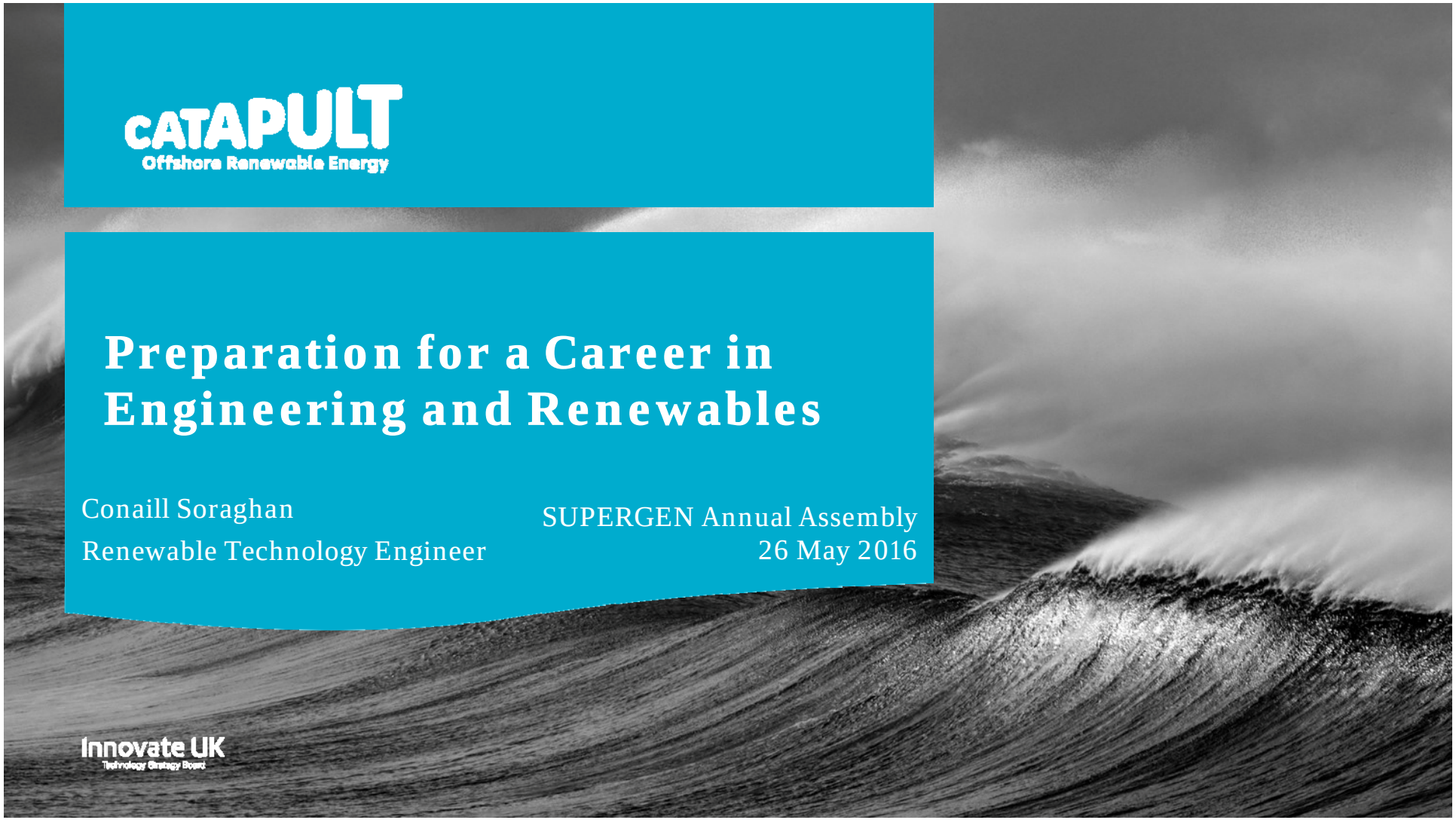

CATAPULT
Offshore Renewable Energy
Preparation for a Career in Engineering and Renewables
Conaill Soraghan
Renewable Technology Engineer
SUPERGEN Annual Assembly
26 May 2016
Innovate UK
Technology Strategy Board

Agenda

1. **What I did:**
   First cohort of The Centre For Doctoral Training in Wind Energy Systems

2. **What I do now:**
   The Offshore Renewable Energy Catapult

3. **Conclusions and Recommendations**

1. The CDT in Wind Energy Systems

A mathematicians route into engineering and renewables

University of St Andrews

UNIVERSITY OF CAMBRIDGE

HeyMath!
Because every student counts

University of Strathclyde Glasgow

M. Math Honours	Masters in Applied Maths Part III	Project Leader	Wind Energy CDT Guinea pig
2003 - 2007	2007 - 2008	2008 - 2009	2009 - 2013

1. The CDT in Wind Energy Systems

CDT First Year – MRes in Wind Energy Systems

Group Project
- Appraising EU Renewables Targets

Courses
- Wind Turbine Design and Mechanics
- Electricity Generation
- Wind Turbine Control
- Wind Power Grid Integration
- Structural Analysis
- Social and Economic Aspects of Renewables

Additional
- Trip to Whitelee
- Interview in the Herald
- Social aspect e.g. Dolphins

Individual Projects
- Modelling a Voltage Source Converter (Scottish Power Industry partner)
- Control of Aggregated VAWTs

1. The CDT in Wind Energy Systems

PHD Area of Focus – **Vertical Axis Wind Turbine Aerodynamics**

Structural benefits
- Simple design
- Potential for mechanical components near ground/ water surface

Poor aerodynamics
- Low efficiency
- Torque ripple

Enhanced control could alleviate issues but no off-the-shelf modelling tools are available for VAWTs.

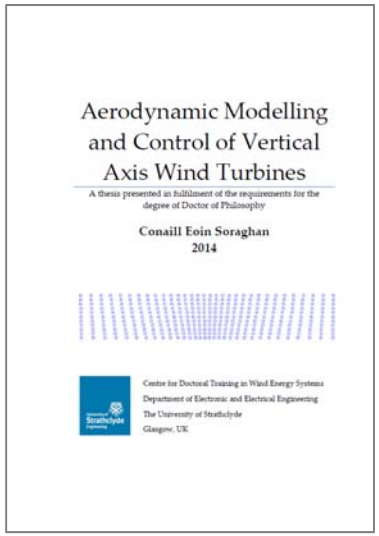
1. The CDT in Wind Energy Systems

CATAPULT Offshore Renewable Energy

PHD Topic and Thesis

Methodology

- Created “StrathDMS” BEM model in Matlab
  - Streamtube expansion
  - Tip loss
  - Flow curvature
  - Dynamic stall
  - Stall induced Multiple solutions
  - Variable pitch
- Exploration of the VAWT design space
- Optimisation of variable pitch control regimes


Aerodynamic Modelling and Control of Vertical Axis Wind Turbines

A thesis presented in fulfilment of the requirements for the degree of Doctor of Philosophy

Conaill Eoin Soraghan

2014

Centre for Doctoral Training in Wind Energy Systems
Department of Electronic and Electrical Engineering
The University of Strathclyde
Glasgow, UK

Findings

- StrathDMS validated against experimental data from literature
- Contribution to actuator disc modelling of VAWTs stemming from the variation in degree of streamtube expansion along a VAWT blade
- A new measure of performance for VAWTs, effective lift to drag ratio, is introduced
- For the first time it is demonstrated that pitch control of VAWTs has the potential to provide alleviation of cyclic loads
- A novel wind farm control based approach to smoothing aggregated power is proposed

“Aerodynamic Modelling and Control of Vertical Axis Wind Turbines”

1. The CDT in Wind Energy Systems

Dissemination of Research

Papers

- Soraghan, C. E., Leithead, W. E., Yue, H. and Feuchtwang, J. "*Double Multiple Streamtube Model for Variable Pitch Vertical Axis Wind Turbines*", AIAA 31st Conference on Applied Aerodynamics, San Diego, 2013.
- Soraghan, C. E., Leithead, W. E. and Jamieson, P. "*Influence of Lift to Drag Ratio on Optimal Aerodynamic Performance of Straight Blade Vertical Axis Wind Turbines*", EWEA Conference, Vienna, 2013.
- Soraghan, C. E., Leithead, W. E. and Yue, H. "*Control Based Power Smoothing for Aggregated Vertical Axis Wind Turbines*", EWEA Conference, Copenhagen, 2012.
- A journal paper was under review for the Wiley Wind Energy Journal:
  Soraghan, C. E., Leithead, W. E., Feuchtwang, J., Yue H., "*An Exploration of Pitch Options for Vertical Axis Wind Turbines",* 2014

Research placement

- Summer 2012, 1 month
- Comparing aerodynamic estimation tools

DTU Wind Energy
Department of Wind Energy

DeepWind

Industry placements

- Lloyds Register
- Edinburgh SME 2 week placement
- European SME consultancy

1. The CDT in Wind Energy Systems

Continual Professional Development

PETS:
Professional Engineers Training Scheme

- Founder and Secretary
- IET and IMechE Accreditation
- Maintained by subsequent yeargroups
- Project Management course

Industry Exposure

- DTU research placement
- Consultancy opportunities
- Industrial visits (Siemens, DNV-GL)

Outreach

- Herald and Guardian
- Science Centre
- My ex-primary AND secondary schools
- STEM ambassador

2. The ORE Catapult

The Offshore Renewable Energy (ORE) Catapult is the UK's flagship **technology innovation and research centre** for **offshore wind**, **wave** and **tidal** energy.

Glasgow Office

Blyth Testing Facilities

Levenmouth Turbine

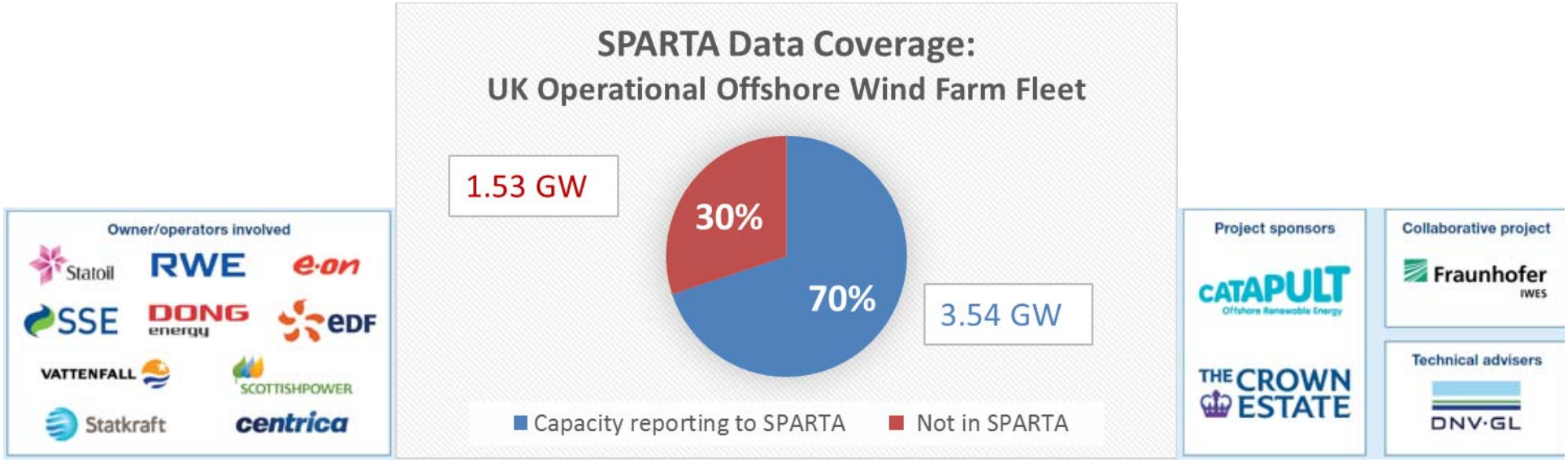
Services

- Core research
- Joint industry programmes
- Component testing
- Innovation challenges

ORE Catapult vision:
Abundant, affordable energy from offshore wind, wave and tide.

2. The ORE Catapult

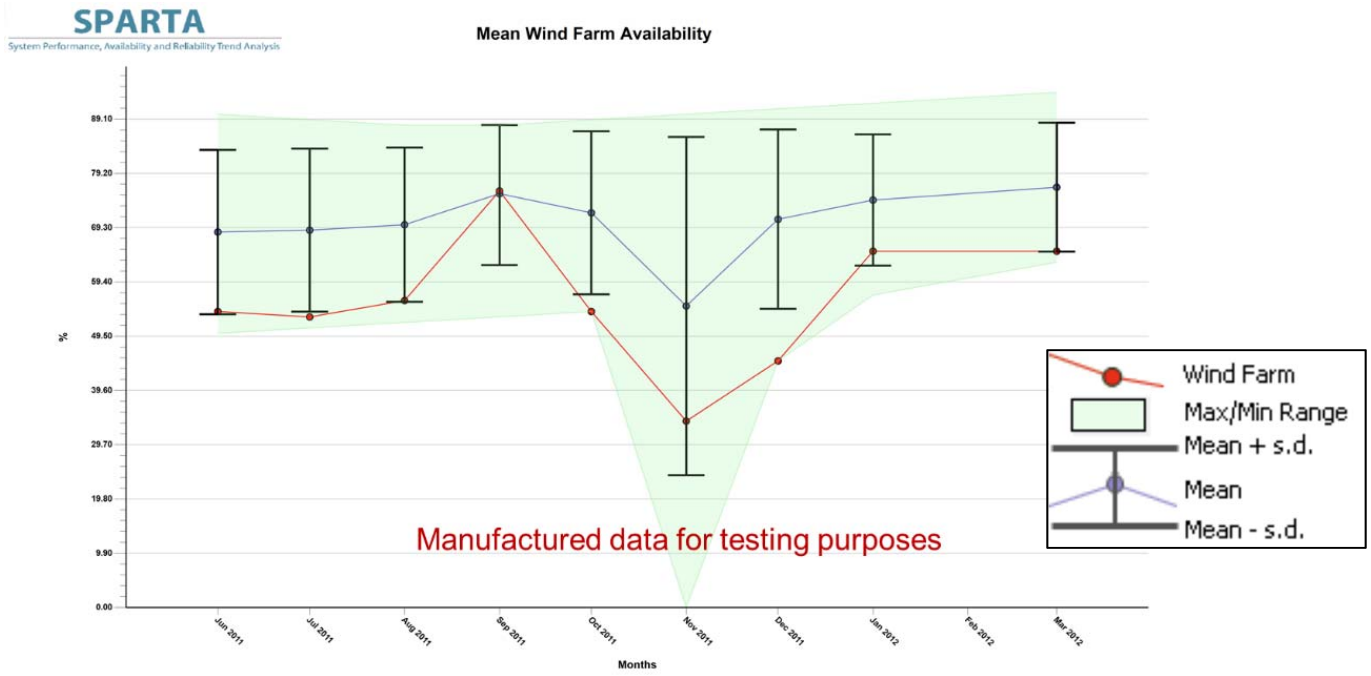
Project case study 1: SPARTA Database



SPARTA stands for **S**ystem **P**erformance, **A**vailability, and **R**eliability **T**rend **A**nalysis.

2. The ORE Catapult

Project case study 1: SPARTA Benchmarking



2. The ORE Catapult

Project case study 1: SPARTA Metrics

Performance

Wind farm generation onshore	
Wind farm generation offshore	
Number of generating hours	
SCADA data availability	
Time Weighted Run Time Availability - wind farm	IEC 61400-26-1
Time Weighted Run Time Availability - turbines	IEC 61400-26-1
Curtailment Losses - Grid	
Curtailment Losses - Other	
Number of Remote restarts	

O&M Logistics

- Number of O/O owned crew transfer vessels
- Number of contracted crew transfer vessels
- Number of seats on all O/O owned crew transfer vessels
- Number of seats on all contracted crew transfer vessels
- Number of O/O owned helicopters
- Number of contracted helicopters
- Number of seats on all O/O owned helicopters
- Number of seats on all contracted helicopters
- Number of vessel crew transfers
- Number of helicopter crew transfers
- Number of offshore based crew, temporary structure
- Number of offshore based crew, permanent structure

Environmental

- Number of non-access days or weather days
- Mean Significant Wave Height
- Number of days Hs above 0.5 m
- Number of days Hs above 1.0 m
- Number of days Hs above 1.5 m
- Number of days Hs above 2.0 m
- Mean hub height wind speed
- Number of days wind speeds above 5 m/s
- Number of days wind speeds above 10 m/s
- Number of days wind speeds above 15 m/s
- Number of days wind speeds above 20 m/s

Reliability (RDS-PP)

- Number of gearbox repairs/replacements
- Number of generator repairs/replacements
- Number of blade repairs/replacements
- Number of major electrical repairs
- Number of major BOP repairs
- Number of other major jack-up repairs
- Days of Jack-Up operation
- Days of inter-array cable outages
- Days of export cable outages
- Number of electrical distribution system repairs
- Number of equal potential bonding system repairs
- Number of rotor system repairs
- Number of blade adjustment system repairs
- Number of drive train system repairs
- Number of yaw system repairs
- Number of hydraulics system repairs
- Number of lubrication system repairs
- Number of other turbine system repairs
- Number of control and protection system repairs
- Number of generator system repairs
- Number of cooling system repairs
- Number of other generator system repairs
- Number of generator lead system repairs
- Number of generator circuit breaker system repairs
- Number of low voltage switchgear system repairs
- Number of compensation system repairs
- Number of transformer system repairs
- Number of other transmission system repairs
- Number of machinery enclosure system repairs
- Number of foundation system repairs
- Number of structure system repairs
- Number of ancillary system repairs
- Number of inter array cable collection assembly repairs
- Number of offshore substation assembly repairs
- Number of export cable assembly repairs
- Number of onshore substation assembly repairs
- Number of other repairs

2. The ORE Catapult

Project case study 2: O&M Case Studies Programme

- Collection and dissemination of 11 O&M case studies
- Information collected via on-site interviews
- Case studies presented at Industry Events
- Funded by The Crown Estate and The Offshore Wind Programme Board
- Intention to continue the programme next year with another 12 case studies

All publically available here: https://ore.catapult.org.uk/analysis-insight

2. The ORE Catapult

Project case study 2: O&M Case Studies Programme

Case Study Name	Lead Company	Author
Self Perform O&M at Robin Rigg	**E.ON**	**Conaill**
An Evidence Based Appraisal of Crew Transfer Vessel Thresholds	RWE	Sally
Early Fault Detection Using SCADA Data	**E.ON**	**Conaill**
End of Warranty O&M Contracting Strategy	Centrica	Sally
Assuring O&M Data Quality	**Centrica**	**Conaill**
Management of H2S Gas in Wind Turbine Sub-Structures	**EDF**	**Conaill**
Early O&M Experience of Jacket Foundations	Vattenfall	Sally
Responding to an HSE Emergency	Centrica	Sally
The Integration of Operational Data Using CORE	**SPR**	**Conaill**
A Novel Offshore Wind Transfer Technique	Repsol	Sally
Helicopter Strategy Appraisal at Westermost Rough	DONG	Sally

All publically available here: https://ore.catapult.org.uk/analysis-insight

2. The ORE Catapult

Continued Professional Development

CEng

- Currently MIET
- Preparing an application

Industry Exposure

- Projects
- Conferences
- Green Awards Rising Star Nomination

Outreach

- Renewable UK: Faces of Wind Energy
- Department for Education

3. Conclusions and Recommendations

How did the CDT set me up for my current role?

Technical know how and confidence

- First year general overview is invaluable in my line of work engaging with multiple stakeholders (O&M)
- Wind turbine design research has helped me understand the components of a wind turbine (SPARTA)
- Programming helped me understand how to design systems (SPARTA/WEBS/Cable Database)
- Modelling a VAWT from first principles provided me with the confidence to apply myself to new areas

Innovation

- The ORE Catapult is an innovation centre – we are tasked with creating and appraising new ideas and methods.
- I focussed on blue skies VAWT research and learnt valuable lessons about the technology readiness level scale

Industry exposure

- The CDT allowed me to develop a professional network that I have drawn on in my evolving role in the Catapult
- The introduction to professional chartership has facilitated a fast track application

Outreach and transferable skills

- The CDT nurtured an appetite for outreach opportunities that I actively seek in my current role
- A focus on transferable skills has helped me become a key facilitator and influencer in priority projects such as SPARTA

3. Conclusions and Recommendations

Recommendations

- **Keep pushing PETS**
- **Use Outlook!**
- **More constructive feedback is required**
  - Friday talks
  - Research Day
  - End of year reports
- **Raise Industry Awareness**
  - Teach about the structure and terminology of the industry
  - Project lifecycle, OEM, operators, service providers, consultant, research, industry bodies
- **Collaboration with ORE Catapult should be enhanced**
  - Mini projects, group projects, PhD projects