Theme 3 Operation, Maintenance & Decommissioning

Durham Research Update

Dr Donatella Zappalá

SUPERGEN Wind General Assembly 2017

16th November 2017

Durham University
Department of Engineering

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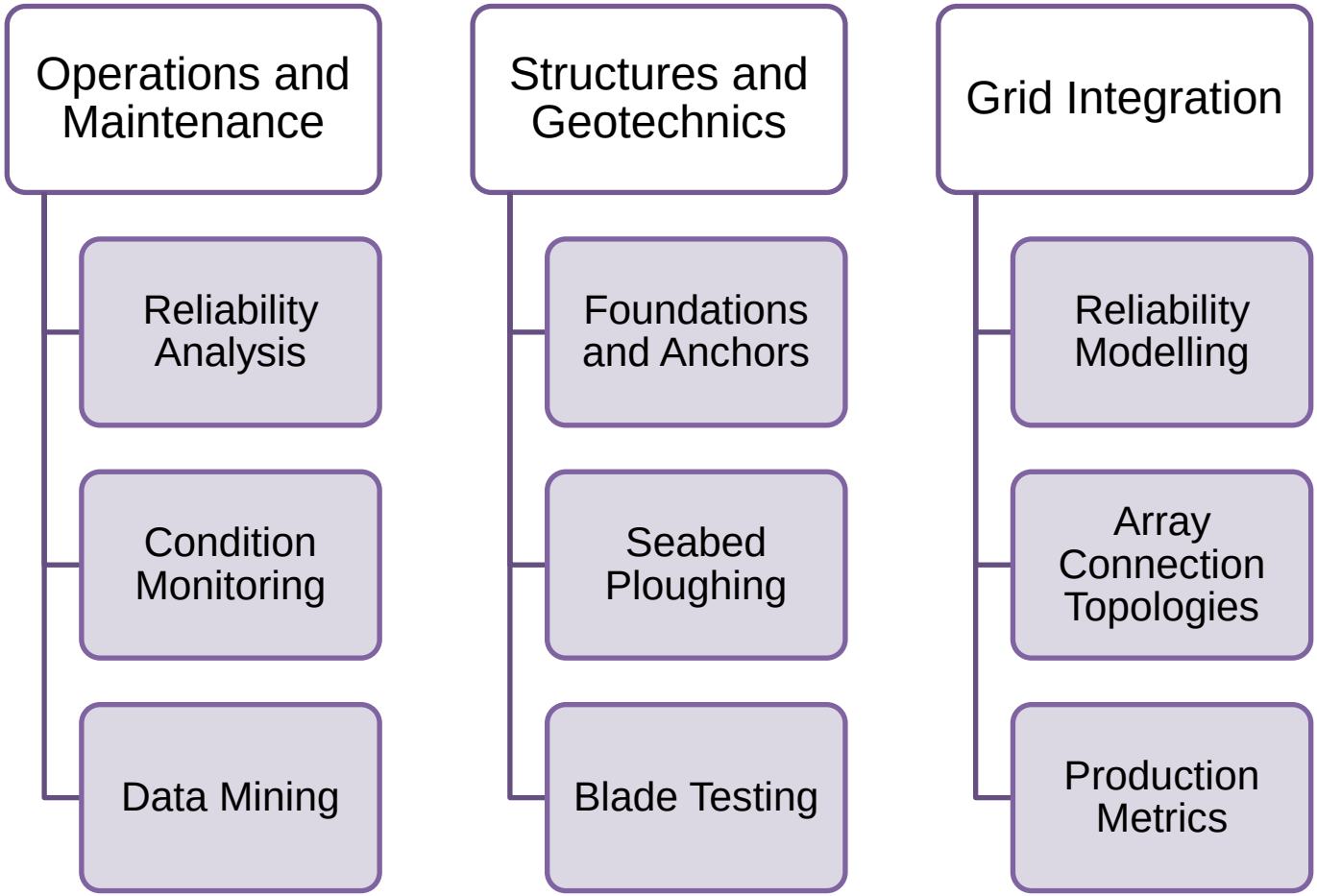
What do we do at Durham?



Wind Turbine Power Converter Reliability: Models and Test Rig

1. Which wind speed **operating conditions** cause the **greatest thermal loading** to power modules and how does this correspond to **damage**?

2. Is **manufacturer thermal data** valid for **lifetime estimation** under **complex wind turbine loading conditions**?

Simulate wind turbine drive train and wind speed profiles → **Simulate power module thermal loading profiles** → **Experimentally validate model and explore assumptions**

- Chris Smith PhD thesis in final preparation
- Invited paper in IET Power Electronics

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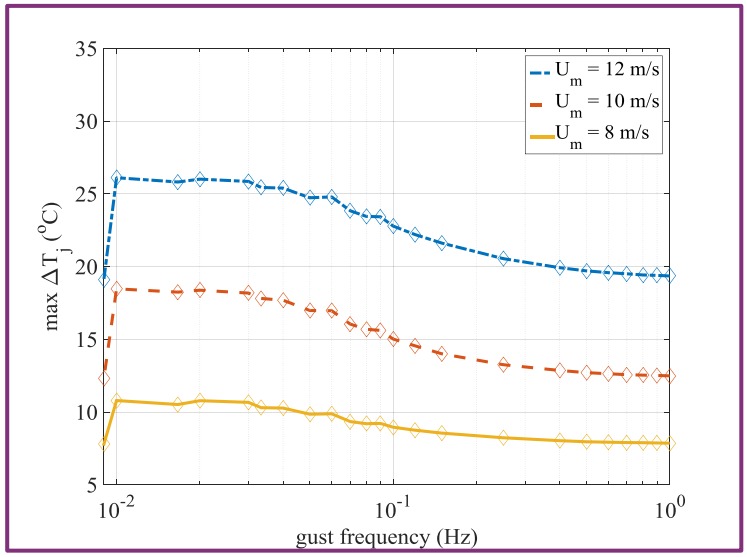
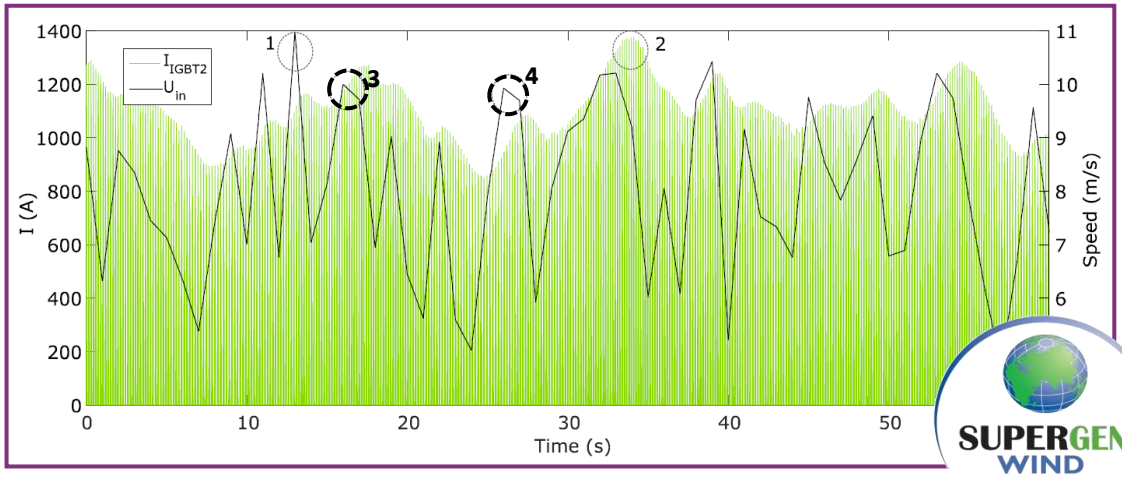
Modelling and Experiment

The lower the frequency of wind speed variation, the higher the temperature swing, the greater the damage

Cannot accurately estimate damage or remaining life from wind speed alone

Turbine drive train has a significant influence on power converter loads





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Trusted Test Experts

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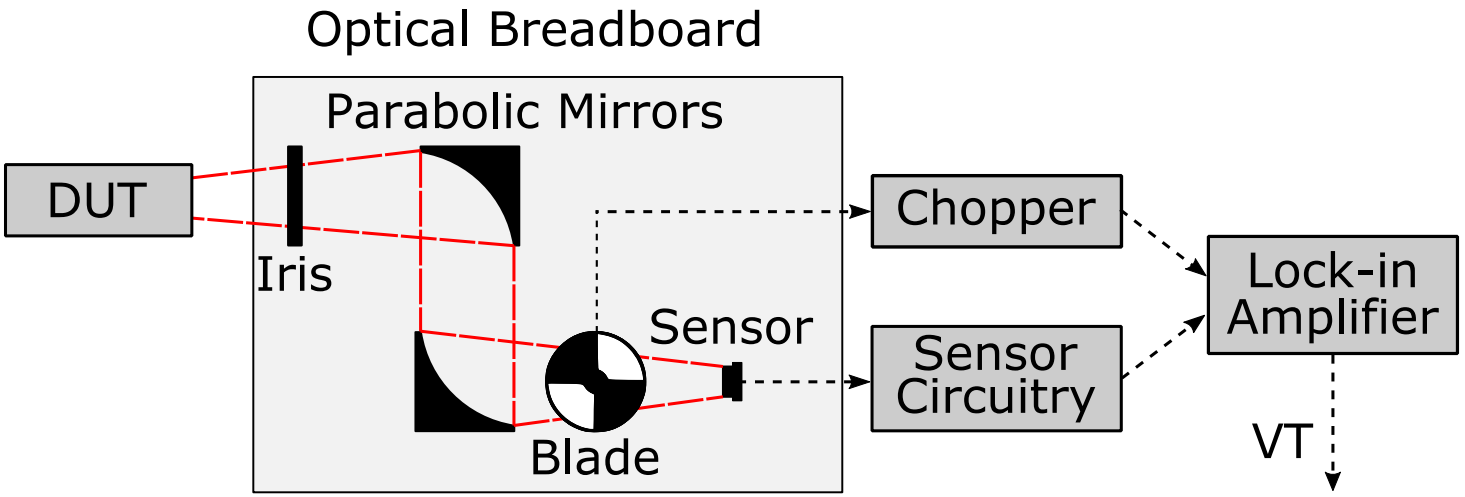
IR Thermal Measurement

Infra-red sensor and high-frequency chopper allow fast, low-noise temperature measurement on power module IGBTs and diodes



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Next challenge: Remove complex lock-in amplifier through signal processing

Ongoing project supported by industrial partner and new lab facilities

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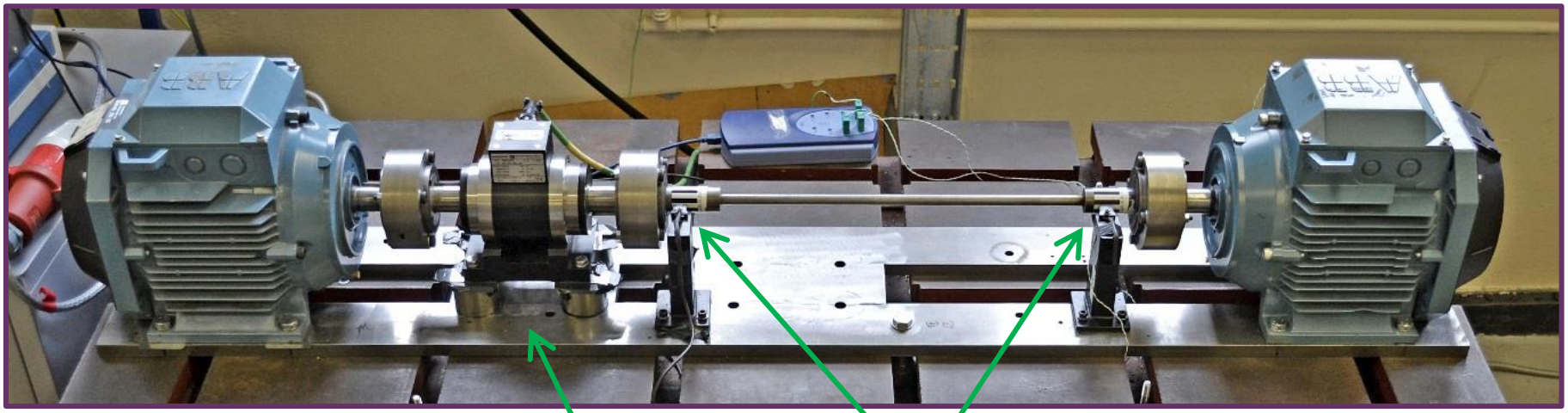
Optical, Non-Contact Torque Measurement System



Speed-controlled Induction Motor

Torque Transducer (reference)

Barcodes and Optical Probes

Grid-connected Induction Generator

- Working alongside Ancona University, Italy
- Paper under review with IOP Measurement Science and Technology

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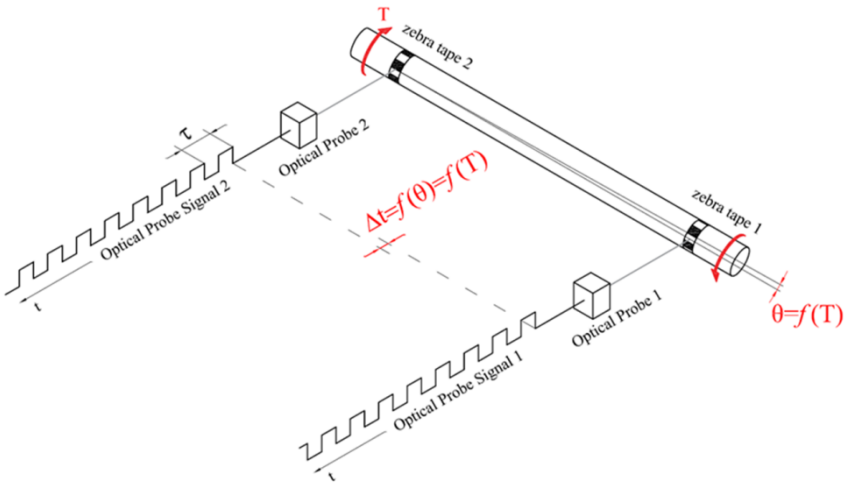
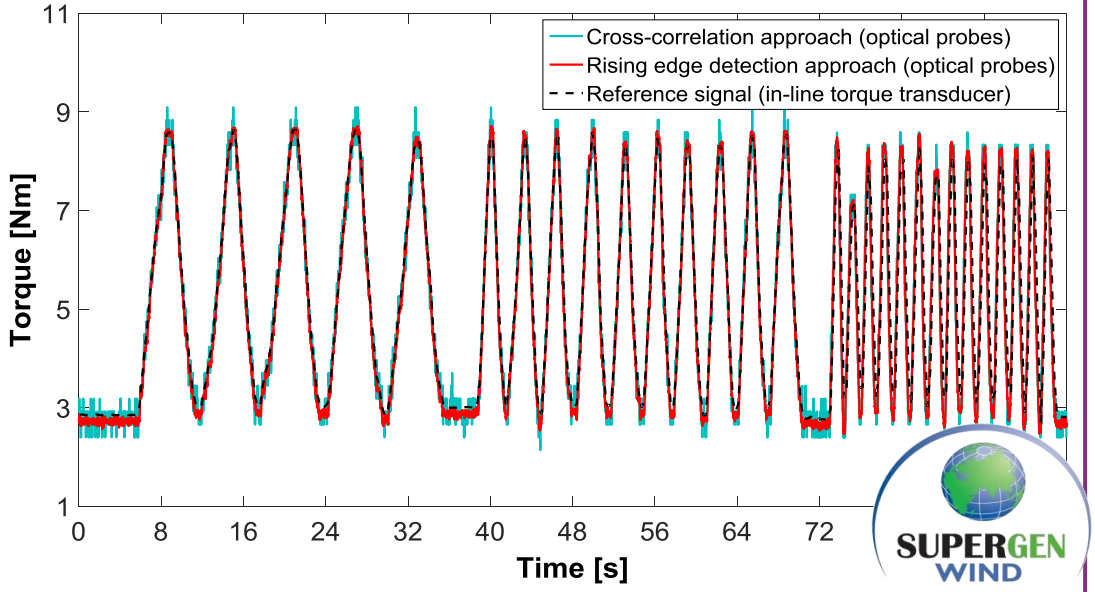
Optical Torque Measurement



Bar codes on the shaft monitored using simple optical probes to create pulses

Time shifts between pulses analysed over time using either edge analysis or cross-correlation approaches



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EPSRC
Engineering and Physical Sciences Research Council

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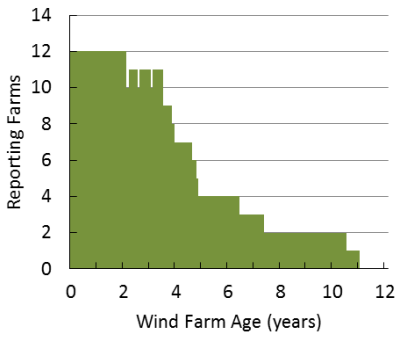
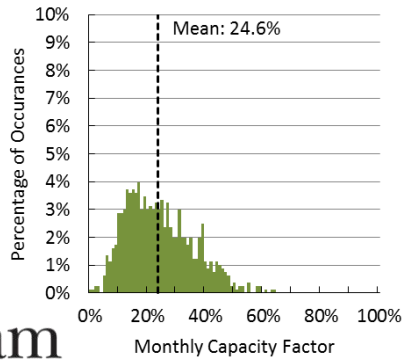
Performance Analysis

How does wind farm performance change with age?

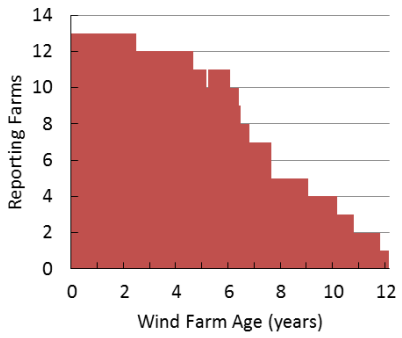
10000+ turbine years of large onshore, Round 1 and Round 2 capacity factor

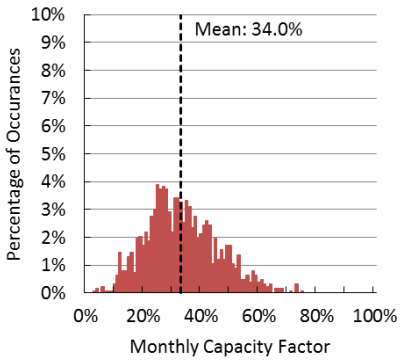
Onshore > 100 MW



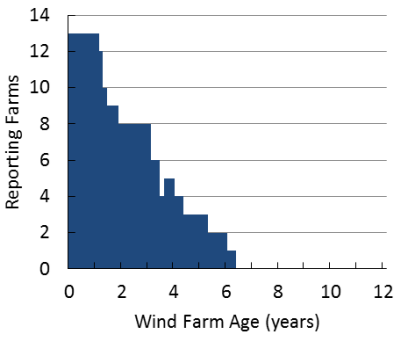


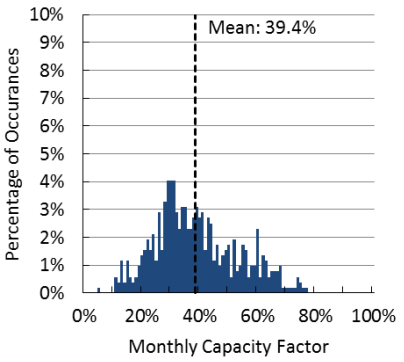
Round 1





Round 2





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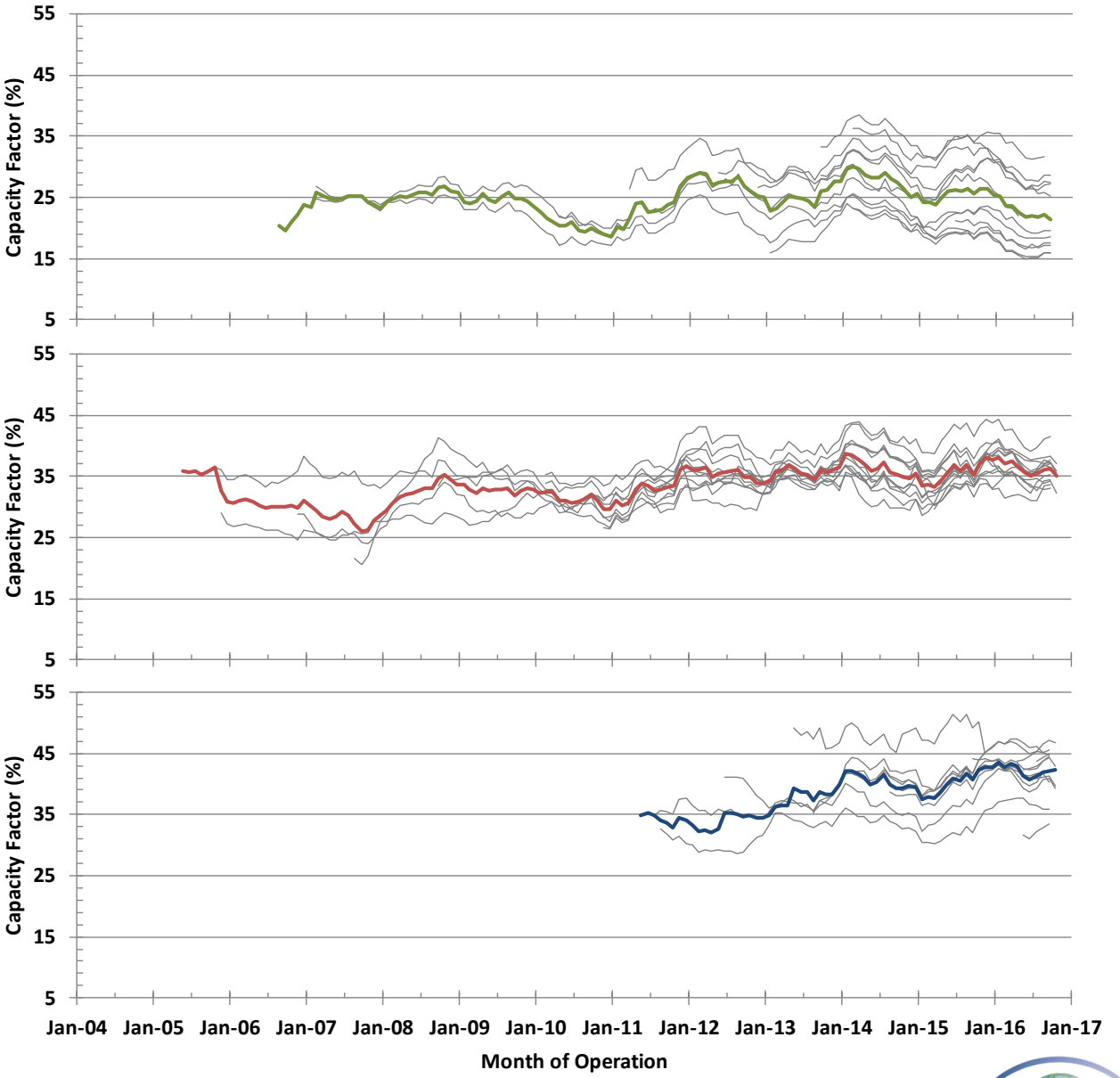
Onshore > 100 MW
777 WTs
1.83 GW

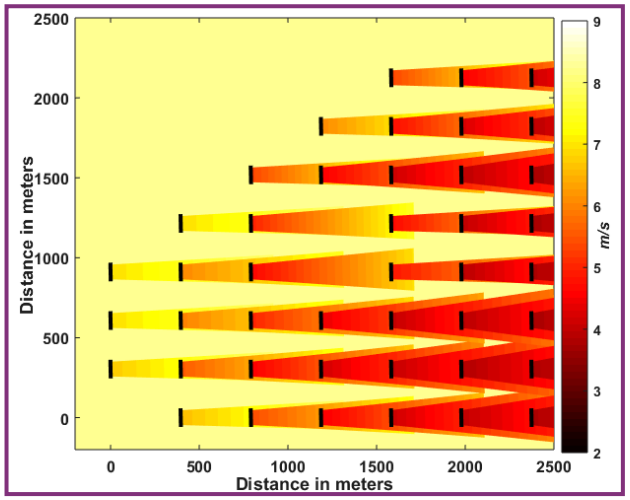
Offshore Round 1
371 WTs
1.18 GW

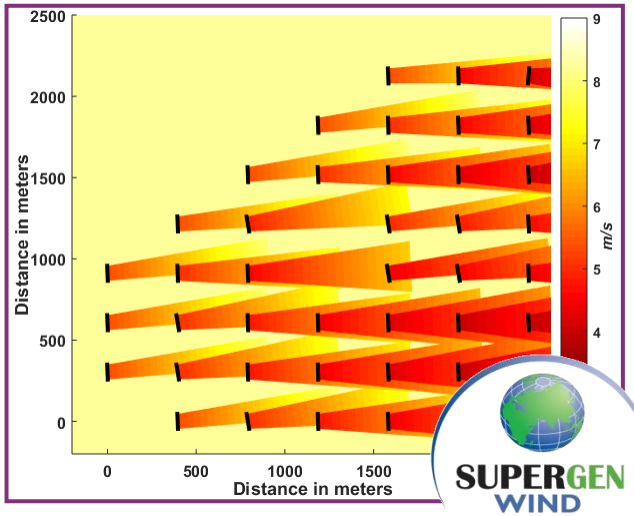
Offshore Round 2
1089 WTs
3.9 GW



Other Ongoing Research Topics

- **Uncertain reliability modelling for large offshore wind farms**
  - £3M HOME-Offshore project
- **Controlling wakes for improved production**
  - Fast optimisation
- **Oil contamination monitoring**
  - Sensors and signal processing
- **Combining SAP and SCADA for improved monitoring and reliability analysis**
  - Two PhD students funded by Ørsted (DONG)





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Thank you for your attention.
Any questions?

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