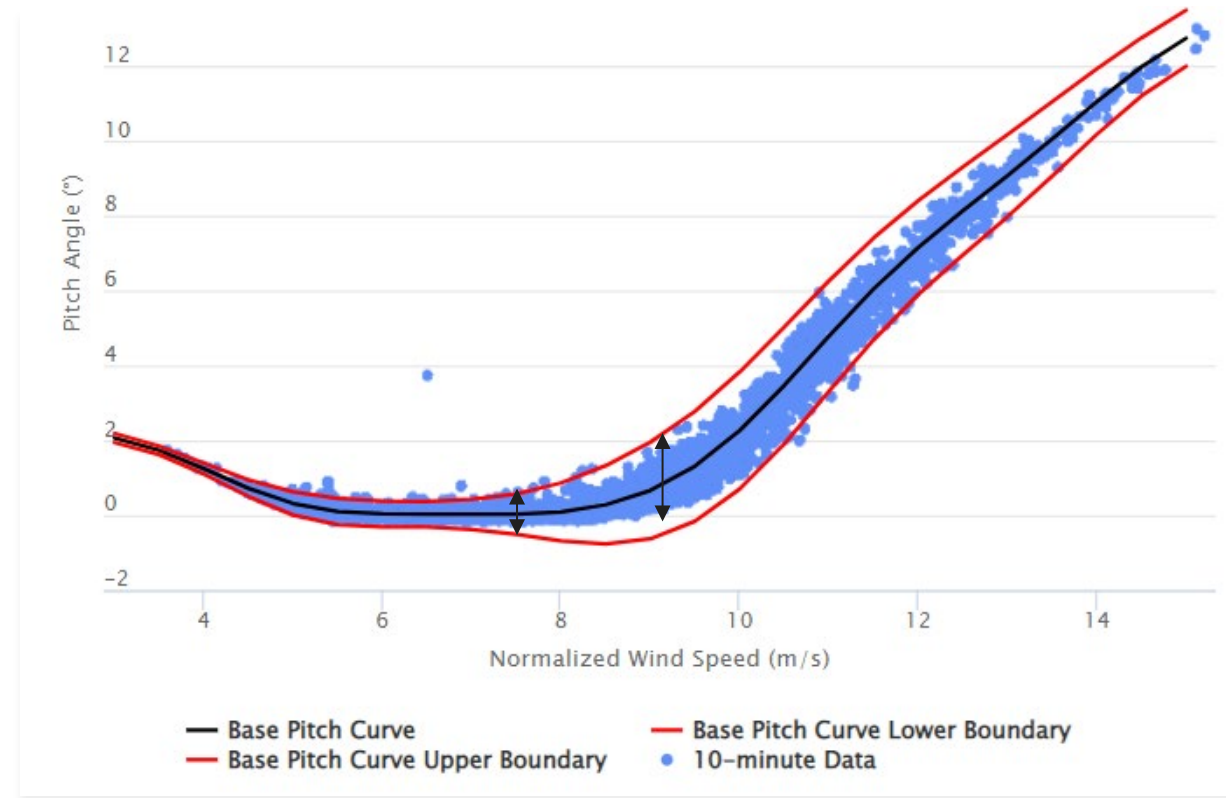
Learning the pitch system behavior

Challenges

- The pitch angle vs. wind speed function is a characteristic of each wind turbine model.
- Greater variability of the angles for higher velocities – heteroscedasticity

Gaussian Process with Heteroscedasticity

- Central trend of the relationship between variables
- Probability of the expected value being close to the central trend





Nacelle Anemometer Monitoring

Linear correlation between two nearby anemometers

Selection of the anemometer pair

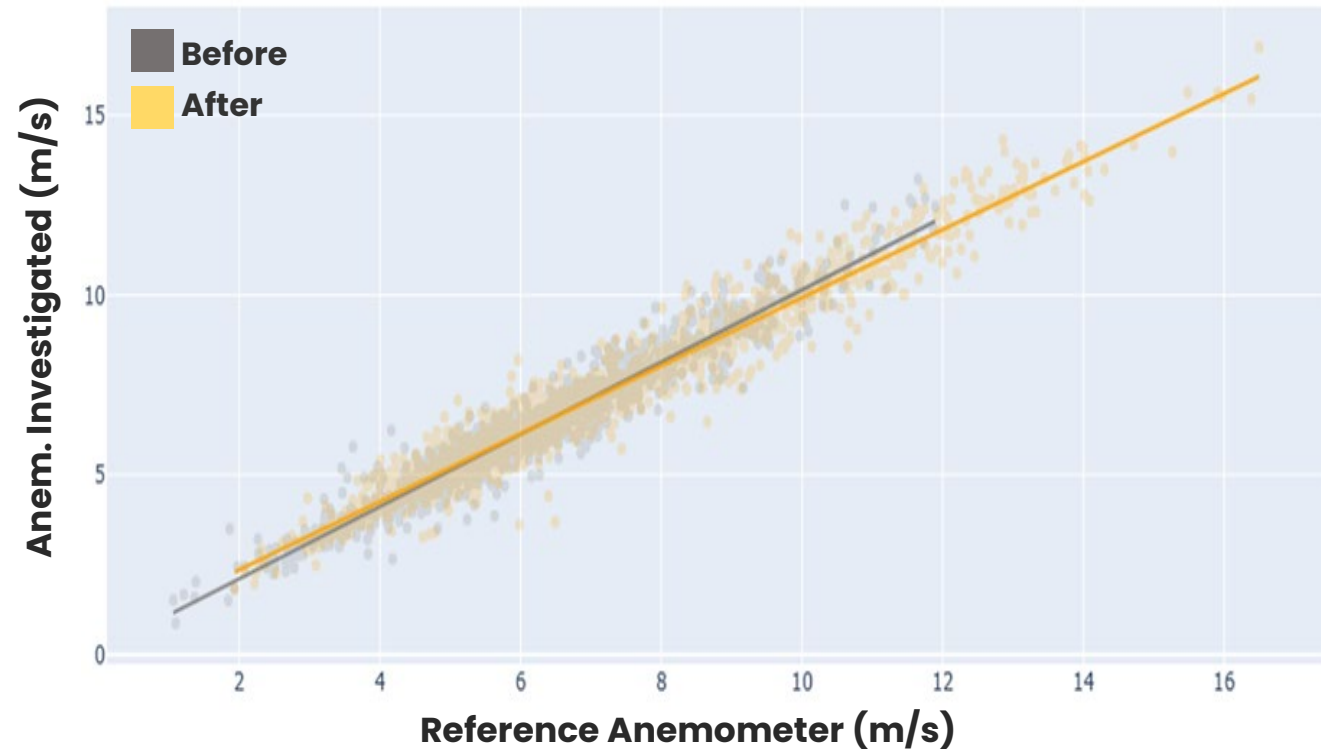
- Temporal shift analysis
- Good linear correlation

Filters and treatments

- Measurement outliers
- Wake effect

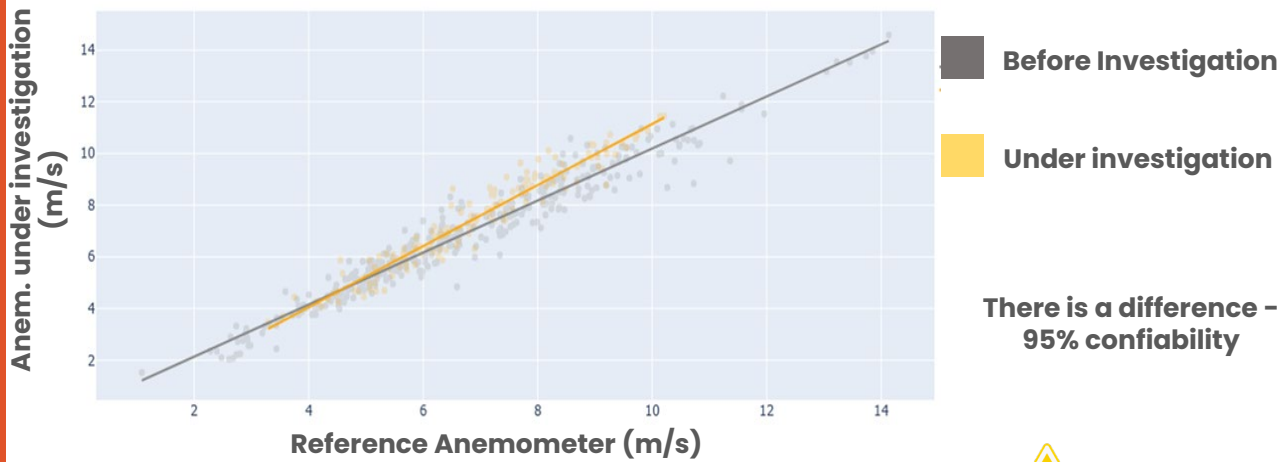
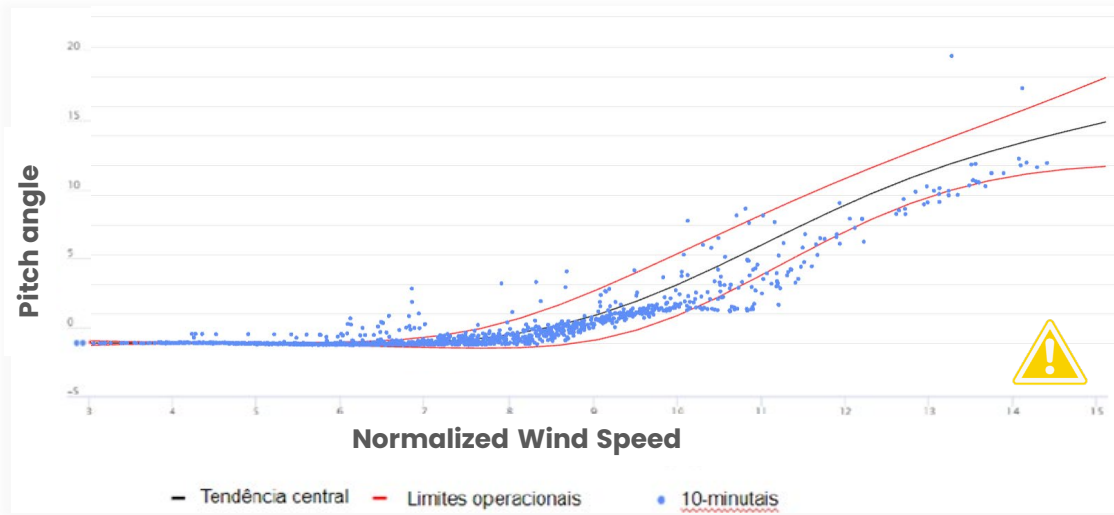
Line similarity analysis

- Null hypothesis: The lines are identical

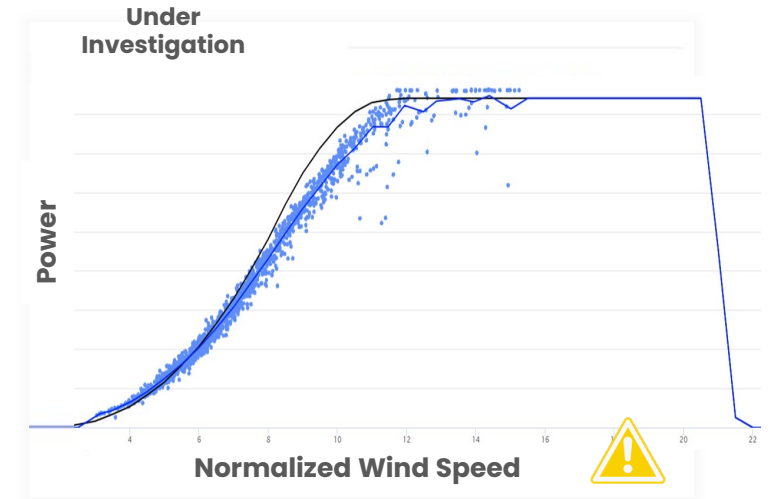


Case 1: Nacelle Anemometer Anomaly

Nacelle Anemometer and Pitch System Monitoring

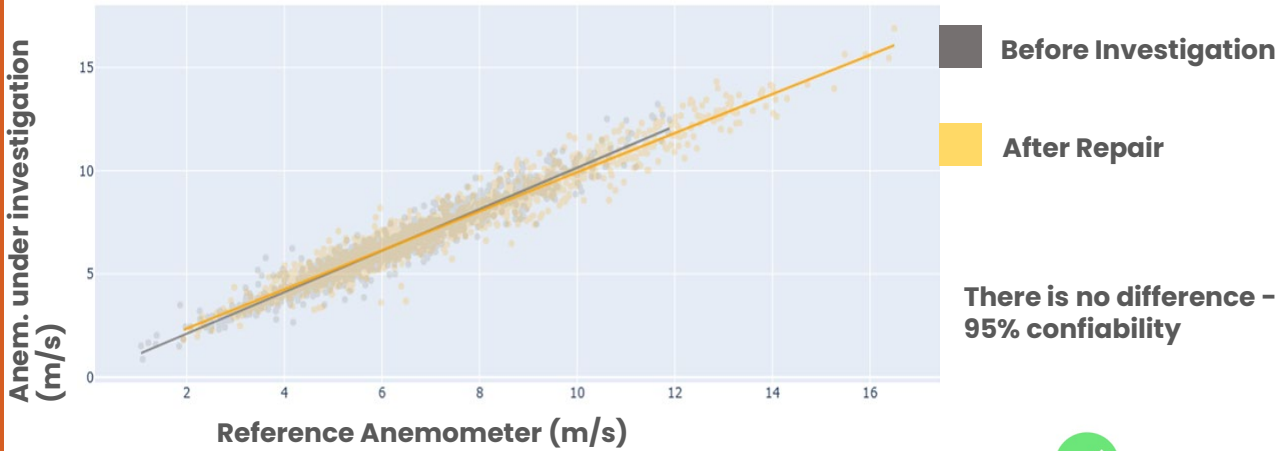
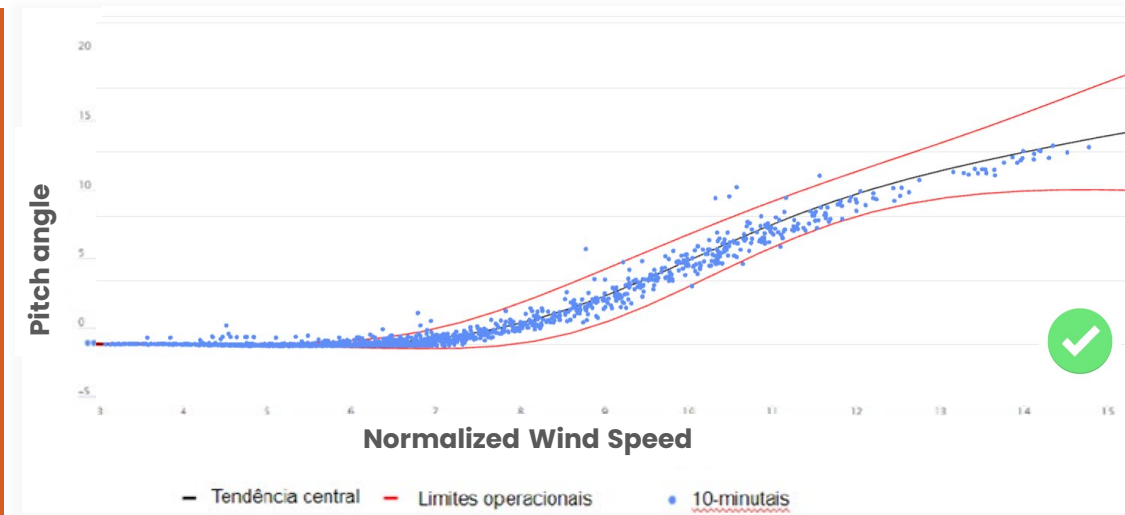


Performance Monitoring

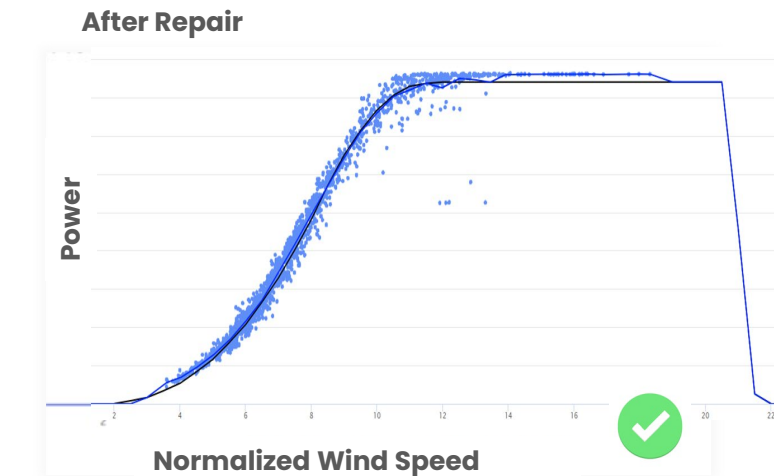
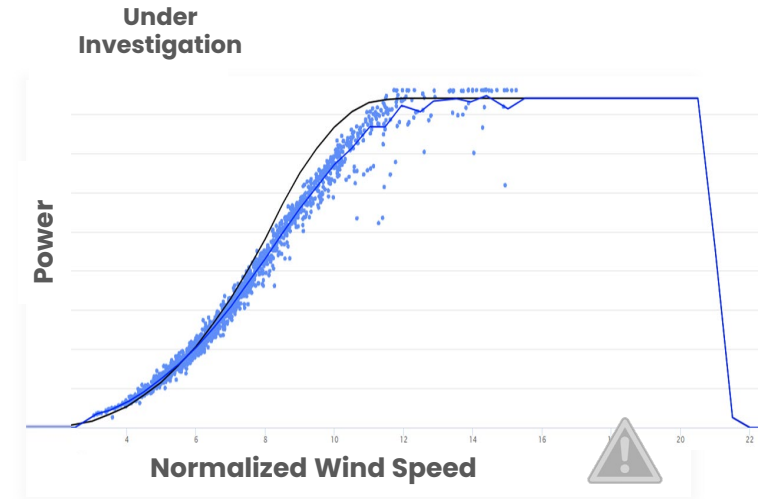


Case 1: Nacelle Anemometer Anomaly

Nacelle Anemometer and Pitch System Monitoring

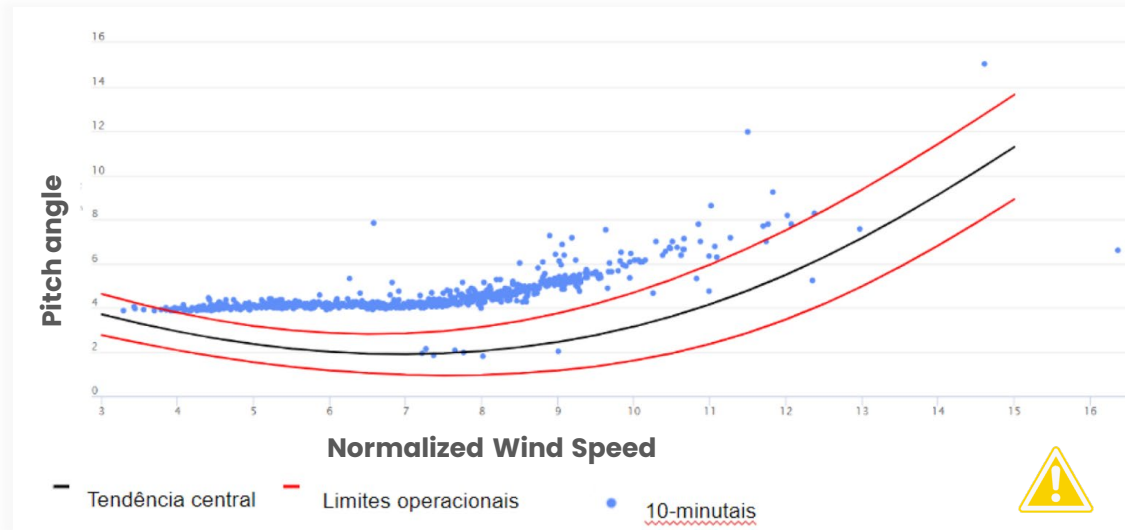


Performance Monitoring

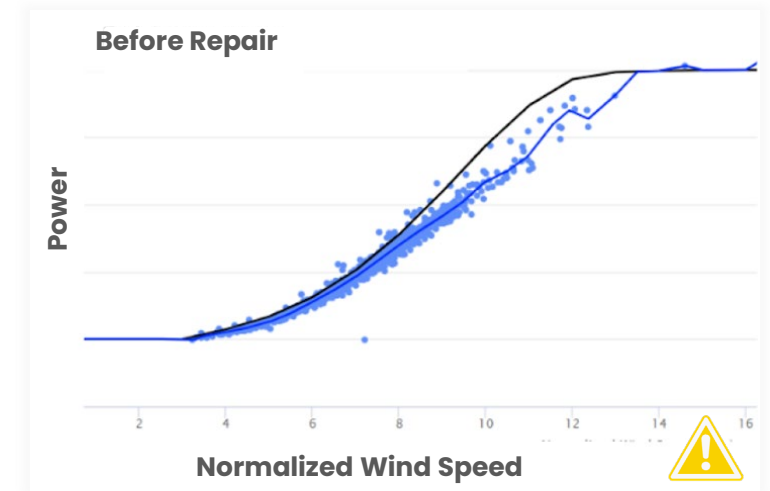


Case 2: Pitch system Anomaly

Nacelle Anemometer and Pitch System Monitoring

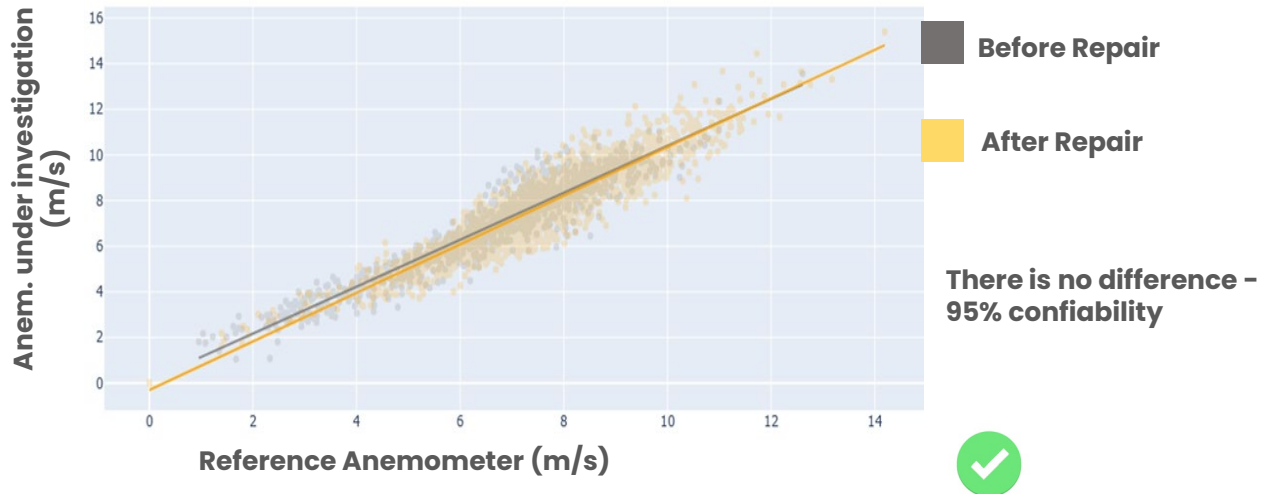
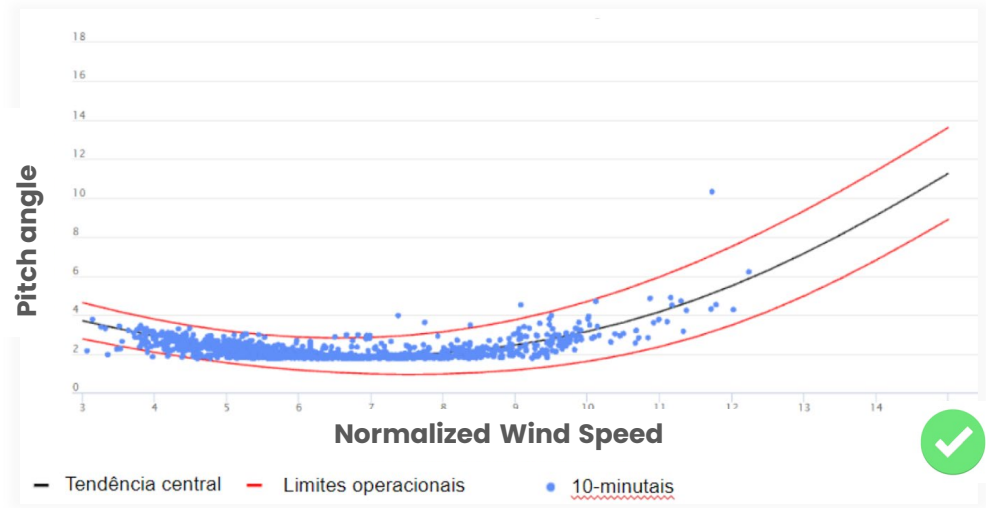


Performance Monitoring

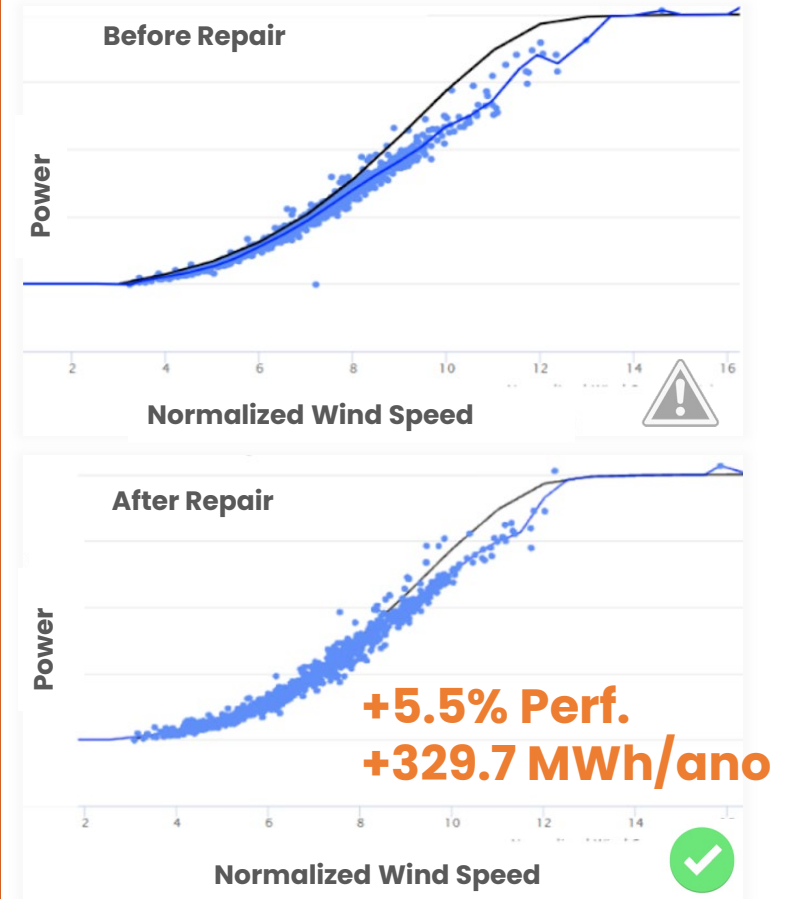


Case 2: Pitch system Anomaly

Nacelle Anemometer and Pitch System Monitoring



Performance Monitoring



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**Thank
you!**

 samuel.lima@delfos.energy

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