Hywind Scotland – status and plans

EERA DeepWind’ 2015, Trondheim
Rune Yttervik, Statoil
Building the Portfolio:

*Material positions in fixed offshore wind*

- **Project execution to operations:**
  - Sheringham Shoal, UK
  - 317 MW
  - *In operation, 2012*

- **Working to bring technology costs down:**
  - Dudgeon Offshore, UK
  - Up to 560 MW
  - *Under development*

- **Larger projects, deeper waters, further from shore:**
  - Doggerbank, UK
  - Up to 9 GW
  - *Under consent*
Floating wind - Potential markets

North sea – Norway and UK

Japan and Korea

US, Atlantic and Pacific coast – and Great Lakes

Iberian Peninsula and Mediterranean Sea
HYWIND
What is Hywind?

- Floating wind turbine (FWT)
- A standard offshore wind turbine placed on a ballasted vertical steel cylinder, anchored to the seabed
- Active motion controller
- Statoil-owned technology

Concept 2001

Model test 2005

Full-scale prototype 2009

Pilot Park, 3-6 turbines <5 years

Large Parks, 500-1000MW <10 years
HYWIND DEMO
Hywind Demo – the World’s first full scale prototype

Conventional technology used in a new way

- slender floating cylinder (simple sub-structure)
- conventional 3-line mooring system
- use of standard offshore wind turbine

In operation from September 2009

- produced ~40 GWh since start-up
- capacity factor 50% in 2011 (overall 40%)
- experienced wind speed of 40 m/s and maximum wave height of 19 m

Blade pitch control to dampen out motions

Floater motions have no negative impact on turbine performance

Concept verified
Hywind Demo - assembly and installation - 2009

- Simple and safe assembly and installation
HYWIND SCOTLAND
Commercialisation of Hywind

Status:
- The technical concept is considered proven

Next step:
- Pilot park to demonstrate improvements and cost reductions

End goal:
- Commercial scale parks of 500-1000 MW
- Cost competitive with bottom fixed

Concept 2001
Model test 2005
Full-scale prototype 2009
Pilot Park, 3-6 turbines <5 years

2015-02-06
Scottish Government positive to floating wind

Scottish First Minister Alex Salmond visits Statoil, August 2010

Recharge article, August 2010

- Scottish consultation regarding introduction of a separate band for «experimental offshore wind»
- The European Commission has granted state aid approval for the introduction of an enhanced ROC (i.e. 3.5 ROC/MWh) for floating wind in Scotland
- 3.5 ROC and 18 months grace period was approved by the Scottish Parliament in 2014
Hywind Scotland - project objectives

Demonstrate cost-efficient and low risk solutions for commercial scale parks

- Test multiple units in park-configuration
- Verify up-scaled design
- Verify reliability and availability of optimised multi-turbine concept
- Mobilise supply chain
### Hywind Scotland Pilot Park

**Project introduction**

<table>
<thead>
<tr>
<th>Description</th>
<th>Hywind Scotland</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installed capacity (5 WTGs)</td>
<td>30 MW</td>
</tr>
<tr>
<td>Area (sea level)</td>
<td>~4 km²</td>
</tr>
<tr>
<td>Water depth</td>
<td>95-120 m</td>
</tr>
<tr>
<td>Average wind speed (@100 m)</td>
<td>~10 m/s</td>
</tr>
<tr>
<td>Mean waves, Hs</td>
<td>1.8 m</td>
</tr>
<tr>
<td>Offshore export cable length</td>
<td>Ca.30 km</td>
</tr>
<tr>
<td>Onshore cable length</td>
<td>Ca.2-3 km</td>
</tr>
<tr>
<td>Transmission voltage</td>
<td>33 kV</td>
</tr>
<tr>
<td>Mooring</td>
<td>Pre-laid chains</td>
</tr>
<tr>
<td>Anchor</td>
<td>Suction</td>
</tr>
</tbody>
</table>

![Map of Scotland showing Hywind Scotland Pilot Park](image)
Pilot park area and export cable corridor
### Upscaling from Demo 2009 to Hywind Scotland 2014

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Hywind Demo</th>
<th>Hywind Scotland</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass</td>
<td>5300 tons</td>
<td>~11500 tons</td>
</tr>
<tr>
<td>Hub height</td>
<td>~65 m</td>
<td>~100 m</td>
</tr>
<tr>
<td>Draught</td>
<td>100 m</td>
<td>~75 - 80 m</td>
</tr>
<tr>
<td>Diameter of sub-structure</td>
<td>8.3 m</td>
<td>~14 - 15 m</td>
</tr>
<tr>
<td>Water depth</td>
<td>220 m</td>
<td>~95 - 120 m</td>
</tr>
<tr>
<td>Rotor diameter</td>
<td>~85 m</td>
<td>154 m</td>
</tr>
<tr>
<td>Capacity</td>
<td>2.3 MW</td>
<td>6.0 MW</td>
</tr>
</tbody>
</table>
Upscaling effects

• Fabrication
  – Increased diameter of the substructure is an important challenge for the fabrication

• Marine operations, assembly site
  – Lifting height increased significantly
  – Available vessels to install under floating conditions very limited
  – The operation related to lifting from a floating installation to another floating installation is very challenging with regards to load transfer
Hywind – WTG and tower assembly on shore
Hywind Scotland Pilot Park

- 3.5 ROC and grace period of 18 months
- Agreement for Lease signed Nov. 2013
- Grid offer signed December 2014
- WTG contract with Siemens signed December 2014
- FEED for substructure and mooring finished January 2015
- Detailed engineering of substructure, tower and mooring system started January 2015
- Consent application ready for submission early 2015
- Concept selection (DG2) March 2015
- Consent anticipated Q2 2015
- FID (DG3) anticipated Q3 2015
- Final commissioning (DG4) Q3 2017
- Energy production approx. 0.13 TWh/yr
- Lifetime 20 years operation
THANK YOU FOR YOUR ATTENTION.

Rune Yttervik
Statoil ASA
www.statoil.com