Expanding into Deeper Waters: Development of the Hywind floating wind concept

BOEM Offshore Renewable Energy Workshop – 2014

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Statoil ASA

Statoil is an international energy company with operations in 34 countries. Building on 40 years of experience from oil and gas production on the Norwegian continental shelf, we are committed to accommodating the world's energy needs in a responsible manner, applying technology and creating innovative business solutions.

Crossing Energy Frontiers

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Statoil: Step wise growth in offshore wind

Offshore wind development building on our core competence

Hywind Demo

Sheringham Shoal

Dudgeon

Hywind Pilot Park

Dogger Bank

Hywind Commercial Scale

Increase Portfolio?

2009- **2012-** **2017-** **2017-** **2020-**

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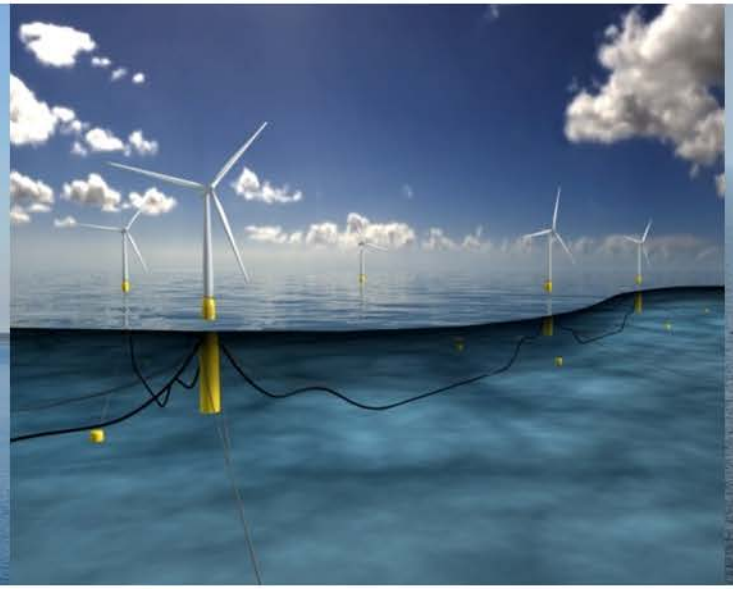
Why floating foundations?

	Bottom-fixed	Floating
Fabrication	- Adaption needed for each unit	+ Standardized, mass production
Installation	- Offshore assembly	+ Inshore/onshore assembly
Environment	- Piling noise during installation - Often in sight from land	+ No piling needed + Can be placed out of sight
Resources	- Limited shallow water resources	+ Almost unlimited deepwater resources + Often better wind conditions
Technology	+ Proven	- Less proven, but demonstration ongoing
Cost	Lower, but less reduction potential	Higher, but larger reduction potential
		

The Hywind concept

- Conventional technology used in a new way
- Simple substructure construction
- Small waterplane area
- Conventional 3-line mooring system
- Blade pitch control to dampen out motions

Hywind – long term objective



Prototype → Pilot Park → Large parks

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

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Hywind Demo - 2009
- the world's first full scale prototype

- 2.3 MW Siemens turbine
- Produced 40 GWh since start-up
- Capacity factor 40%
- Floater motions have had no negative impact on turbine performance
- Experienced wind speed of 40 m/s and maximum wave height of 19 m
- Concept verified

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Hywind Demo Assembly and Installation

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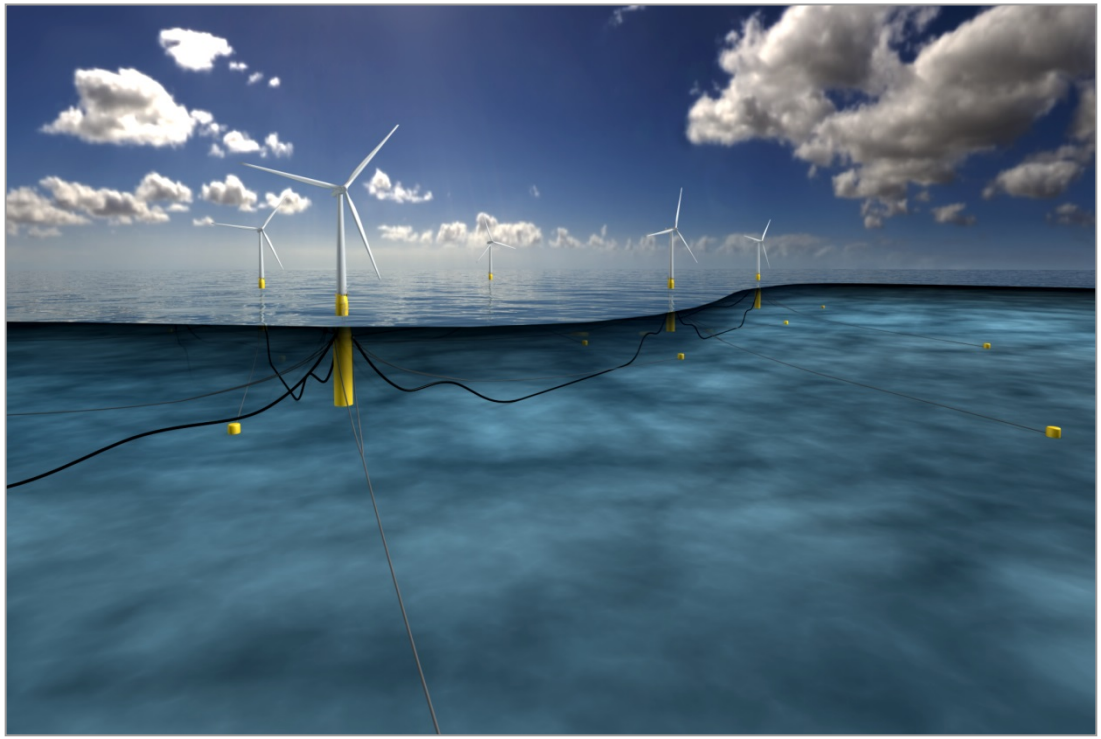
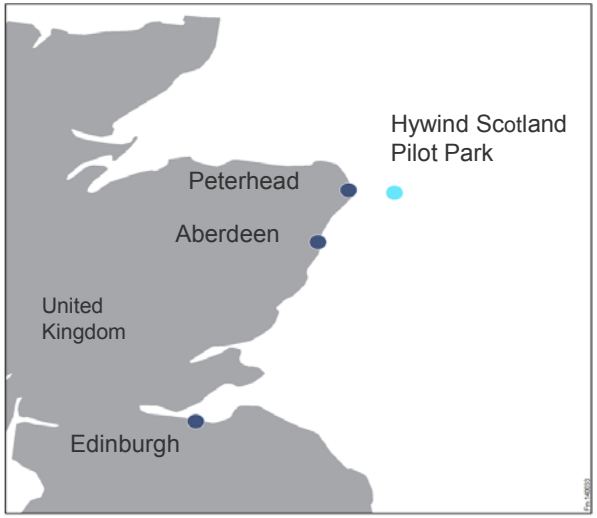
Hywind Scotland Pilot Park – 2017



- 5 x 6 MW turbines
- Water depth 95 – 120 m
- Wind speed 10.1 m/s
- Agreement for Lease 2013
- Consent in 2015
- First deliveries to grid 2017

Objective:
Demonstrate cost efficient solution and reduce risk for commercial scale deployment



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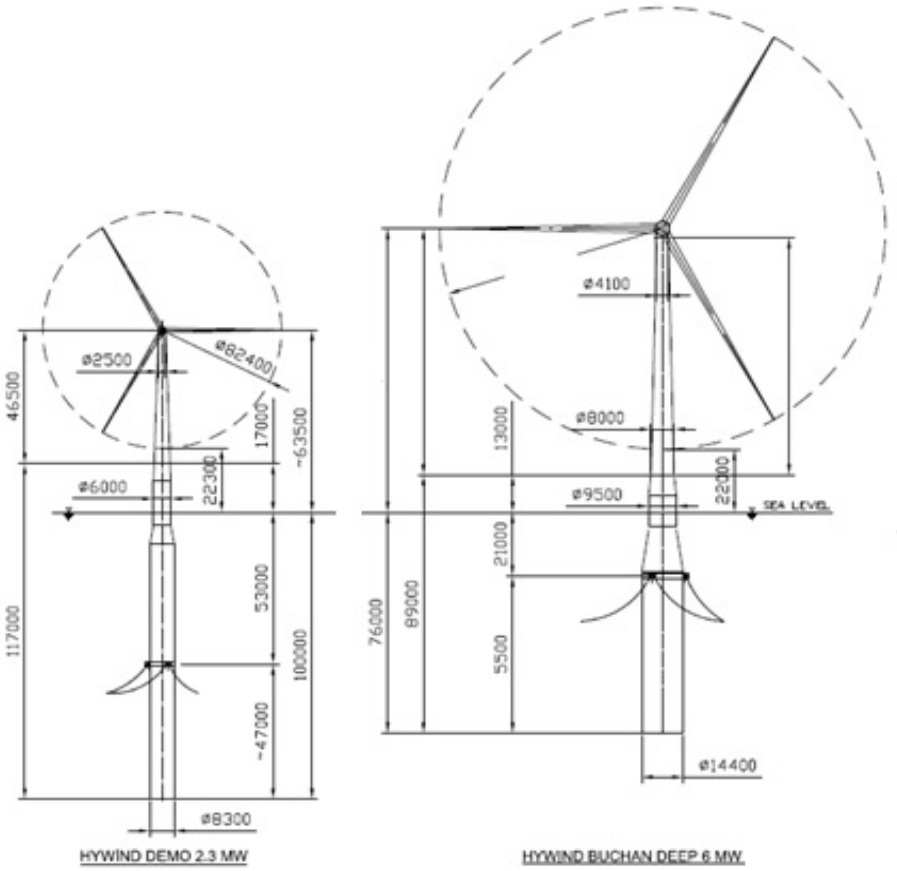
Pilot Park objectives



- Verify up-scaled and optimized design
- Test multiple units in park-configuration
- Improve fabrication and installation efficiency
- Mobilize supply chain

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The future is floating!

- Will the world's first commercial scale floating wind farm be on US west coast?

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There's never been a better time for good ideas

Global Offshore Wind 2014

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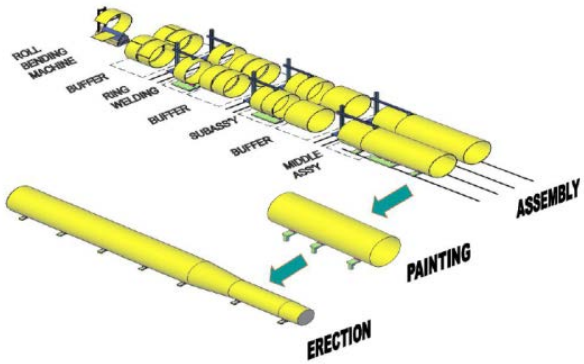
Wake effects for floating WTGs

- WTGs in the wake of other WTGs will experience asymmetric wind loads
- No information on the effect of wake loading on floater motions
- Analytical studies will be verified with full-scale measurements

Substructure fabrication

- Hywind design has been developed for efficient mass production, similar to that of WTG towers and monopiles
- Fabrication feasibility has been confirmed from a number of fabrication studies
- The pilot park will be used to monitor and evaluate the fabrication process, and identify scale effects which can be used to optimize production for future wind farms



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Assembly and installation

- Simple, safe and efficient in-shore assembly is a main advantages of floating wind units compared with fixed
- Large potential to save cost by optimization of logistics and vessel utilization
- The pilot park will be used to demonstrate scale effects to reduce unit cost, and gain learnings that will lower cost further in future large scale projects