The importance of both physics and data-driven models for improving maintenance strategies of offshore wind farms

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WindEurope 2022

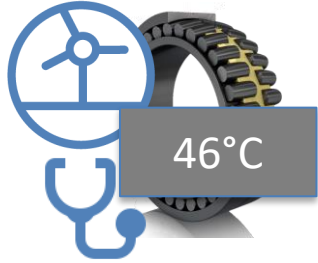**IBERDROLA** ROMEO

Internal Use

Offshore Wind O&M

O&M Costs (maintenance + downtime): driver for LCOE

Condition based maintenance (CBM): most viable strategy

Digitalisation: necessary for CBM; involves a lot of decision making

Domain expertise: important for decision making

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Data Scales in Offshore Wind
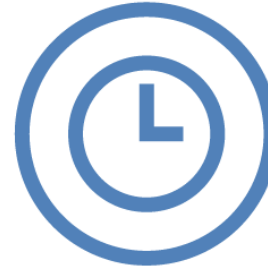

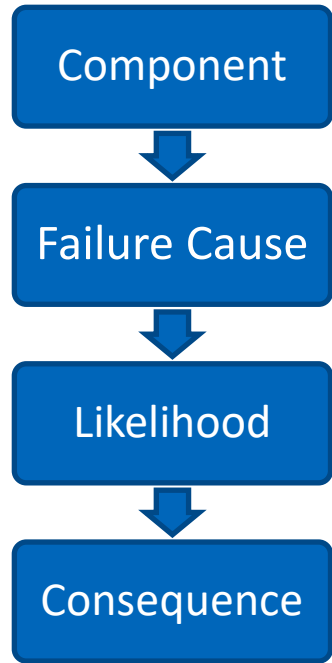**Bearing Temp.**

1 Signal

X

Complete Asset

40-100 Signals

X

24-7-365

52,560 Measurements

X

Fleet

Thousands of Assets

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Which components to monitor?

Component → Failure Cause → Likelihood → Consequence
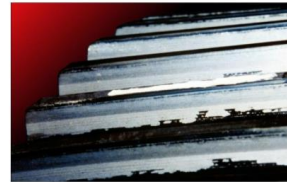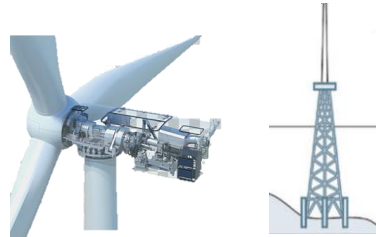
[Image: nawindpower]
Micropitting on Gear Teeth

Risk Quantification →

Downtime | Environment
Cost | Safety

Criticality Score → Low risk → Low Priority Components

High risk → Monitoring Options → Develop

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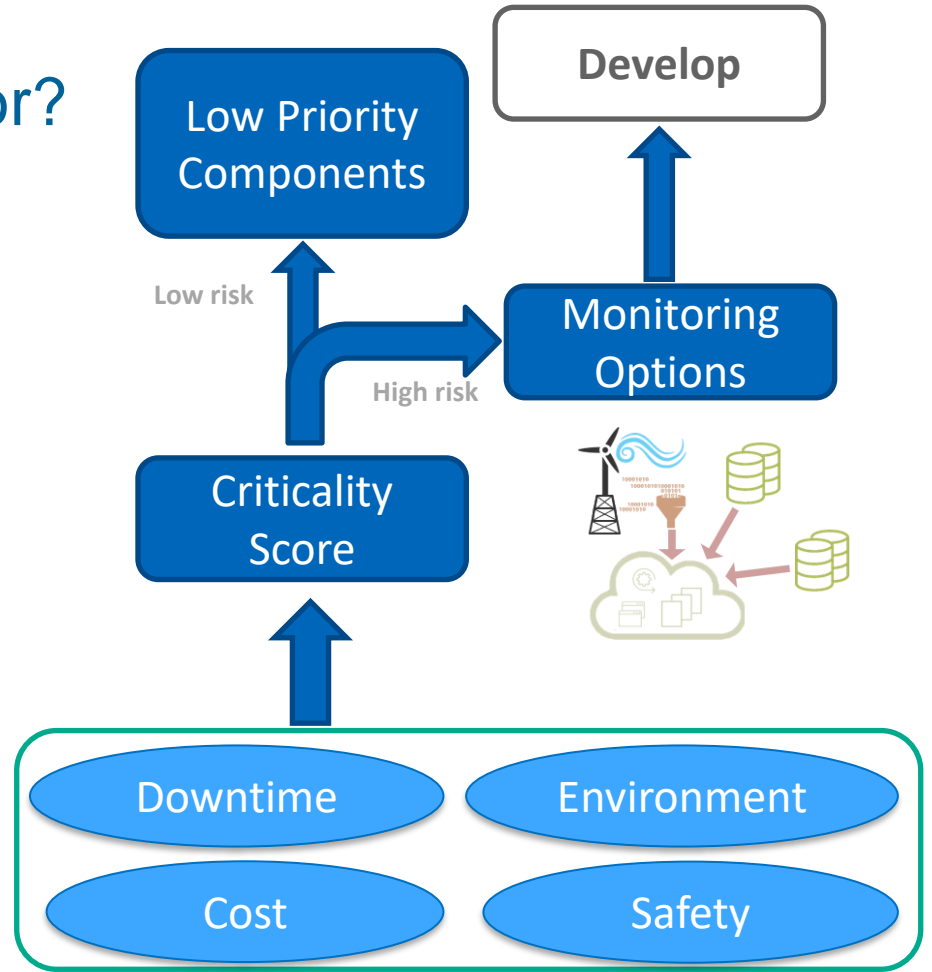
Model Building
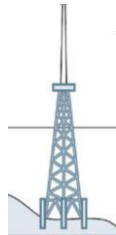
Wind Turbine

IBM

Adwen   eDF

Foundations

RAMBØLL

Physics Based

Data Driven
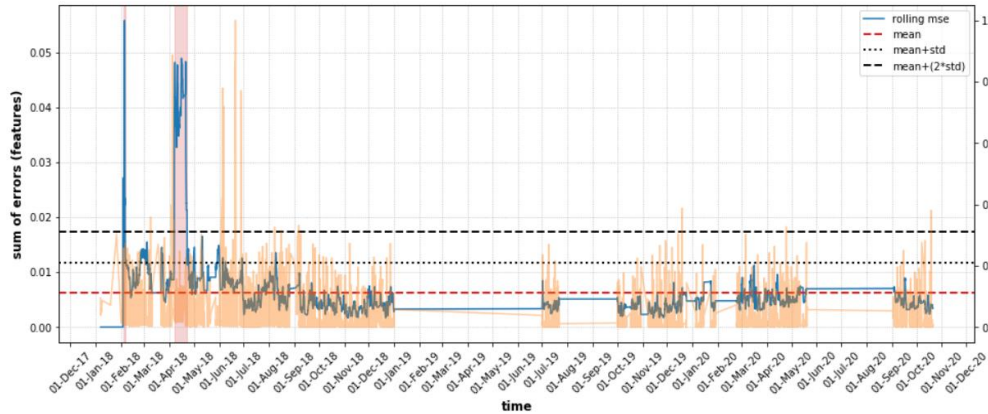
Physical understanding of failure modes

Machine learning
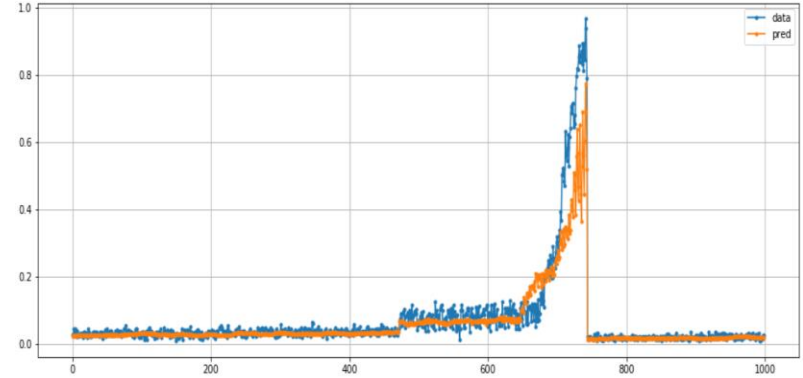
Wikinger

Teesside

East Anglia 1

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Wind Turbine Models
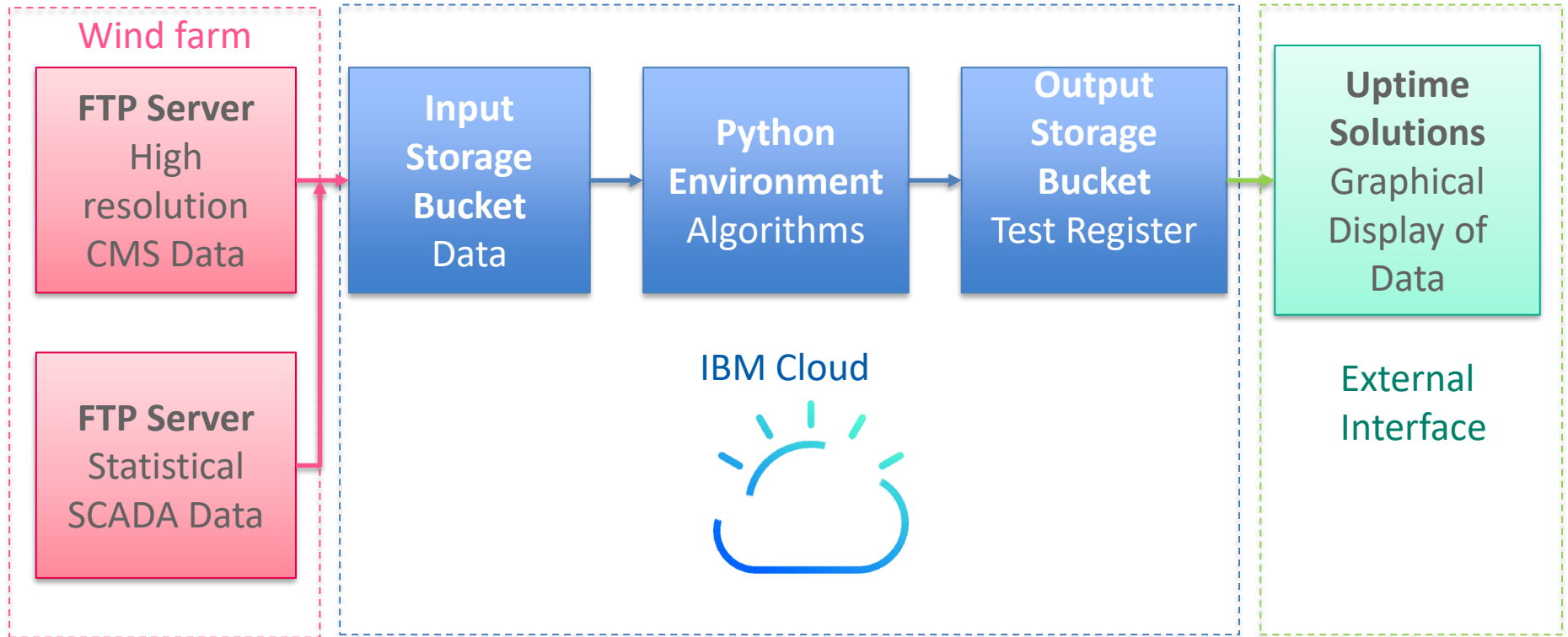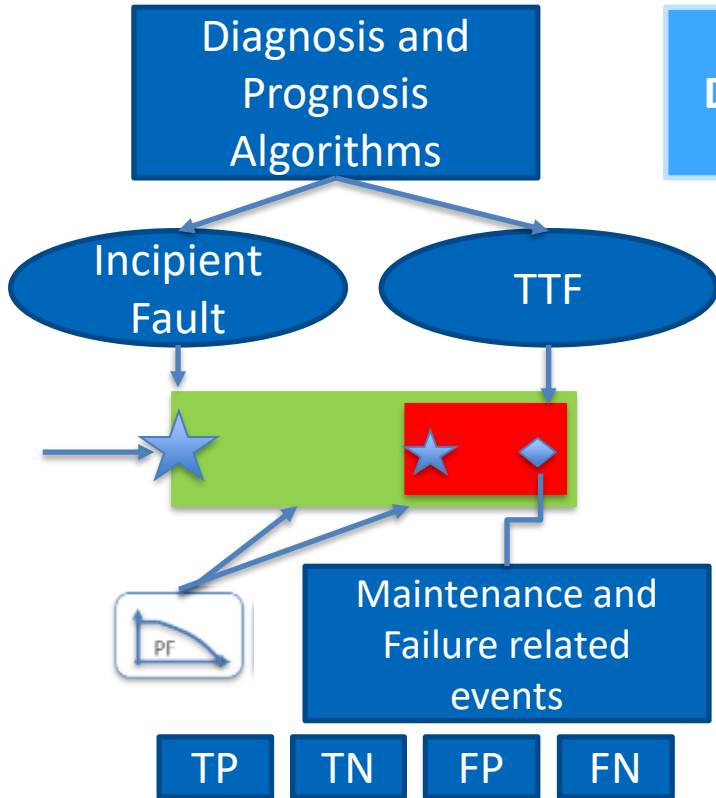

Anomaly detection module output

Forecasting module output

- ➤ Data driven models using neural networks
- ➤ Anomaly detection
- ➤ Bearing indicator forecasting (based on domain knowledge)

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Data Integration

FTP Server
High resolution CMS Data

FTP Server
Statistical SCADA Data

Input Storage Bucket
Data

Python Environment
Algorithms

Output Storage Bucket
Test Register

Uptime Solutions
Graphical Display of Data

IBM Cloud

External Interface

Graphical representation of the hardware and software components

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Evaluation

Diagnosis and Prognosis Algorithms

Incipient Fault

TTF

Maintenance and Failure related events

TP TN FP FN

Technical Evaluation

Decision Making

Decision Trees

Actions

O&M Cost Model - Predetermined/CBM

Balance of costs
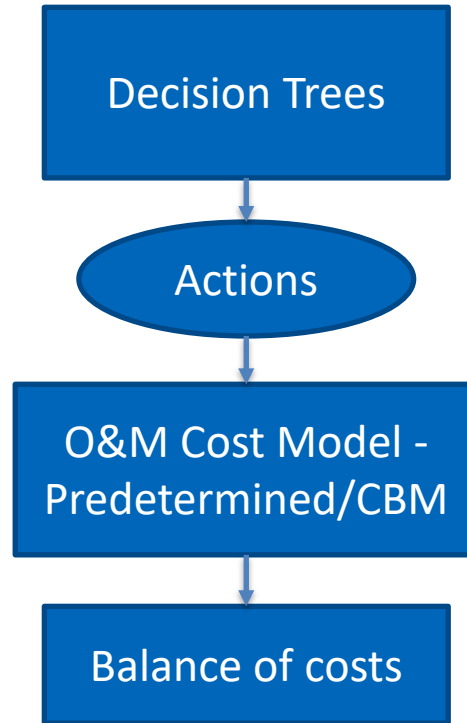
Economic Evaluation

8

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Lessons learned

- ♣ Engineering/ domain expertise : important for model selection, model building and evaluation

- ♣ Data engineering and data integration is a very crucial element

- ♣ Iterative and long term evaluation of models needed before used for decision making

Intern

Thank you for your attention!

✉ skoukoura@scottishpower.com

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Internal Use