

WIND FARM CONTROL TO MEET GRID AND O&M REQUIREMENTS

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Presentation Outline

- Aims and Objectives
- Novelty of Work
- Development of Wind Farm Model
- O&M Data Analysis
- Results
- Conclusions

Aims and Objectives

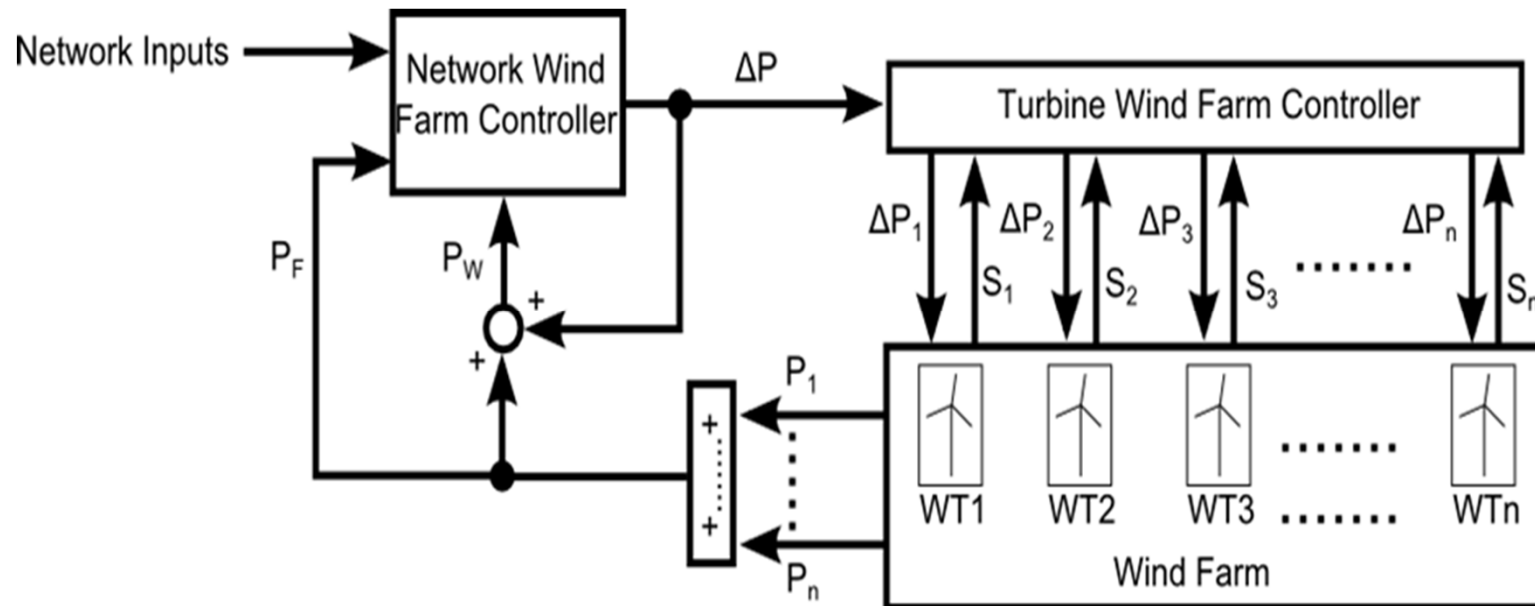
The project's work programme consists of the following tasks:

- Selection of suitable wind turbine and wind field models capable of representing wake interactions.
- Construction of a model of the Supergen Wind Exemplar Wind Farm of 169 5MW turbines.
- Determination of a suitable specification of the wind farm controller (input for the specification should include O&M and repair strategies).
- Design and assess performance of wind farm controller.

Novelty of Work

- Creation of a wind farm model capable of representing wake interactions between wind turbines.
- Development of a wind farm level controller able to change the power output of the wind farm, allowing the operator to control the wind farm as a conventional power plant.
- Analysis of the O&M failure data from offshore multi-megawatt wind turbines. This analysis included the investigation of how the failures were affected by site conditions.
- Creation of a power network model (based on the B2 boundary) to check how the wind farm can provide ancillary services to the grid.

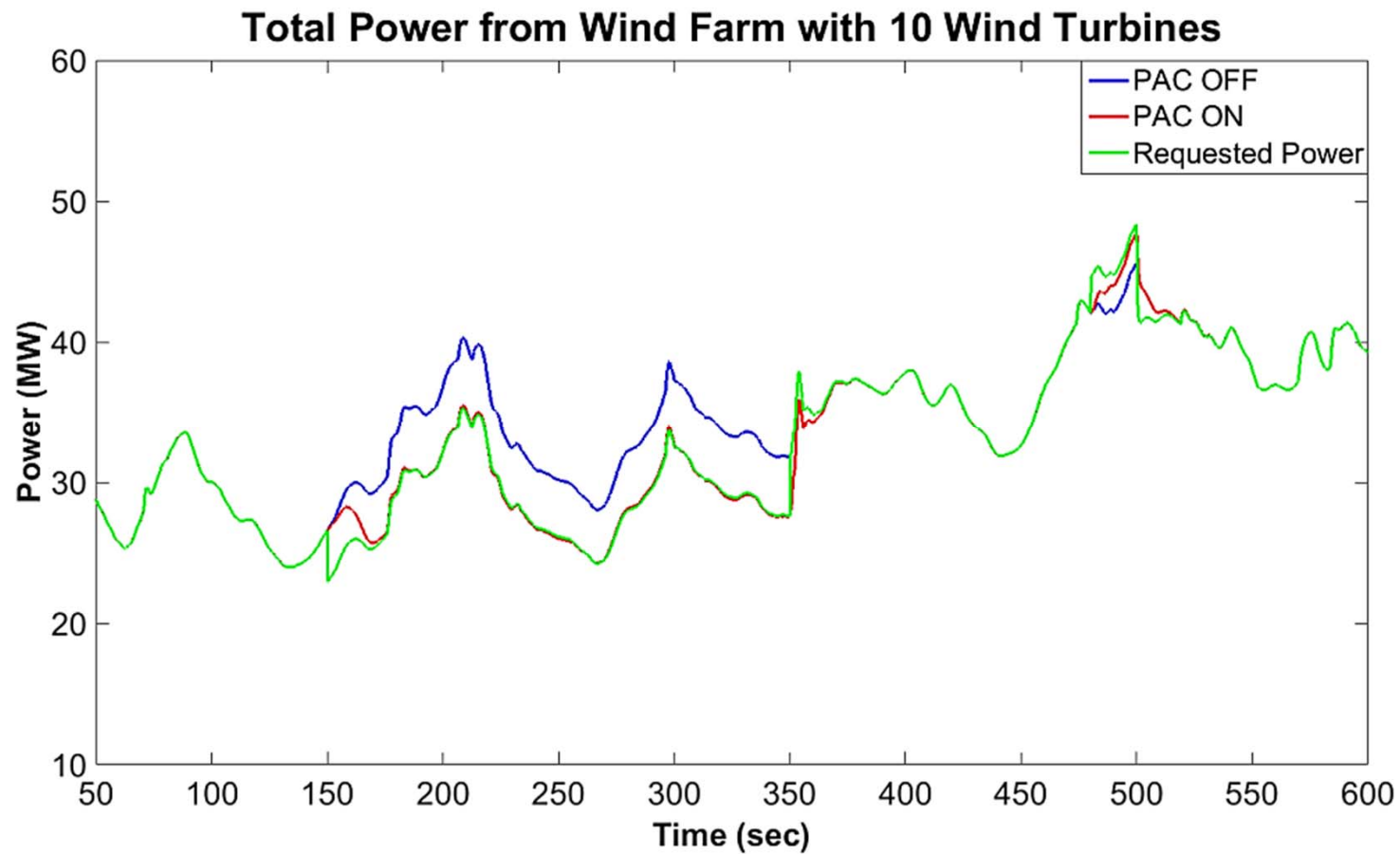
Overview of Wind Farm Model



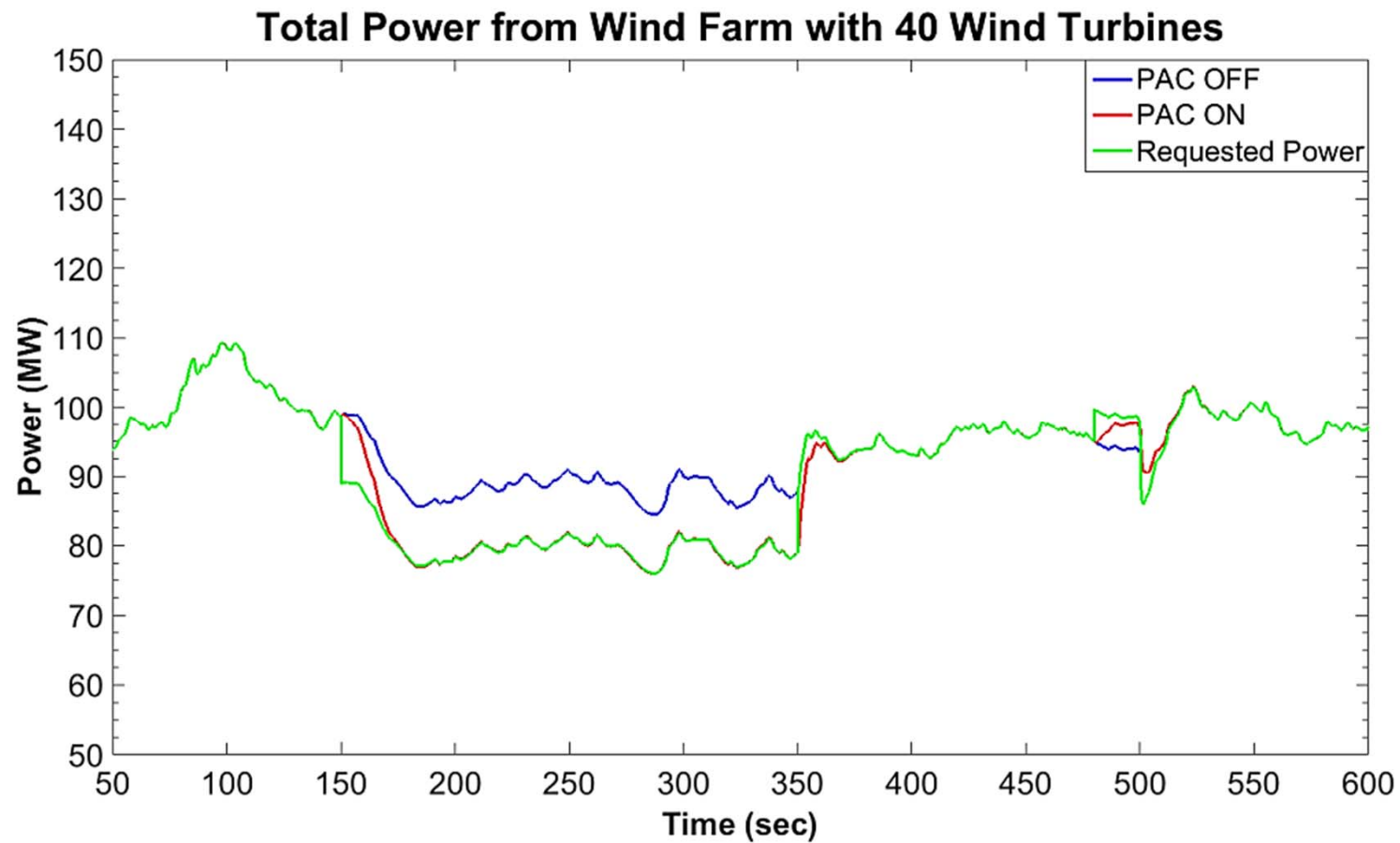
Development of Wind Farm Controller

- All simulation results presented are performed in Simulink.
- The two wind farms consist of 10 5MW Supergen wind turbines and 40 5MW Supergen wind turbines (i.e. 5 rows and 8 columns).
- Lateral distance between turbines in a row is 400m and the longitudinal distance between turbines in a column is 800m.
- The wind farm controller ensures that the total ΔP is distributed between all the available wind turbines.
- It is assumed that only some turbines are available to alter their power output (i.e. 7 turbines for the first model and 28 turbines for the second model). The rest are unavailable to alter their power outcome.

Simulation Results



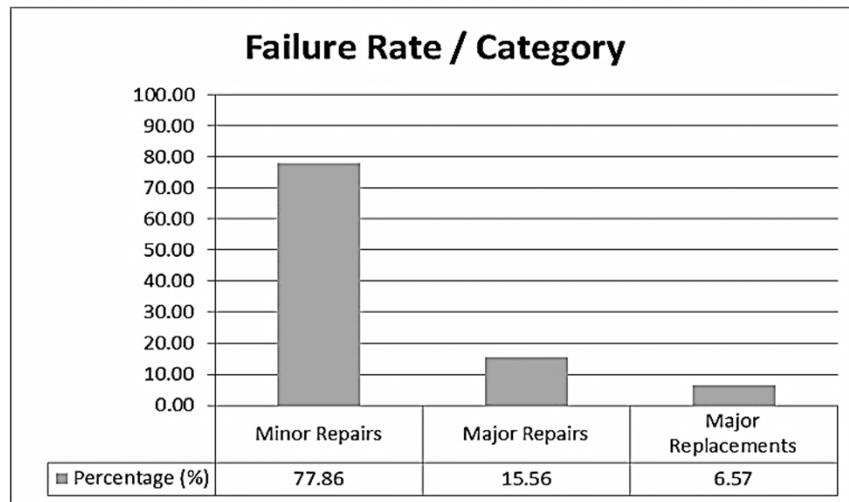
Simulation Results



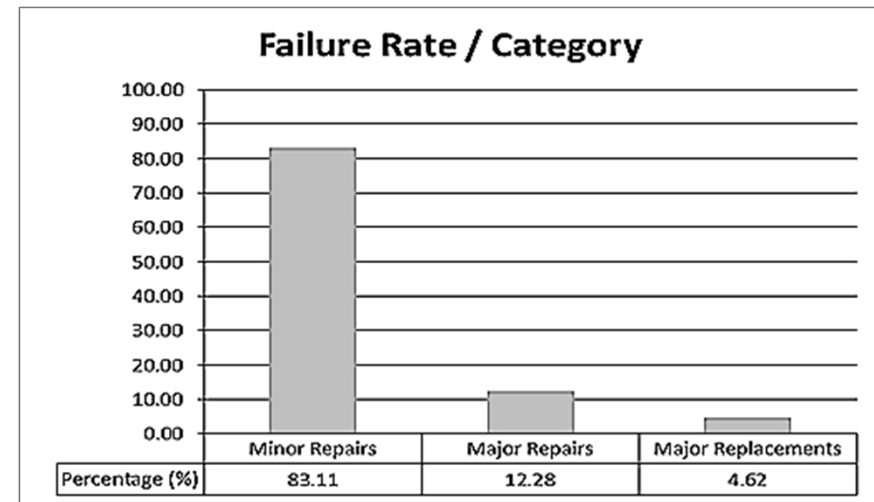
O&M Data Analysis

- The population analysed in this paper consists of between 40-100 wind turbines from 2 different offshore wind farms.
- Both wind farms have been operational for more than 5 years.
- The turbines analysed are all identical, indirect drive, modern multi-megawatt offshore turbines with rated powers of between 2-5MW and blade sizes between 80m and 120m.
- Exact turbine models, wind farm locations, rated power and blade size cannot be provided for confidentiality reasons.
- The analysis included data from the month that the failure occurred, but also from a month before the failure occurred.

O&M Data Analysis Results

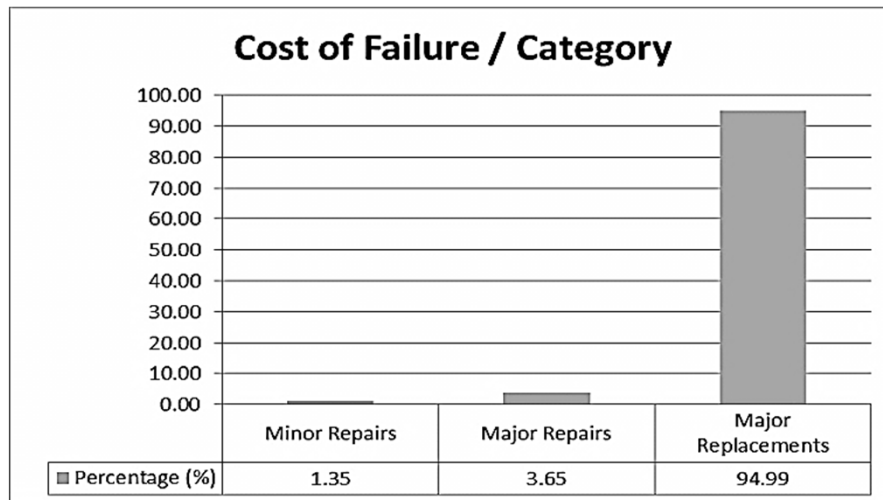


Failure Rate per
Category for Wind
Farm 1

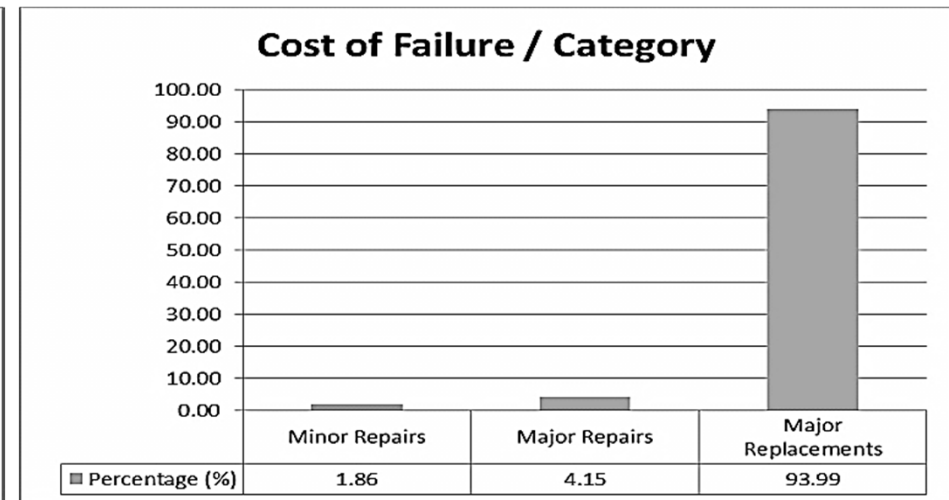


Failure Rate per
Category for Wind
Farm 2

O&M Data Analysis Results



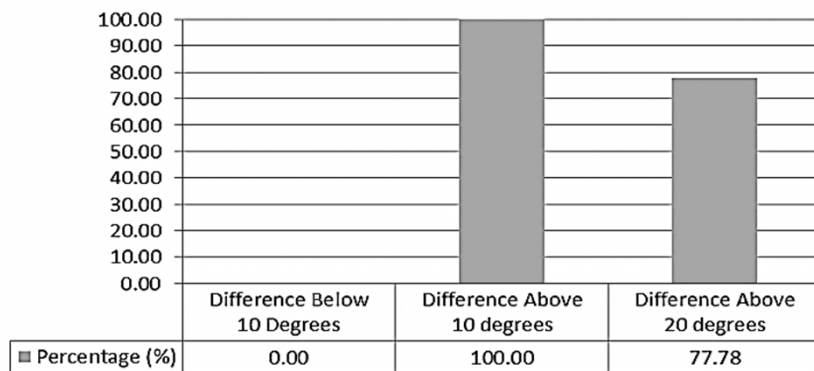
Cost per Category
for Wind Farm 1



Cost per Category
for Wind Farm 2

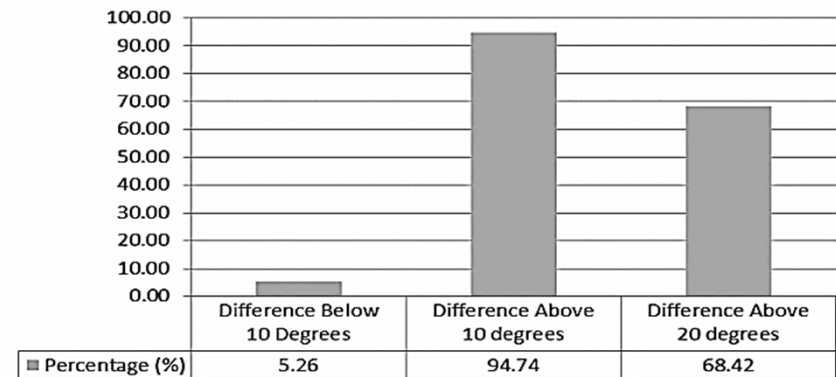
O&M Data Analysis Results

Major Replacements / Wind Farm Wind Direction



Effect of Mean Wind Direction over Wind Farm 1 on Major Replacement Failures

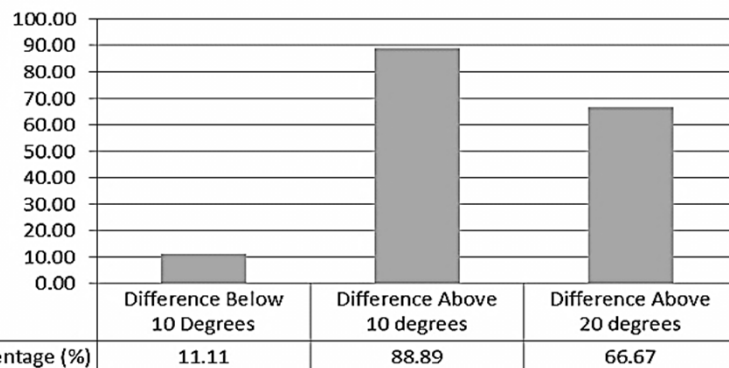
Major Replacements / Wind Farm Wind Direction



Effect of Mean Wind Direction over Wind Farm 2 on Major Replacement Failures

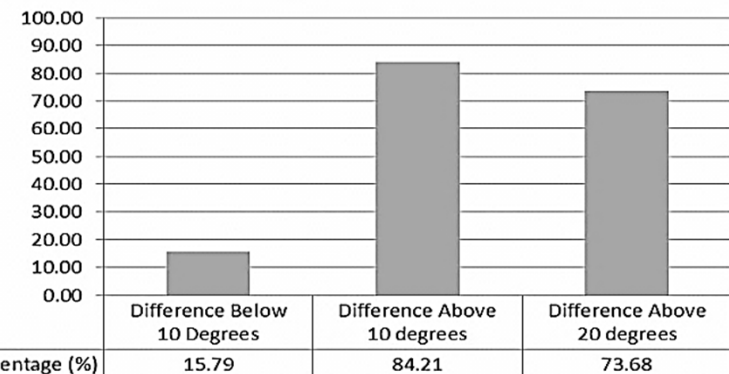
O&M Data Analysis Results

Major Replacements / Vicinity Wind Direction



Effect of Mean Wind Direction over Neighbouring Turbines on Major Replacement Failures (Wind Farm 1)

Major Replacements / Vicinity Wind Direction



Effect of Mean Wind Direction over Neighbouring Turbines on Major Replacement Failures (Wind Farm 2)

Conclusions

- The controllers under development allow the wind farm to be utilised almost like a conventional power plant.
- The wind farm controller ensures that all the turbines are operating within the accepted/safe zone.
- The O&M data analysis will be an input to the wind farm controller in order to avoid using turbines that are more likely to experience a major failure in the future.

Questions



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