Agenda

• Brief Introduction to ORE Catapult
• The Wider Pipeline
• ORE Catapult Research Strategy
• Offshore Wind – The opportunity
  • The Offshore Wind Innovation Hub
• Wave & Tidal Industry Overview
  • Current Research Activity
• ORE Catapult Research Hubs
ORE Catapult:
The UK’s technology innovation centre for offshore renewables

1 of 11 national Catapults, technology innovation centres in key sectors for the UK economy (others including High Value Manufacturing, Cell and Gene Therapy, Satellite Applications)

Funded by UK Government, industry and bid-for research grants

Effectively a Government research and innovation lab with a hands-on role to support high potential companies

- 80+ technical experts
- £150m+ of open access labs
- Active in £27m of research projects
- 151 partnerships with SMEs
- Strong partnerships with leading universities
- ~£15m Govt. stipend / pa
How does ORE Catapult operate?

Catapult’s expertise extends UK’s innovation deeper into early stage technology & research

Research
Understanding the physics

Technology
Development & furthering of new ideas

Industry
Test & manufacture

Current innovation & testing in UK

Basic principles observed
Demonstration in laboratory environment
Prototype demonstration in operational environment

LCOE & UK Impact

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The Wider Pipeline

- Academic, ORE Catapult and Industrial relations are serviced with specific ‘vehicles’
- The Offshore Wind Innovation Hub (OWIH) convenes industry challenges
  - Academia has a presence on the OWIH advisory board
- ORE Catapult will align industry challenges with the Supergen research programme
- The Academic Engagement Plan (AEP) collaborates on strategic, advisory and project levels
  - Research Hubs provide strategic partnerships in key research areas/themes
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ORE Catapult - Our Assets

Largest concentration of open access and independent test and research facilities anywhere in the world

- 50M AND 100M BLADE TESTING
- 3MW TIDAL TURBINE NACELLE TESTING
- 15MW WIND TURBINE NACELLE TESTING
- OFFSHORE ANEMOMETRY PLATFORM
- MARINE AND SUBSEA TESTING
- ELECTRICAL AND MATERIALS LABORATORIES
- 7MW LEVENMOUTH DEMONSTRATION TURBINE
ORE Digitalisation

**Research Areas/Themes**

**Resource Assessment**
- Power performance assessment
- LiDAR for control applications
- Wake modelling

**Rotor**
- Dual axis blade test solution
- Rain erosion test solution

**Powertrain**
- Advanced E&M testing methodologies
- Bearing & GB CMS
- Elec. components health monitoring

**Electrical Infrastructure**
- Energy storage
- Offshore HV/MVDC power collection systems (HDMMC)
- Advanced cable test solution
- eHIL virtual grid (WF)

**Structure & Foundation**
- Floating WT
- Corrosion mitigation
- Dynamic cables

• HIL development
• LDT availability and yield improvement
• LDT measurement data

• eGrid development
• Powertrain reliability improvement
• WT/WF to grid integration optimisation (eHIL)
Research Programmes Overview

- Rotor
- Powertrain
- Testing & Validation of New Tech
- Operational Performance
- Emerging Technologies
- Structure & Foundation
- Resource assessment
- Electrical infrastructure
Research Programmes Overview (Assets)
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UK has 5.5 GW of offshore wind installed, ~19GW in the pipeline

- The UK has a large pipeline of future sites
- Future sites will be further offshore
- Today offshore wind provides 10% of the UKs electricity
The most recent subsidy round came in lower than expected

- Total offshore wind capacity of 3.2GW awarded
- Weighted average strike price of £62.14/MWh
- Weighted average LCOE £55/MWh
- Contract for Difference = 15 year guaranteed price

<table>
<thead>
<tr>
<th>Project</th>
<th>Owners</th>
<th>Strike Price (2012 real)</th>
<th>LCOE (2011 real)</th>
<th>Capacity</th>
<th>Commissioning</th>
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</thead>
<tbody>
<tr>
<td>Triton Knoll</td>
<td>Innogy/Statkraft</td>
<td>£74.75/MWh</td>
<td>£65/MWh</td>
<td>860MW</td>
<td>2021/22</td>
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<tr>
<td>Hornsea Project 2</td>
<td>DONG Energy</td>
<td>£57.50/MWh</td>
<td>£51/MWh</td>
<td>1,386MW</td>
<td>2022/23</td>
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<tr>
<td>Moray East</td>
<td>EDP/Engie</td>
<td>£57.50/MWh</td>
<td>£51/MWh</td>
<td>950MW</td>
<td>2022/23</td>
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<tr>
<td>Total</td>
<td></td>
<td><strong>£62.14/MWh</strong></td>
<td><strong>£55/MWh</strong></td>
<td><strong>3,196MW</strong></td>
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</tbody>
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Offshore Wind Innovation Hub (OWIH)

Purpose of the Hub

The Offshore Wind Innovation Hub will provide a coordinated approach to offshore wind innovation in the UK. It will;

• Impartially identify the innovation needs of the sector,
• Sign post to funding calls and help identify opportunities for the UK supply chain to address the needs of the sector
• Undertake targeted R&D project brokering in response to funding calls

http://offshorewindinnovationhub.com
Technology Innovation Roadmapping

- Create a holistic view of the sector’s technology priorities
- Align priorities between Industry, academia and government.
- Identify and communicate Market Opportunities

The IH offers strategic support to government to ensure coherence and alignment across the UK and internationally.

The IH agrees industry’s priorities drawing on the advice of the Advisory Group and its internal capacity.

The IH offers delivery support to industry by helping it prepare for funding calls, convening consortia, and disseminating and showcasing its work.

The IH maintains technology roadmaps by integrating project outcomes into innovation plans.
# Building the Roadmaps – O&M Example

<table>
<thead>
<tr>
<th>Operations</th>
<th>Maintenance</th>
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</thead>
<tbody>
<tr>
<td><strong>Commercial &amp; Strategy</strong></td>
<td><strong>Service</strong></td>
</tr>
<tr>
<td><strong>Coordination &amp; People</strong></td>
<td><strong>Planning</strong></td>
</tr>
<tr>
<td><strong>Assets &amp; Technical</strong></td>
<td><strong>Servicing</strong></td>
</tr>
<tr>
<td><strong>Trade &amp; Yield Optimisation</strong></td>
<td><strong>Forced Outages</strong></td>
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<tr>
<td><strong>Vessels &amp; Access</strong></td>
<td><strong>Statutory Inspections</strong></td>
</tr>
<tr>
<td><strong>Marine Coordination</strong></td>
<td><strong>Planned Corrective</strong></td>
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<tr>
<td><strong>Inventory Management</strong></td>
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<tr>
<td><strong>Human Factors</strong></td>
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<tr>
<td><strong>Survey &amp; Inspection</strong></td>
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<tr>
<td><strong>Monitoring</strong></td>
<td></td>
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<tr>
<td><strong>Control Optimisation</strong></td>
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<tr>
<td><strong>Lifetime Management</strong></td>
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</tbody>
</table>
Non-driver based substructure inspection

Non-driver based substructure inspection

Actor

Beneficiary

Industry

Owner Operators

UK Benefit

Low

Medium

High

Potential to reduce LCOE

Low

Medium

High

Forecast start and finish

Now

2020

2025

2030

2035

2040

2045

2050

TRL

1

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6

7

8

9
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Wave & Tidal Industry Overview

- Wave & tidal lags behind offshore wind in terms of maturity and cost
- However, huge potential resource is available
  - 30 to 50GW of potential installed capacity (20% of the UK electricity demand)
- Tidal energy will need to demonstrate that it can align itself with the cost reduction path of offshore wind
  - Ultimately generating power for under £100 per MWhr
- Technical and commercial development path for tidal energy includes:
  - Determining the optimum platform design to harvest tidal energy
  - Fully understanding how to design, build and operate reliably within a hostile sub-sea environment
- Wave energy technology developers face a number of significant challenges
- The industry is still in early development and continues to explore a wide variety of technology solutions
Wave & Tidal – Selection of Current Research Project Activity

**AUV3D**: Bristol based SME ROVCO develop RoVs and specialist subsea tooling. ORE Catapult is collaborating with ROVCO to test their prototype high-quality underwater stereo camera system.

**EnFAIT**: Nova Innovation's 15m EUR H2020 LCE15 CIRCE' project focussed on scaling up their Shetland tidal turbine array.

**Marine-i**: Cornwall RDI Hub is a 3-year £9.4m European Structural Investment Fund project (ERDF £6.9m, Public Match £0.8m and Private Match £1.7m).

**MONITOR**: €2M, 39-month project developing novel reliability models for tidal turbines, focusing on blades and support structure.
Wave & Tidal – Selection of Current Research Project Activity

**SCORE2:** The Supply Chain innovation for Offshore Renewable Energy (SCORE) 2 project is a £6 million supply chain innovation project. Catapult is a Delivery Partner with Orbis Energy.

**RiaSoR II:** Follow-on project for improving reliability across arrays at the design stage using statistical analysis. Work to date includes development of a VMEA design framework, focusing on the electrical elements and power take off.

**WASP:** Windfarm Autonomous Support vessels Project (WASP) will benchmark the technology challenges facing the sector transition to autonomous support operations and chart a roadmap for the phased introduction of RAI systems for spares supply, asset surveillance, security patrol and crew transfer.
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ORE Catapult Research: Academic Research Hubs

ORE Catapult is building a network of Research Hubs with leading universities in key areas.

Objectives:

- Enhance internal capability and knowhow for commercial clients
- Provide industry with access to highly relevant expertise today
- Progress understanding in key areas for future problem areas

Wind Blade Research Hub
Partnering with University of Bristol (5-year programme)
Tackling blade design, manufacture and integrity (materials, NDT, condition monitoring and aerelastic properties)
£2.3million budget secured; £700k provided by ORE Catapult

Future Research Hubs

<table>
<thead>
<tr>
<th>Electrical Infrastructures</th>
<th>Powertrains</th>
</tr>
</thead>
<tbody>
<tr>
<td>O&amp;M (multi-University)</td>
<td>Foundations/Structures</td>
</tr>
</tbody>
</table>

[Diagram showing various research hubs and focus areas]
Typical Research Hub Governance

ORE Catapult

- Research & Disruptive Innovation (RDI) Director
- Head of Strategic Research
- KA Leader
  - Senior Core Researchers
  - Academic Engagement Plan (AEP) Manager

University

- Scientific Director
  - Project Manager
  - Senior Academic

Researchers
Questions?
<table>
<thead>
<tr>
<th>Location</th>
<th>Address</th>
<th>Contact Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>GLASGOW</td>
<td>ORE Catapult Inovo&lt;br&gt;121 George Street&lt;br&gt;Glasgow&lt;br&gt;G1 1RD</td>
<td>T +44 (0)333 004 1400&lt;br&gt;F +44 (0)333 004 1399&lt;br&gt;<a href="mailto:info@ore.catapult.org.uk">info@ore.catapult.org.uk</a>&lt;br&gt;ore.catapult.org.uk</td>
</tr>
<tr>
<td>BLYTH</td>
<td>ORE Catapult&lt;br&gt;National Renewable Energy Centre&lt;br&gt;Offshore House&lt;br&gt;Albert Street&lt;br&gt;Blyth, Northumberland&lt;br&gt;NE24 1LZ</td>
<td>T +44 (0)1670 359 555&lt;br&gt;F +44 (0)1670 359 666</td>
</tr>
<tr>
<td>LEVENMOUTH</td>
<td>ORE Catapult&lt;br&gt;Fife Renewables Innovation Centre (FRIC)&lt;br&gt;Ajax Way&lt;br&gt;Leven&lt;brKY8 3RS</td>
<td>T +44 (0)1670 359 555&lt;br&gt;F +44 (0)1670 359 666</td>
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