2017 Wind Energy Systems Engineering Workshop

Where we are today in the Offshore Wind Industry

13/09/2017 | Miriam Noonan
Agenda

• Brief Overview of ORE Catapult
• Offshore Wind in Europe Overview
• Cost Reduction - What we’ve seen so far
• Cost Reduction - What do we expect to see in the next 5 years?
• Conclusion
ORE Catapult Overview
The catapult network: A long-term vision for innovation & growth

Catapults

- Established by InnovateUK
- Designed to transform the UK's capability for innovation
- Core grant leveraged with industry and other public funding 140 employees – strong collective experience
- >80 technical experts (research and engineering)
Testing and Demonstration Assets

Dual axis blade testing

Bearing testing

Novel cables

Real data for real simulations
Offshore Wind Overview
Forecast European capacity to ~24GW by 2020 and 60GW by 2030
Includes 10GW in UK by 2020 and 20GW by 2030
Estimate average ~€6-7bn per year required
Between 3 countries, up to 7,500MW available over 2 years of auctions

Each country has different regulatory regimes
- In common – competitive bidding
- Key difference – UK and Germany currently competing sites; Netherlands bidders compete for same pre-consented sites.
- Germany will be changing to a Dutch-style model for installation from 2026 onwards.

<table>
<thead>
<tr>
<th>Country</th>
<th>2017 (MW)</th>
<th>2018 (MW)</th>
<th>Total (MW)</th>
<th>Finance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>1,490</td>
<td>1,550</td>
<td>3,100</td>
<td>€7bn</td>
</tr>
<tr>
<td>Netherlands</td>
<td>700</td>
<td>700</td>
<td>1,400</td>
<td>€3bn</td>
</tr>
<tr>
<td>UK</td>
<td>3,200</td>
<td>3,200</td>
<td>3,200</td>
<td>€8bn</td>
</tr>
<tr>
<td>Total</td>
<td>3,750</td>
<td>3,750</td>
<td>7,500</td>
<td>€18bn</td>
</tr>
</tbody>
</table>
Cost Reduction - What we’ve seen so far
Cost Reduction Monitoring Framework 2016-17

Quantitative Results

- LCOE reduced 32% in 5 years
- £100/MWh target achieved 4 years earlier than anticipated

http://crmfreport.com/
Qualitative Results

Cost Reduction Monitoring Framework 2016-17

- Nearly all indicators on or ahead of target
- All indicators medium or high confidence on outlook

Inner rings: 2014/15
Middle ring: 2016 score
Outer ring: 2020 outlook

Inner and main ring:
- Ahead of target
- On target
- Behind target
- Missed target

Outer ring:
- High confidence
- Medium confidence
- Low confidence

http://crmfreport.com/
Cost Reduction - What do we expect to see in the next 5 years?
Cost Reduction - UK Focus

![Graph showing Levelised Cost of Energy (LCOE) over time.](image)

- **LCOE at FID**
- **2020 target**: £100
- **LCOE implied by CfD auction strike price ceilings**
Competitive Bid Pricing

- Levelised Cost of Energy (£/MWh)

LCOE at FID

- **2020 target £100**
- ~LCOE for €72.70 Borssele 1&2
- ~LCOE for €63.80 Vesterhav
- ~LCOE for €54.50 Borssele 3&4
- ~LCOE for €54.50 German Auction Round 2017
- UK CfD Allocation, 2017
What’s driving this cost reduction?

Technology
- Increasing capacity factor
- Larger turbines
- Longer life assets

Location
- Operating synergies
- Optimising site locations

Market Confidence
- Lower debt rates
- Lower insurance premiums
- Increasing market competition
Competitive Bid Pricing

<table>
<thead>
<tr>
<th>LCOE €/MWh</th>
<th>CRF</th>
<th>Capacity factor</th>
<th>1.5 MW turbine</th>
<th>30 year life</th>
<th>Operating synergies</th>
<th>Site</th>
<th>Cost of capital</th>
<th>Transmission</th>
<th>Other OPEX</th>
<th>Tax</th>
<th>Outturn before further reductions</th>
<th>Further cost reductions</th>
<th>Subsidy-free in Germany</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start</td>
<td>Technology</td>
<td>Location</td>
<td>Strategy</td>
<td>Germany</td>
<td>End-game</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
So what’s next?

Enabling Technologies

Floating Wind
- Deepwater locations
- Simple installation and decommissioning

Larger export systems
- Further from shore
- Higher capacity cables
- Larger developments

Continued Cost Reduction

Efficient Operations
- Improving O&M strategy
- Higher capacity factors
- Specialised vessels

Growing Market
- Established supply chain
- Economies of scale
Thank You
## Contact us

<table>
<thead>
<tr>
<th>Location</th>
<th>Address</th>
<th>Phone Numbers</th>
<th>Email(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GLASGOW</td>
<td>ORE Catapult Inovo&lt;br&gt;121 George Street&lt;br&gt;Glasgow G1 1RD</td>
<td>T +44 (0)333 004 1400&lt;br&gt;F +44 (0)333 004 1399</td>
<td><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 NE24 1LZ</td>
<td>T +44 (0)1670 359 555&lt;br&gt;F +44 (0)1670 359 666</td>
<td></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 KY8 3RS</td>
<td>T +44 (0)1670 359 555&lt;br&gt;F +44 (0)1670 359 666</td>
<td></td>
</tr>
</tbody>
</table>
## Who we work with

### Industry Advisory Group
- Senvion
- DONG Energy
- GE Energy
- edp renewables
- Siemens
- Subsea7
- RWE
- Atlantis
- SSE
- EDF Energy
- The Crown Estate
- EMEC
- Green Investment Bank
- Samsung Heavy Industries
- Samsung Heavy Industries

### Research Advisory Group
- Swansea University
- University of Sheffield
- Cranfield University
- Imperial College London
- University of Exeter
- Queen’s University Belfast
- University of Strathclyde
- University of Oxford

### Partnerships & strategic alliances
- Green Investment Bank
- Tekmar
- Invisotech
- Atlantis
- Innovation Nova Innovation Ltd

### SMEs
- ACT Blade Ltd

---

 ore.catapult.org.uk  
 @orecatapult

cATAPULT  
 Offshore Renewable Energy