Subsea Innovation challenges for Offshore Wind

Andrew Tipping, Commercialisation Manager

February 2017
Agenda

Who are the ORE Catapult

UK Market Context

Creating the Challenges

Innovation Challenges

Case Studies

Funding Options
The Catapult Network
A long-term vision for innovation & growth

11 Catapults

£1.4bn IUK programme, funded by BEIS
To transform the UK's capability for innovation
Driving growth in key strategic sectors for the UK

“Affordable energy from Wind, Wave and tidal”

Research
Testing
Advisory Services
Who we work with

<table>
<thead>
<tr>
<th>Industry Advisory Group</th>
<th>Research Advisory Group</th>
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<tbody>
<tr>
<td>Senvion</td>
<td>Swansea University</td>
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<tr>
<td>Dong Energy</td>
<td>University Of Sheffield</td>
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<td>GE Energy</td>
<td>The University Of</td>
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<td>edp Renewables</td>
<td>Shrewsbury</td>
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<td>Siemens</td>
<td>Queen's University</td>
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<tr>
<td>Atlantis Power</td>
<td>Imperial College</td>
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<td>Subsea 7</td>
<td>London</td>
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<tr>
<td>SCOTTISHPOWER RENEWABLES</td>
<td>University Of Exeter</td>
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<tr>
<td>SSE</td>
<td>University Of Strathclyde</td>
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<td>EDF Energy</td>
<td>University Of Oxford</td>
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<tr>
<th>Partnerships &amp; strategic alliances</th>
<th>SMEs</th>
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<tr>
<td>The Crown Estate</td>
<td>Tekmar</td>
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<td>EDF Energy</td>
<td>InvisoTech</td>
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<td>Green Investment Bank</td>
<td>Atlantis</td>
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<td>Energy Technology Partnership</td>
<td>Innovation</td>
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<td>Samsung</td>
<td>Nova Innovation Ltd</td>
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<td>Samsung Heavy Industries</td>
<td>ACT Blade Ltd</td>
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UK’s offshore wind opportunity

- 1,465 offshore turbines (3,320 in Europe)
- 5.1GW operational (11 GW in Europe)
- 8 - 10GW installed by 2020
- Latest CFDs £105-120/MWh indicate LCOE £102-107/MWh
- 2nd CfD Auction announced £290m April 17
Offshore wind Market Opportunity

Now

Global Market 11GW
UK Market 5GW

2020

Global Market 20GW
UK Market 10GW

<table>
<thead>
<tr>
<th>Project</th>
<th>Value of total project %</th>
<th>UK content / GVA</th>
<th>Key players</th>
<th>Time to Market and Dev costs</th>
<th>Barrier to entry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbine</td>
<td>30-35%</td>
<td>Low-Med</td>
<td>OEMs</td>
<td>Long / High</td>
<td>High for turbines, med for tech.</td>
</tr>
<tr>
<td>BOP</td>
<td>35%</td>
<td>Med</td>
<td>OEMs and Tier 1</td>
<td>Med / high</td>
<td>High</td>
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<tr>
<td>O&amp;M</td>
<td>20 – 25%</td>
<td>High-V High</td>
<td>Large offshore contractors SMEs</td>
<td>Short / High for ops, low for tools</td>
<td>Low</td>
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Big opportunity for UK supply chain innovation and investment
Informing innovation: O&M Forum

- Discussion forum with UK offshore wind farm owner/operators
- Attended by offshore wind farm asset managers

Outputs

- Valuable insight to help shape ORE Catapult activities
- Joint Industry Projects
- Innovation Challenges
Eon takes out two Robin Rigg turbines

Eon is decommissioning a pair of six-year-old Vestas V90 turbines at its 180MW Robin Rigg wind farm in the Solway Firth between England and Scotland. MPI jack-up Adventure took down the 3MW machines in an operation that kicked off earlier this month.

Crews are currently working to remove the transition pieces and monopile foundations, marking what is thought to be the first time commercial UK offshore turbines have been decommissioned.

Eon said removal, which is expected to be completed by the end of the month, was prompted by “natural movements of the sandbank and the loss of seabed level” at the site on the north side of Robin Rigg.

“Turbines A1 and B1 were first shut down in April due to the problem. This has no impact on the remaining turbines and this issue is unconnected to the engineering works currently ongoing at the wind farm,” said Eon, which has been addressing historic grout issues at Robin Rigg.

The company added that no decision had been taken on whether to replace the two machines or to remain with a 174MW layout.

- Donald Trump’s third legal attempt to halt construction of an 11-turbine wind farm off the Aberdeenshire coast was heard by the UK Supreme Court earlier this month.

Vattenfall’s 100MW project could be visible from the US tycoon and presidential candidate’s Menie golf complex in north-east Scotland.

…prompted by “natural movements of the sandbank and the loss of seabed level…”
Cable monitoring

Completion now in sight for Thanet export cable repairs

Baful Beaty Power Transmission and Distribution is hoping to complete export cable repairs at Vattenfall's 300MW Thanet wind farm this month.

The project's 100 Vestas 3MW turbines have been constrained to half power since February as only one of two 132kV wires has been available.

OFTO Baful Beaty said weather had the delayed works, which were contracted in April.

Vattenfall will be compensated for lost generation but sources warned this may not cover the full cost.

“The OFTO will be able to offset the repair costs against insurance but will nevertheless lose an insurance deductible, which will amount to many hundreds of thousands of pounds,” said one source.

“Vattenfall will not be able to recover lost generation revenues other than via the OFTO compensation, which is capped.

“Some consider this to be a weakness within the OFTO regime,” he added, warning that “many millions” will eventually be unrecoverable.

Cables at the project run 13km between the Thanet offshore substation and landfall at Pegwell Bay in Ramsgate.

“The project’s 100 Vestas 3MW turbines have been constrained to half power since February as only one of two 132kV wires has been available.”

‘Explosion’ knocks out exports from Gwynt y Mor

An “explosion” on one of two offshore substations at RWE npower’s 576MW Gwynt y Mor wind farm off north Wales hit exports for a period earlier this summer, according to a source.

The failure of gas insulated switchgear (GIS) resulted in an emergency call-out for transmission operator Baful Beaty, which took over the connection assets in February.

The incident restricted output “for a few days” in July and supply was switched to the second substation to minimise disruption, it is thought.

“The switchgear blew up around three to four weeks ago,” said the source. “The incident would have been costly and it is a complex job to work on.”

Baful Beaty refused to be drawn on the nature of the incident, how long it took for repairs and the likely cost.

“A GIS failure occurred offshore at Gwynt y Mor in July and was quickly and fully rectified by the manufacturer. The equipment is now back in service,” said a spokeswoman for Siemens, which supplied the offshore electrics, also refusing to comment.

The GIS helps to step up turbine output from 33kV to 132kV and to feed it into the grid.

Offshore Cable Claims Severity Increases by 25% in 2015: £60million in claims (GCUBE, June 16)
EDF sets corrosion challenge

£10,000 on offer to stop rot in monopile foundations offshore

“Corrosion within monopile foundations is a cause for concern for offshore wind farms. The main problem is a deviation from the original design assumptions made for early offshore wind farm projects. This predicted that the inside of the monopile would be completely air and water-tight,” said EDF.

Source: ReNews 19th July 2016
Marine Growth on Jackets

Current Method
- Time Consuming
- Vessel required
- Weather restricted
- Diver risk or expensive ROV setup

CAPEX & OPEX
Eliminate marine growth to reduce steel requirement at design phase for foundations
Engaging the supply chain: Needs Driven Innovation

Owner/Operators

Operational Issue

ORE Catapult

Innovation Challenge Call

Collaborative Innovation Project

Technology Solutions

Supply chain innovators

Ideas

Innovations

+ External Funding
Cost reduction strategies for O&M

- Reduce demand for vessels/technicians through improved planning/dispatch decisions and use of autonomous vehicles
- Increase efficiency of maintenance tasks
- Fewer missed opportunities to perform O&M due to improved access forecasting and improved planning
- Improve reliability through improved condition monitoring of components
- Increase life-time of wind farms using software tool that enables improved management of wind farm components
- Optimise selection and scheduling of resources intra-day (vessels, technicians, equipment, inventory) due to improved planning and access forecast.

Vessel time  Technician time  Fuel Cost  Weather delays
## Subsea Innovation Challenge Examples

<table>
<thead>
<tr>
<th>Knowledge Area</th>
<th>Innovation Challenge Area (examples)</th>
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<tr>
<td>Electrical infrastructure</td>
<td>Improved condition monitoring of subsea cables</td>
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<td>Foundations &amp; substructures</td>
<td>Improved scour monitoring / corrosion monitoring</td>
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<tr>
<td>Operation &amp; maintenance</td>
<td>Develop autonomous solutions for subsea survey</td>
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<tr>
<td>Environmental</td>
<td>Improve marine mammal detection during piling operations</td>
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</table>
• Challenge areas launched and on website with Expressions Of Interest (EOI) process.

www.ore.catapult.org.uk/innovationchallenges
Case Study: SMAR Azure

ORE Catapult Support

- Responded to Blade Innovation Challenge
- Identified funding avenues for feasibility study of novel blade technology
- Funding bid co-development
- Secured 3 rounds of Energy Catalyst funding (Innovate UK)
- Supported investment/ OEM pitch development
- ACT Blade, set up to exploit technology

Novel textile blade technology developed from sail design and manufacturing
Case Study: Limpet Technology Demonstration

ORE Catapult Support
- Access to full scale operational turbine
- Supported demonstration of a range of technologies
- Building investor and customer confidence

Technicians inspect a blade controlling their work position using Limpet
Case study: Autonomous subsea survey

Access to expertise (intro to utility)
Test and demonstration
Access to funding
Funding Programs: Innovate UK

Innovate UK
Technology Strategy Board

**Infrastructure Systems: Round 2**
£25,000 - £5 million
3 months – 3 years
Technical feasibility, industrial research or experimental development
Must have one SME involved
Up to 75% intervention

Open: 16th Jan
Reg: 15th March
Closes: 22nd March

Brokerage Event: Edinburgh Thurs 2 Feb
Funding programs: ETP

Up to £20k (70% funding)
Scottish SMEs
Access Scottish Universities
Early stage concepts/ Feasibility
Power Systems & Networks, Wind, Marine
Funding programs: SME Instrument

EASME
Executive Agency for Small and Medium-sized Enterprises

Horizon 2020 SME Instrument
A recipe for success

€50,000 - €2.5 million
70% Funding
Funding programs

SCORE program
Up to £50k (40% funding)
Catapult as a partner organisation

Up to £20k (70% funding)
Scottish SMEs
Access Scottish Universities
Early stage concepts/ Feasibility
Technology Demonstration: Met Mast, Docks & 7MW turbine
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