Hywind roadmap, R&T and operations

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UIB 29 January 2018
Providing offshore wind to >1M homes

Playing to Statoil’s strengths

- Deeply competitive financing, development & operations
- Leveraging our global presence & supply chain
- Ability to apply technology to reduce energy costs

Attractive and growing market

<table>
<thead>
<tr>
<th>Project</th>
<th>Capacity</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hywind demo</td>
<td>2.3 MW</td>
<td>In operation</td>
</tr>
<tr>
<td>Sheringham Shoal</td>
<td>317 MW</td>
<td>In operation</td>
</tr>
<tr>
<td>Dudgeon</td>
<td>402 MW</td>
<td>Commissioning</td>
</tr>
<tr>
<td>Hywind Scotland</td>
<td>30 MW</td>
<td>Commissioning</td>
</tr>
<tr>
<td>Arkona</td>
<td>385 MW</td>
<td>In construction</td>
</tr>
<tr>
<td>Dogger Bank</td>
<td></td>
<td>Consented</td>
</tr>
<tr>
<td>Hywind large scale</td>
<td></td>
<td>Auction won</td>
</tr>
</tbody>
</table>

- 3 x 1.2 GW
- 1-2 GW

Vast potential for floating wind

- Virtually unlimited resources
- Standardised foundations
- Site flexibility
- Environmental benefits

Illustrative only, based on water depths, wind conditions and potential large markets
Cost development for floating offshore wind

Statoil’s cost roadmap for Hywind
Capex/MW and 2030 LCOE target

BVG Associates LCOE trajectory for floating vs bottom fixed offshore wind
Levellised cost of energy (LCOE)

Source: BVG Associates
Leverage three pillars for Hywind cost reduction

**Build on bottom fixed industry**
1) Larger turbines
2) Standardised vessels
3) Operations and maintenance

**Establish industry standards for floating wind**
1) Mooring and anchoring
2) Cables and substations
3) Marine operations

**Optimise Hywind substructure**
1) Low cost materials
2) Robust fabrication processes
3) Production-friendly design
Full-scale measurement; closing the learning gap

- **Full-scale wind measurements**
  - Wind resource prediction method tested against full scale measurements.
  - Turbulence and wake models verified with full scale measurements from Hywind Scotland.
  - Analysis tools for floating turbine and wakes verified with full scale measurements and updated.
  - Coherence measurement at Norwegian cost.
Full-scale measurement; closing the learning gap

• Floating offshore wind
  - New floating wind turbine controllers tested and verified
  - Improved design methods and software tools, based on result from full scale measurements on Hywind Scotland, for hull, tower and mooring system
Improved method for Assembly

• **Marine operation**
  - Methods for heavy maintenance at various site conditions
  - Assess and qualify industrialized Hywind installation methods
  - Installation methods for Hywind concept assemble in different water depths.
Increased lifetime, reduced cost

- Wind turbine
  - Tools for advanced O&M data analysis and predictive/condition based maintenance for wind parks
  - Analysis model for drive train
  - Passive load reduction methods implemented in analysis software.
New Energy Operations - Operational Excellence
Hywind Demo experience…

• In operation from September 2009, concession to 2020 Excellent HSE record- no serious incidents!

• Hywind controllers tested and verified, further demonstrated by Hywind Scotland

• Production 10,1 GWh in 2011 ➔ Capacity factor 50.1% in 2011. Average Cap. Factor 41%

• Production: close to 65 GWh since start-up

• Production as good as or better than other 2.3 MW Siemens wind power turbines. NORWEA prize for the best producing wind-turbine in Norway in 2011, 3rd best in 2012, 2nd best in 2014

• Experienced wind speed over 40 m/s and maximum wave height of 19 m. Floater motions have no negative impact on operations- in contrary

• No major issues. Same O&M as for the conventional bottom-fixed. All technical systems are working well – concept verified

• Valuable experience/learning still to be gathered and used in future floating development! Digitalization opens new possibilities! New technologies can be tried and tested!

…success to be continued
Marine Energy Test Centre Karmøy

- Established around Hywind Demo as the first demo turbine with aim to be a “national test centre”
- All infrastructure in place, 40MW concessions
- 6 concessions for shallow 20-50 meter and 2 for deep water 200 meters
- 15MW 22kV cable (Hywind Demo 2,3 MW)
- Well functioning O&M base at Skudeneshavn
- Using local vendors ➔ “knock-on” effect on the Norwegian supply chain
- Hywind “Living laboratory”, good cooperation with Norwegian and international Universities and R&D institutions
High activity - test and use of new efficient O&M solutions

- R&D and testing of new turbine controller for Hywind Scotland,
- HSE courses, drills,
- Weather buoys, marine and production forecasting,
- Demo and testing of new technologies and O&M systems
- Validate test of autonomous drones/robotics
- Huge media interest, investor visits

- Testing of innovative vessels, equipment and access solutions ie:
  - Buksér & Ber ing “Buddy”
  - Windcarrier “Bayard3” w/ MaXccess
  - “Island Crown” w/ Uptime
  - Fjellstrand / WMO “World Passat”
  - A+D Vessel Motion Measurement System
  - Deepocean / “Edda Fonn” w/ ROV
  - Stinger Micro- and Mini ROVs
  - Umoe Mandal «Umoe Firmus»
  - Rødne «Rygerkongen»
  - Karmsund Shipping «Steven»
  - MCS «MCS SWATH1»
Digitalization-new possibilities for collaboration driving innovation and continuous improvement

Optimized O&M
Always safe
High value
Low Carbon

Cloud Data Platform

Data → Analysis Algorithms Expertise → Intelligence

Apps

Knowledge

Process digitalisation
Advanced analytics
Robotics and remote control

Digital opportunity driven by 3 technological enablers