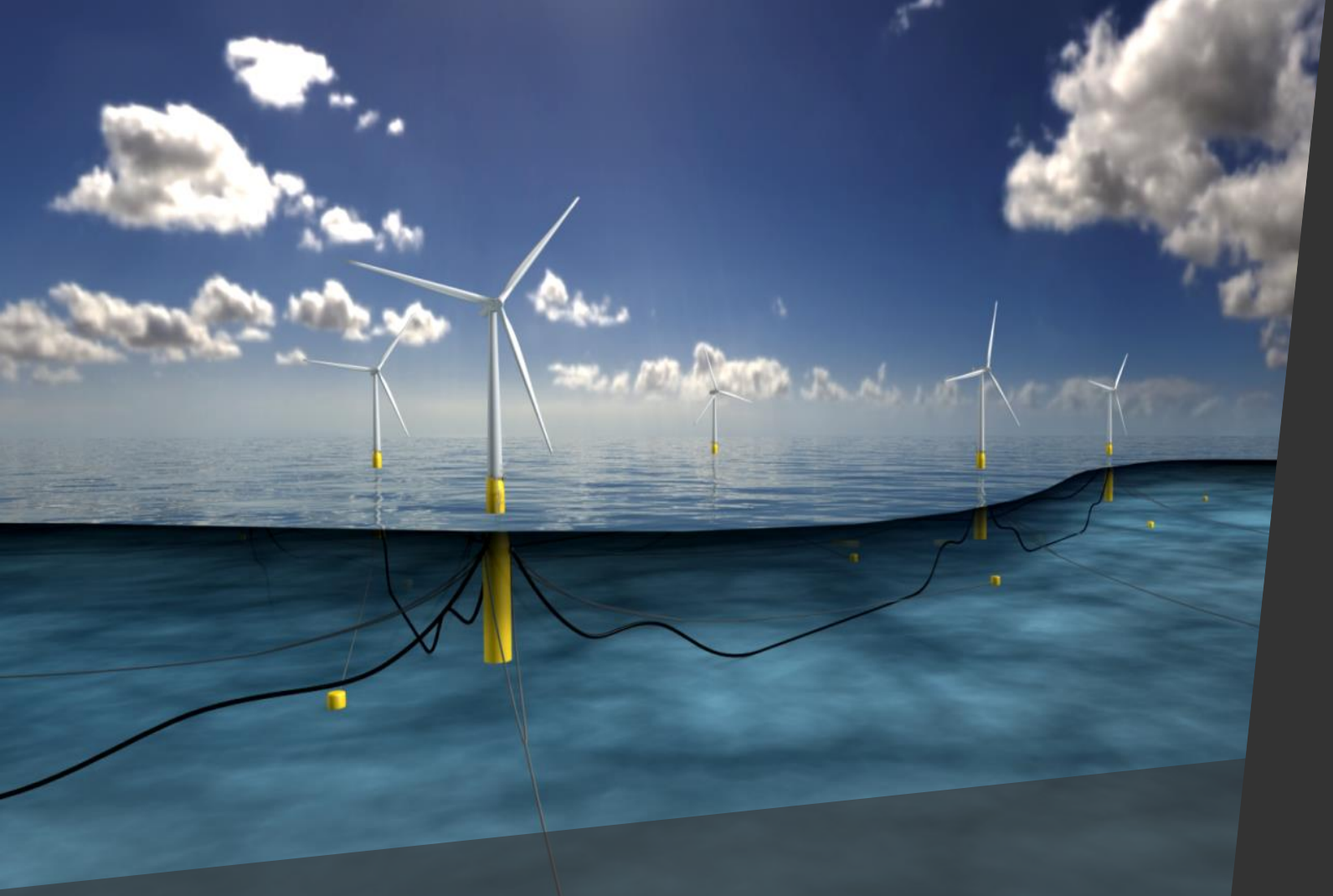


Hywind Scotland – status and plans

EERA DeepWind’ 2016, Trondheim

Knut Erik Steen, Statoil

Offshore wind

Playing at our strengths

- Financial control and project management excellence
- Multi contracting interfaces
- Marine operations
- Managing technology and subsurface
- Operations excellence
- Managing technology risks and use
- Safety culture and community engagement

Statoil positioning in offshore wind

Current Portfolio

Hywind Demo

2.3MW

In operation

Sheringham Shoal

317MW
1.11 Twh / yr

In operation

Dudgeon

402MW
1.7 Twh / yr

FID

Construction and installation phase

Hywind pilot park

30MW
0,14 Twh / yr

FID

Construction and installation phase

Increase Portfolio & Acreage

North West Europe

Japan

US

Dogger Bank

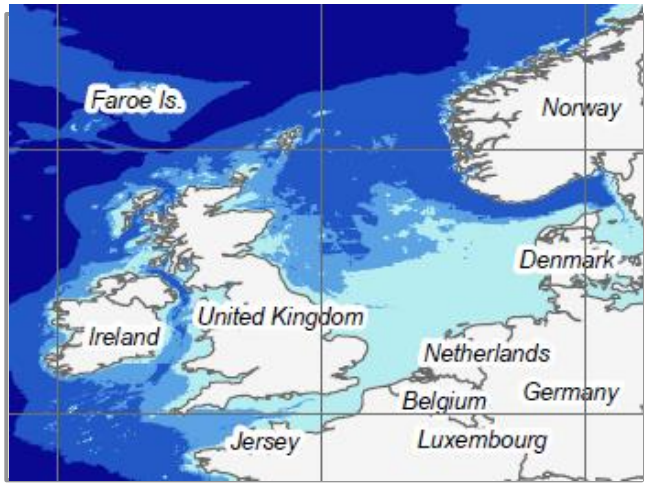
1200MW
each project

Hywind Commercial Park

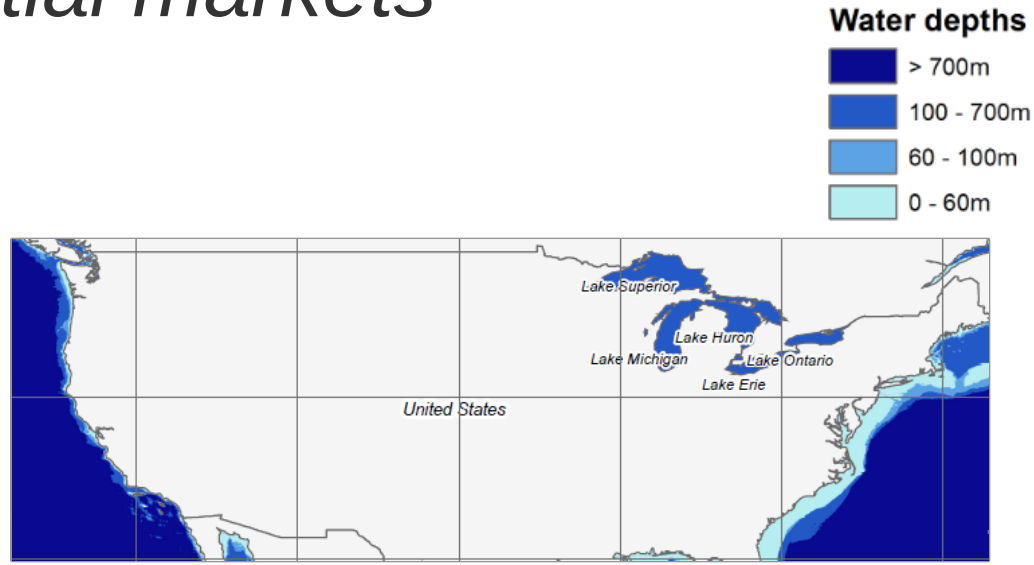
2009- **2012-** **2017** **2017-** **2020-**

Statoil

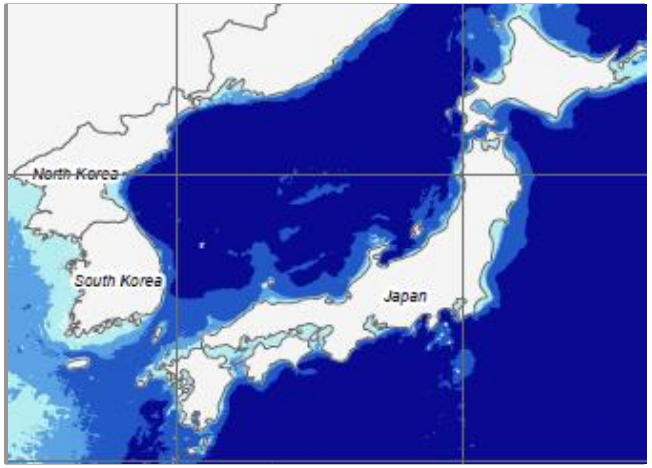
Floating wind - *Potential markets*



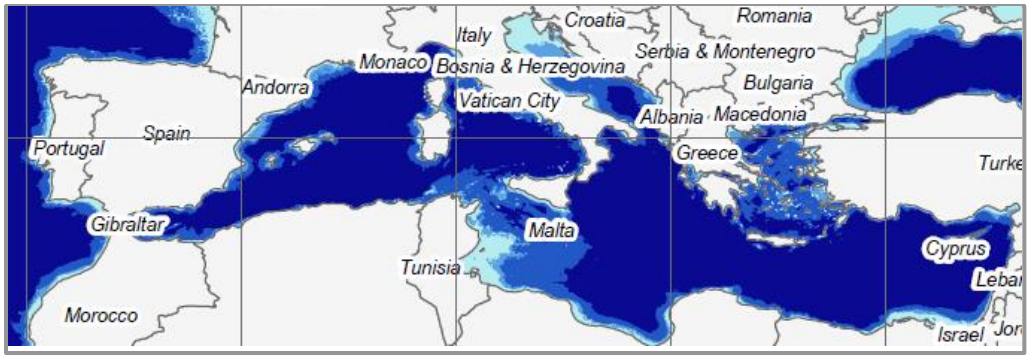
North sea – Norway and UK



US, Atlantic and Pacific coast – and Great Lakes



Japan and Korea



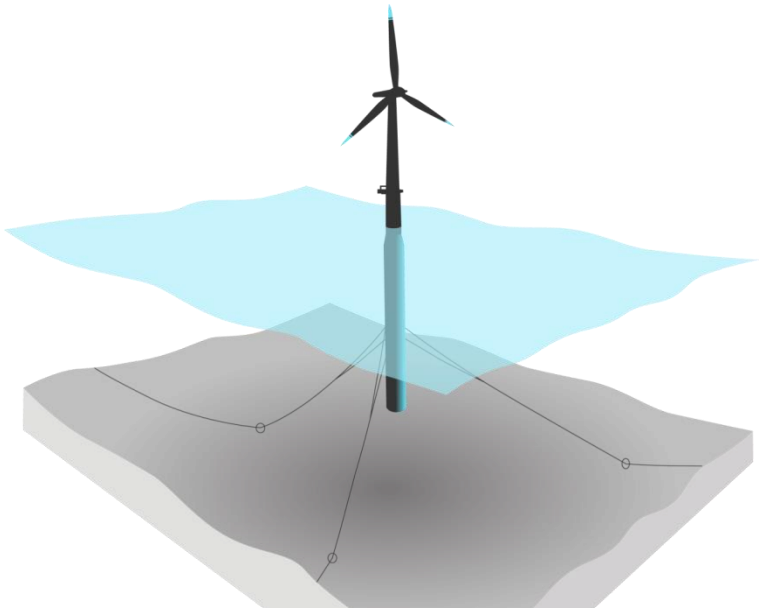
Iberian Peninsula and Mediterranean Sea

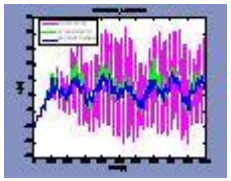
Statoil

HYWIND

What is Hywind?

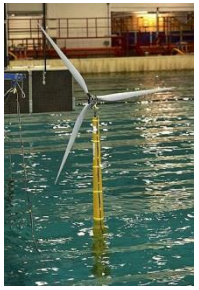
- Floating wind turbine (FWT)
- A standard offshore wind turbine placed on a ballasted vertical steel cylinder, anchored to the seabed
- Active motion controller
- Statoil-owned technology





Concept

2001

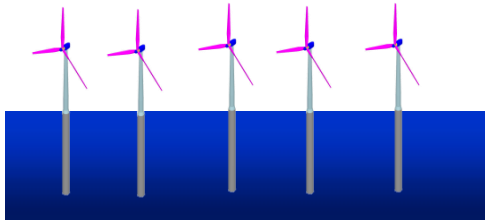


Model test

2005

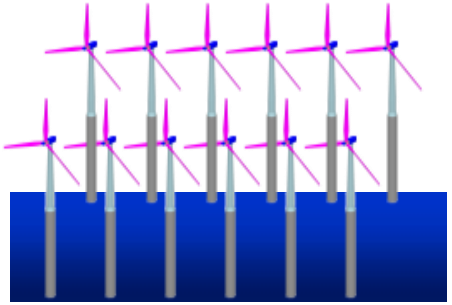
Full-scale prototype

2009



Pilot Park, 3-6 turbines

<5 years



Large Parks, 500-1000MW

<10 years

Statoil

HYWIND DEMO

Hywind Demo – the World's first full scale prototype

10 km offshore Norway at 200 meter depth:

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

Statoil

Hywind Demo - assembly and installation - 2009

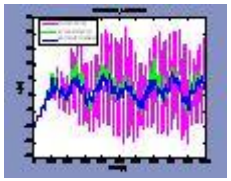
- Simple and safe assembly and installation

Statoil

HYWIND SCOTLAND

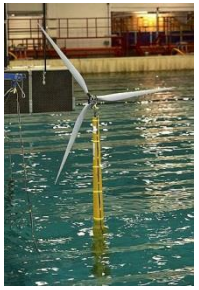
Commercialisation of Hywind

Status:	Next step:	End goal:
• The technical concept is considered proven	• Pilot park to demonstrate improvements and cost reductions	• Commercial scale parks of 500-1000 MW • Cost competitive with bottom fixed



Concept

2001

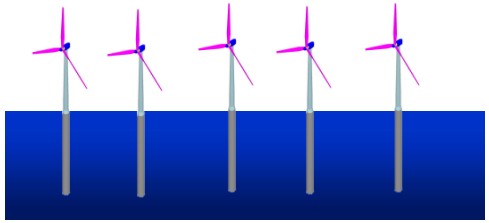


Model test

2005

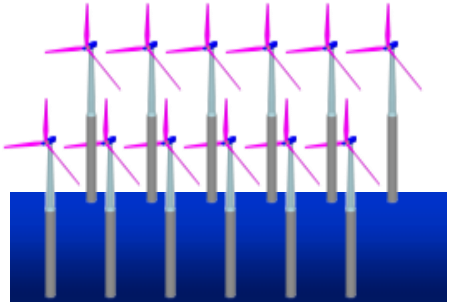
Full-scale prototype

2009



Pilot Park, 3-6 turbines

<5 years



Hywind Scotland - project objectives

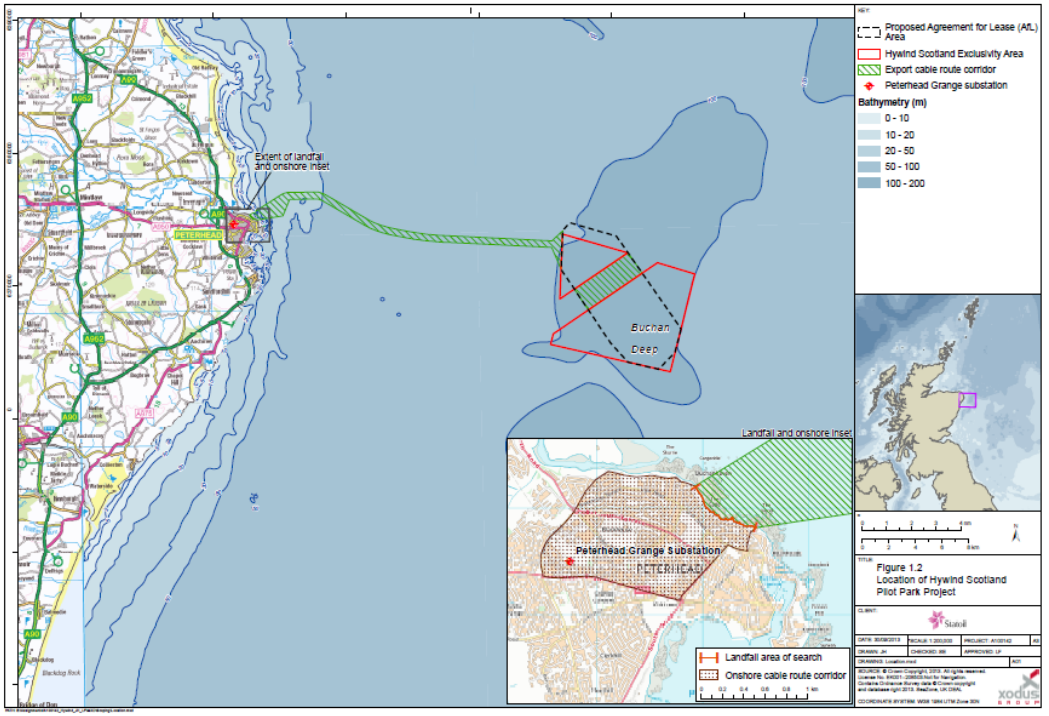
Demonstrate cost-efficient and low risk solutions for commercial scale parks

- Test multiple units in park-configuration
- Verify up-scaled design
- Verify reliability and availability of optimized multi-turbine concept
- Mobilize supply chain

Hywind Demo Hywind Scotland

Hywind Scotland Pilot Park

Hywind Scotland	
Area (sea level)	~4 km^2
Water depth	95-120 m
Average wind speed (@100 m)	10.1 m/s
Mean waves, Hs	1.8 m
Installed capacity (5 WTGs)	30 MW
Offshore export cable length	30 km
Onshore cable length	2-3 km
Transmission voltage	33 kV
Tentative milestones: • Final Investment Decision • Offshore installation & commissioning	Q3 2015 2017

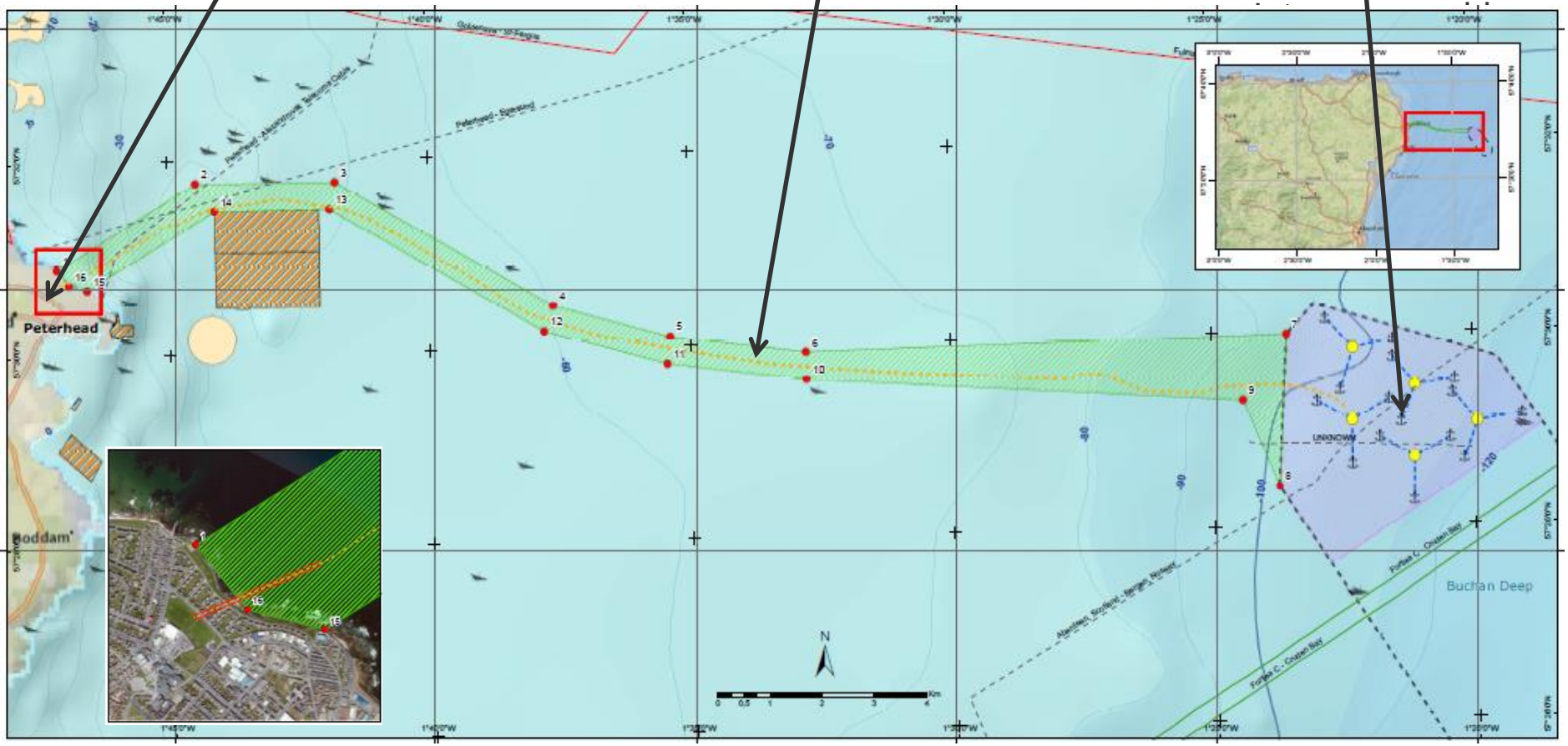


Classification:

Statoil

Hywind Scotland test park at a glance

- Electrical swichgear plant
- Export cable
- 5 x 6MW WTG units
- Mooring system



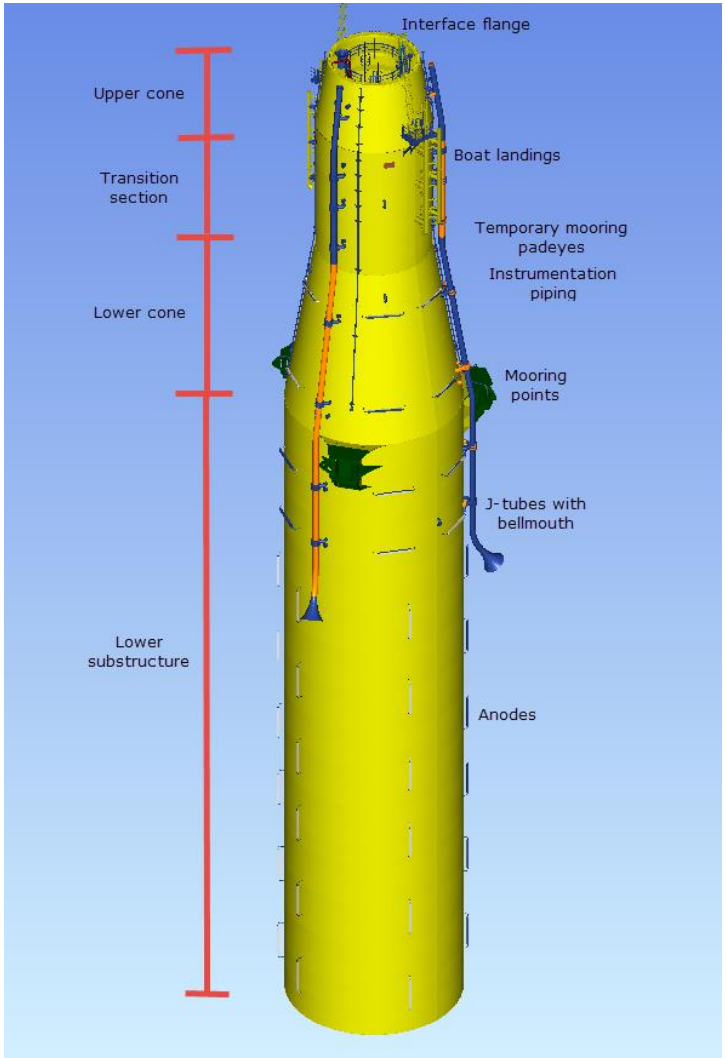
Statoil

Upscaling from Demo 2009 to Hywind Scotland 2014

Dimension	Hywind Demo	Hywind Scotland
Mass	5300 tons	~11500 tons
Hub height	~65 m	~100 m
Draught	100 m	~75 - 80 m
Diameter of sub-structure	8.3 m	~14 - 15 m
Water depth	220 m	~95 - 120 m
Rotor diameter	~85 m	154 m
Capacity	2.3 MW	6.0 MW

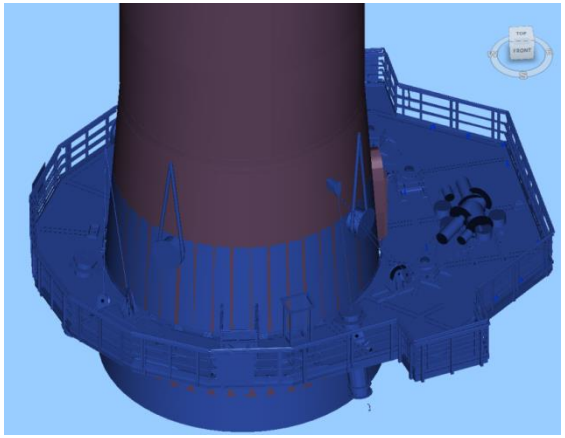
Statoil

Substructure & Tower



Height : 91m

Diameter : 14,4m →7,5m



Height : 83m

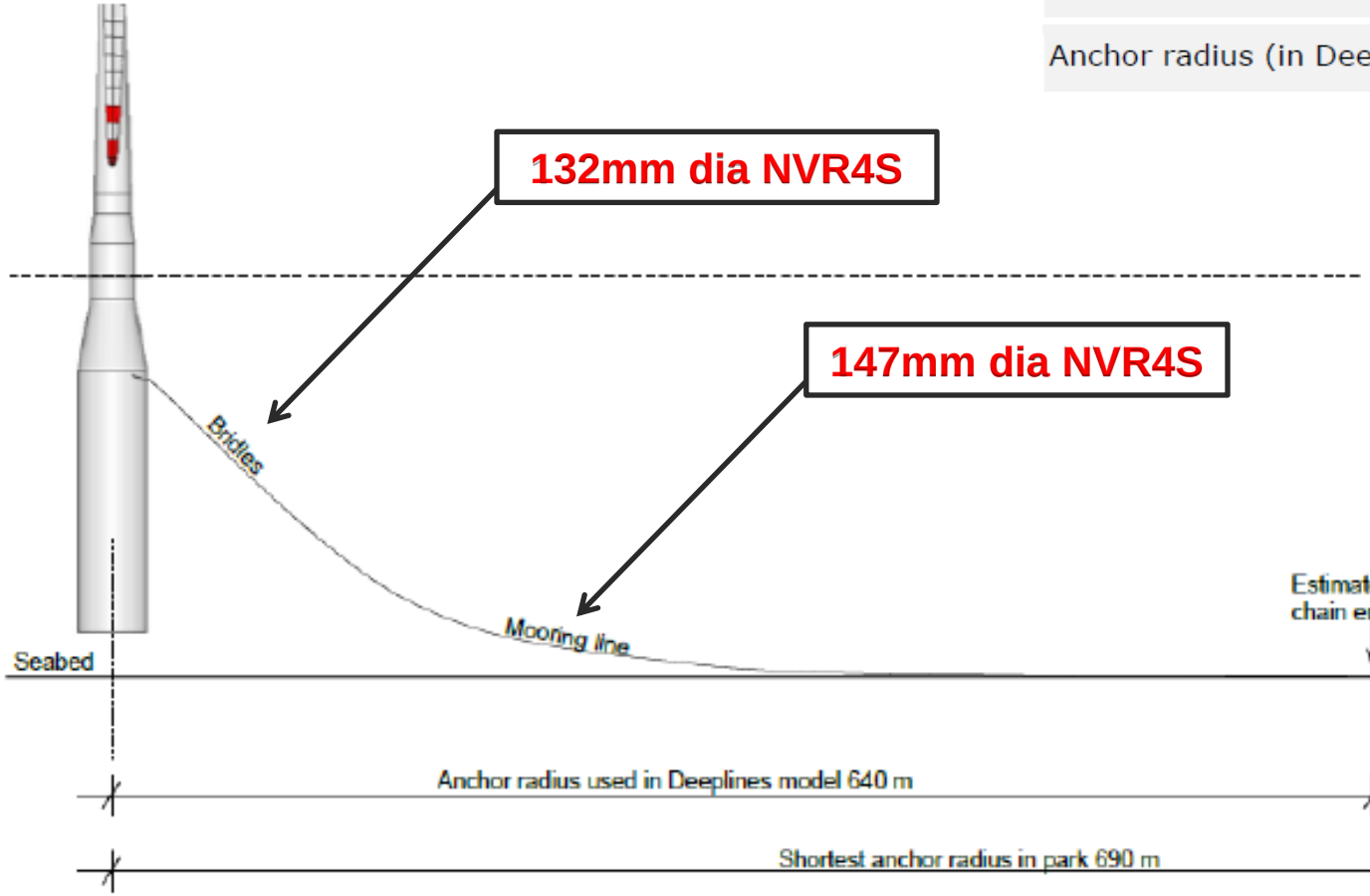
Diameter : 7,5m →6,5m

Statoil

Mooring System

- Normal safety class (confirm
  - Suction anchor: 5m dia x

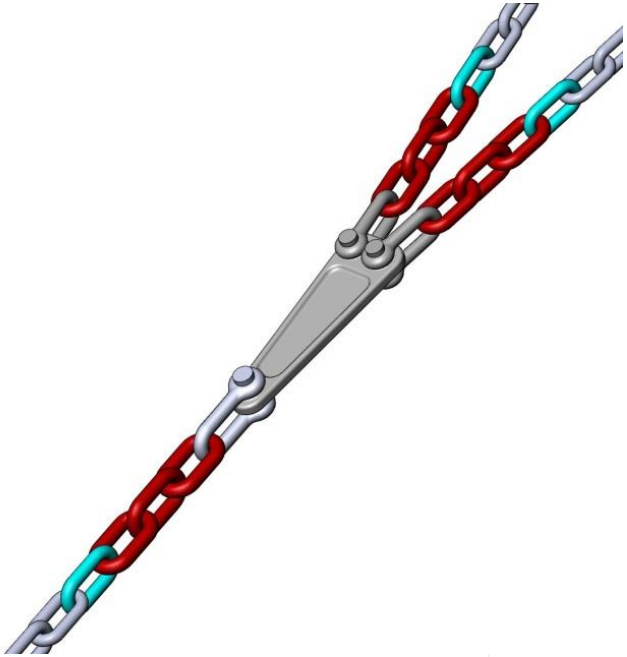
	T3_A
Bridle dimension	132 mm
Bridle length	50 m
Moring line dimension	147 mm
Pretension at triplate	900 kN
Mooring line length (in DeepLines model)	609.4 m
Anchor radius (in DeepLines model)	640 m

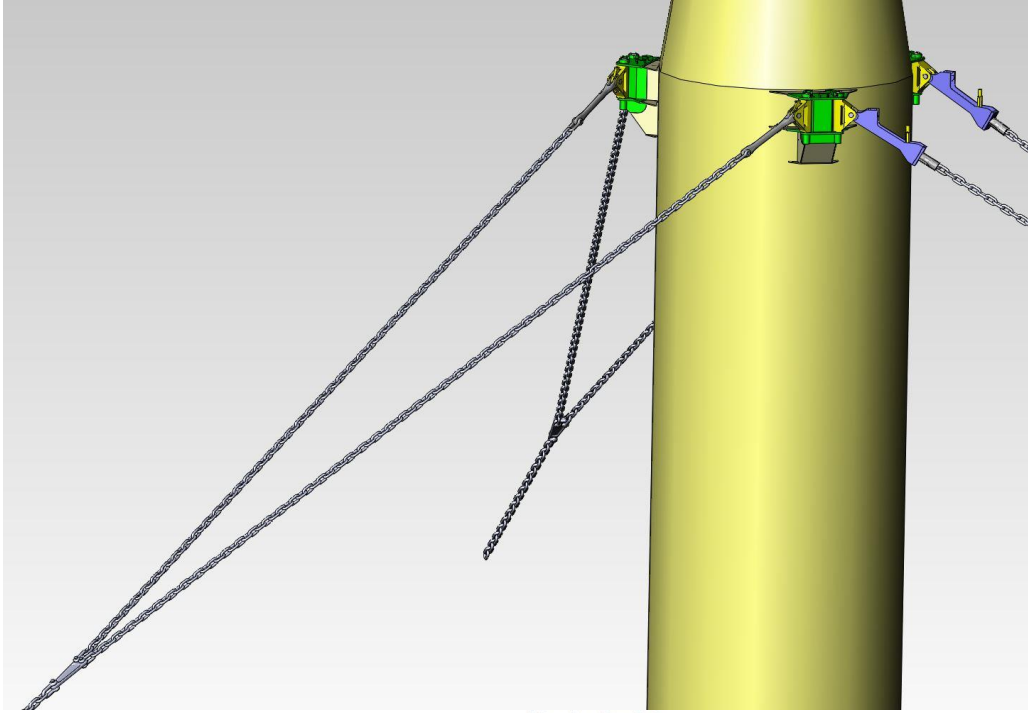


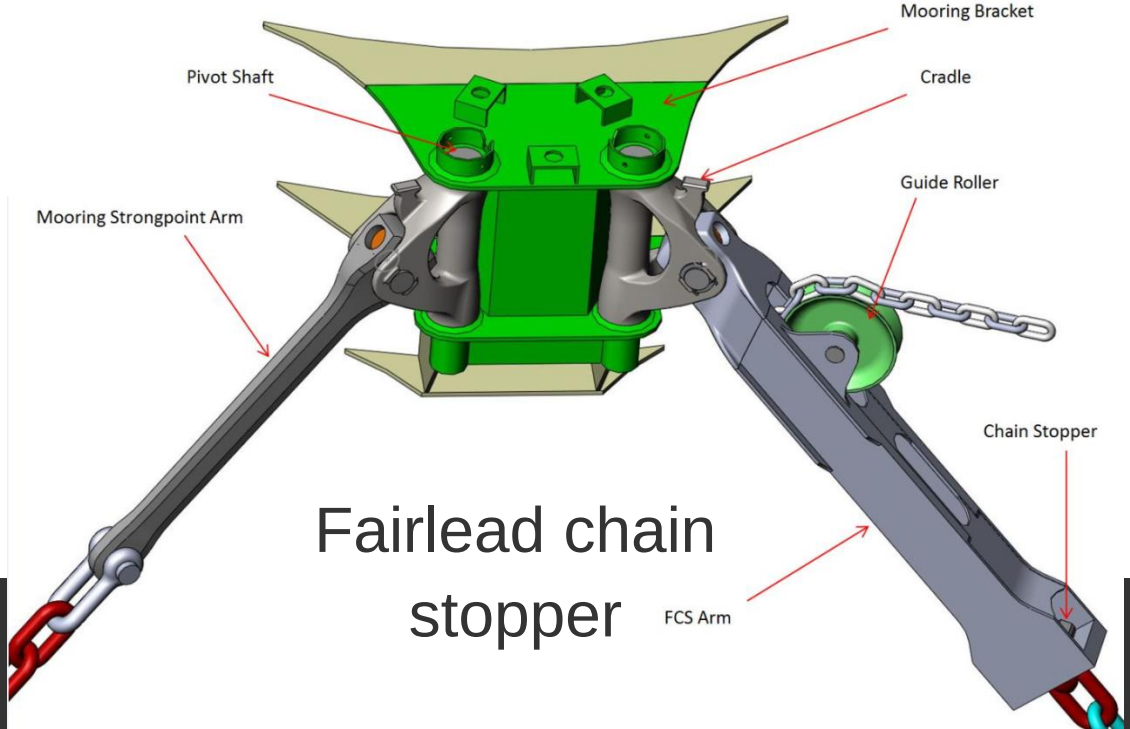
WTG Mooring Lines
Datum WGS84
Projection UTM z30N

WTG	Line ID	Anchor ID	Status	Rev	Length (m)
HS1	111	111	Planned	v3	733
	112	112	Planned	v3	740
	113	113	Planned	v3	875
HS2	121	121	Planned	v3	691
	122	122	Planned	v3	743
	123	123	Planned	v3	775
HS3	131	131	Planned	v3	783
	132	132	Planned	v3	825
	133	133	Planned	v3	787
HS4	141	141	Planned	v3	774
	142	142	Planned	v3	809
	143	143	Planned	v3	788
HS5	151	151	Planned	v3	777
	152	152	Planned	v3	832
	153	153	Planned	v3	824

Mooring Details

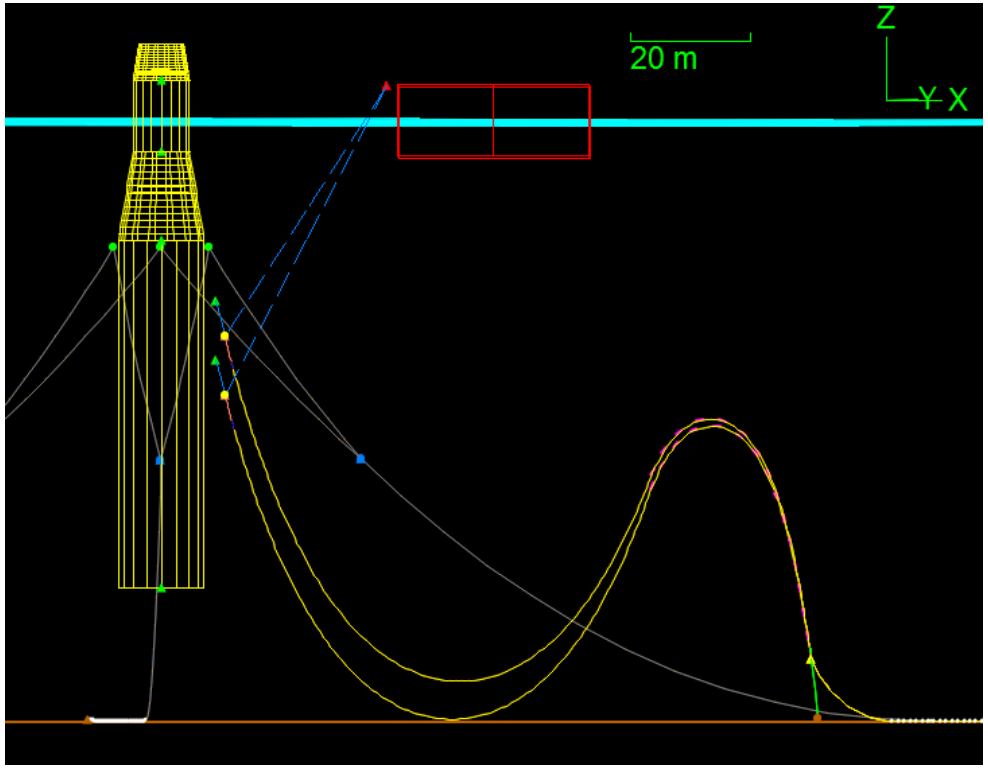


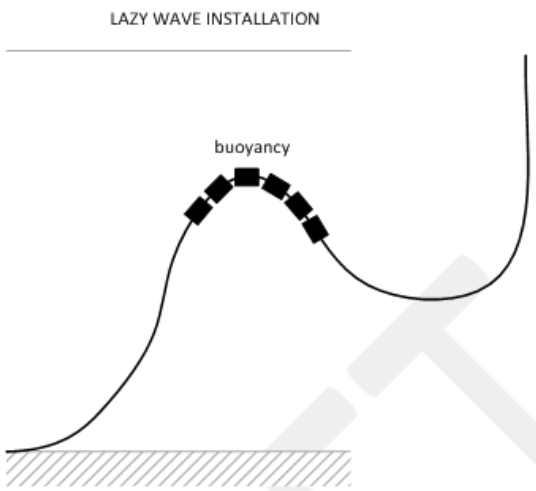


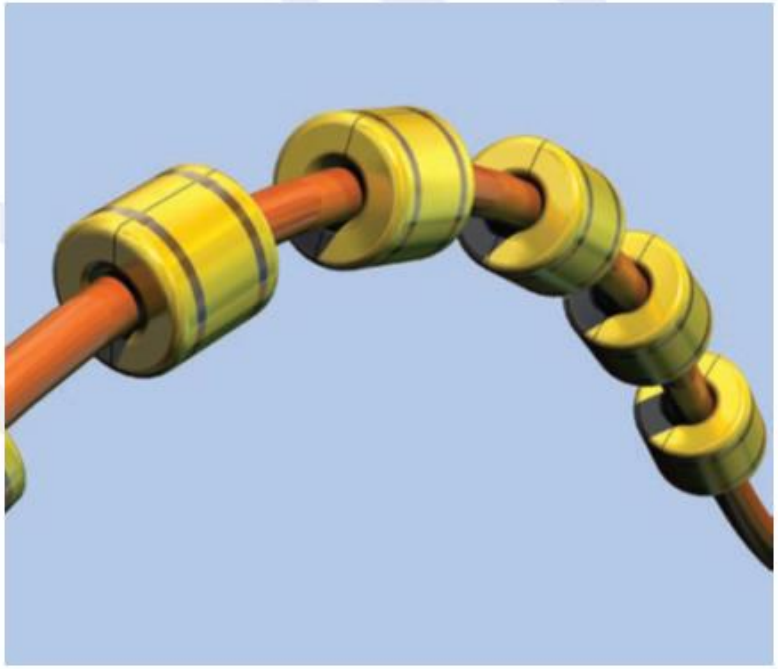


Fairlead chain stopper

Dynamic cable layout (Lazy-Wave)







SWT-6.0-154 turbine

Rotor Diameter: 154m

Rotor Area : 18.600m^2

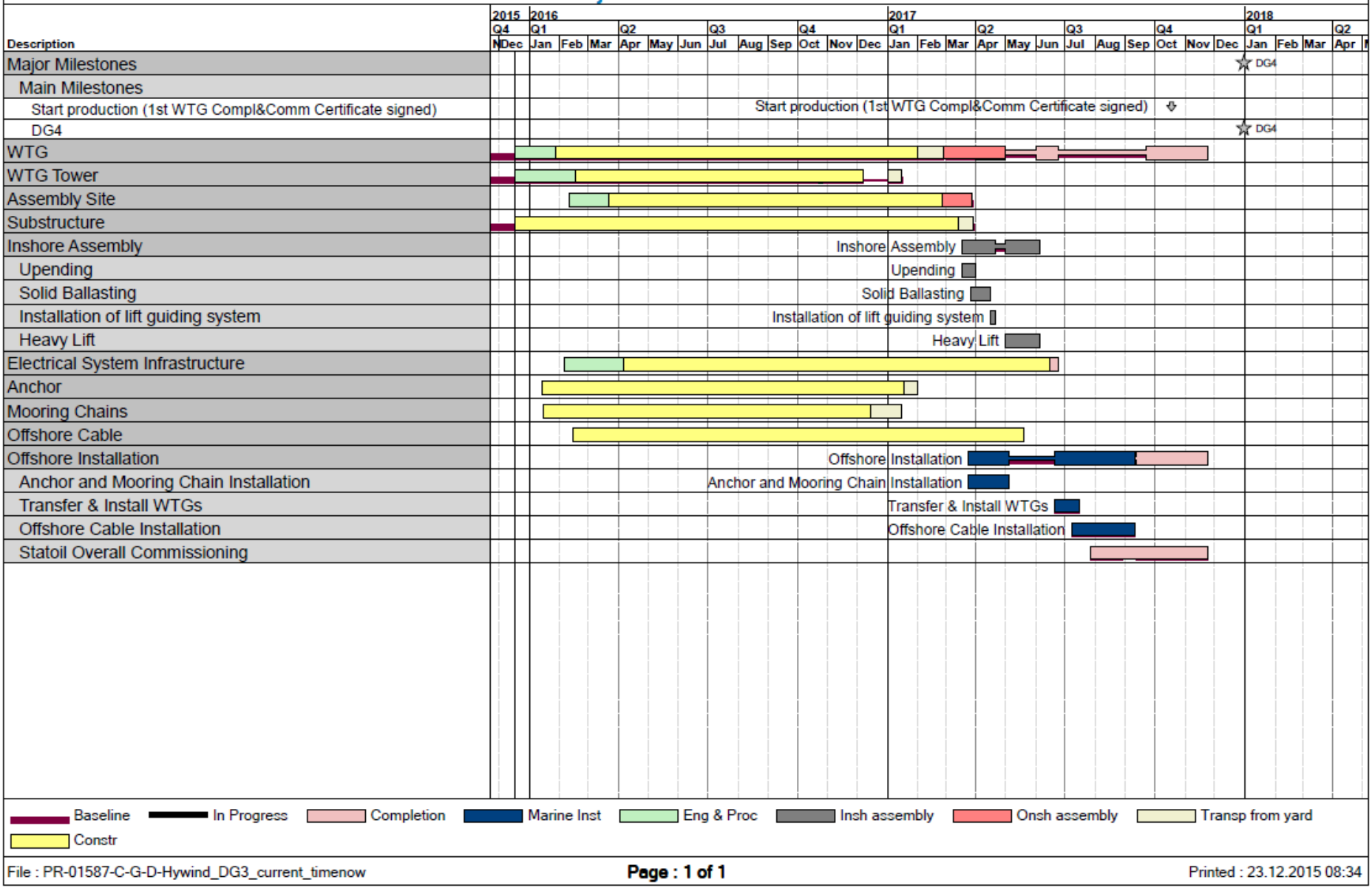
Upscaling effects

- Fabrication
  - Increased diameter of the substructure is an important challenge for the fabrication
- Marine operations, assembly site
  - Lifting heigth 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

Project Master Schedule



File : PR-01587-C-G-D-Hywind_DG3_current_timenow

Page : 1 of 1

Printed : 23.12.2015 08:34

Project execution strategy

Contract overview

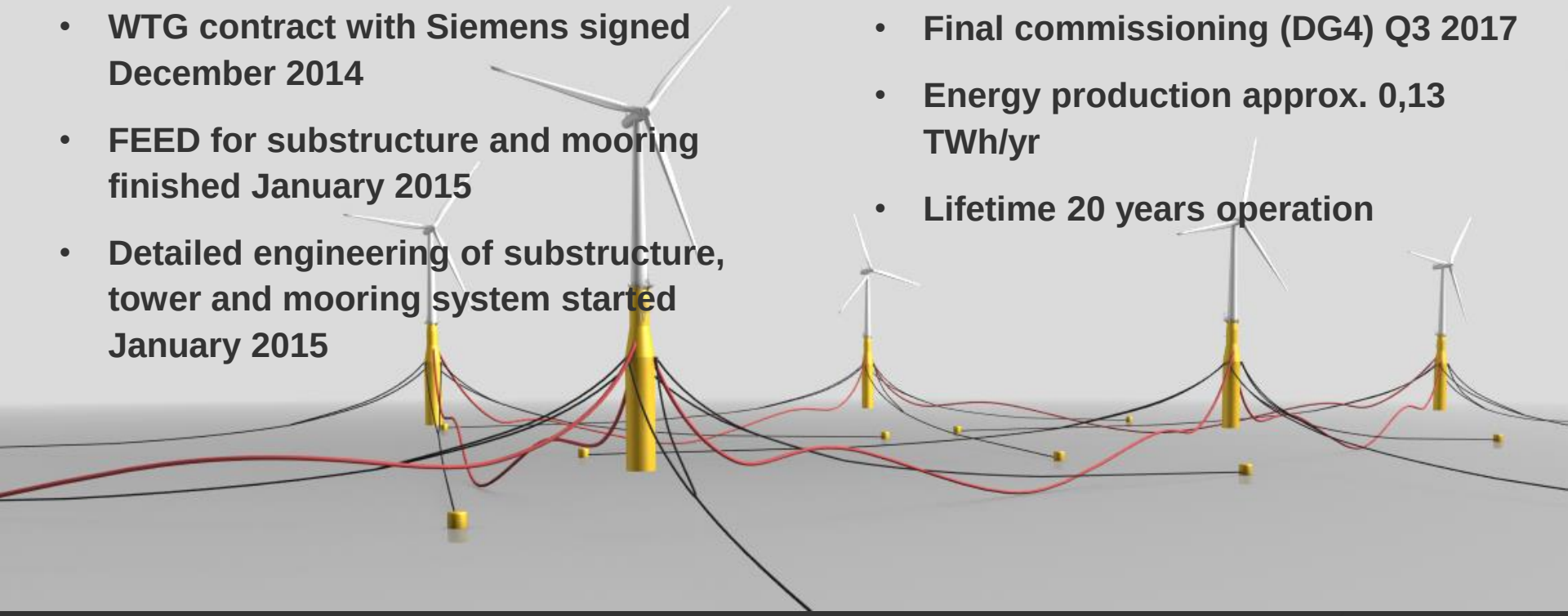
CONTRACTS	Offshore Wind Turbine (EPC)	Substructure (FC)	WTG Towers (FC)	Mooring chain (FC)	Suction anchors (FC)	Marine operations (EPCI)	Export and inter array cable (EPC+I)	Electrical System Infrastructure (EPCI)	Assembly site
Project Mgmt/planning Facility Scope									
Studies		Parallel studies with several contractors. Mooring design part of substructure	D.I.S (tower study)	Olav Olsen		Marine operation studies	Cable study	Landfall study	
FEED, Engineering& Mgmt Assistance	Siemens	Aibel						ESI Class D study	
Detail Engineering	Siemens					Competition through pre-qualified tenderers	Competition through prequalified tenderers	Competition through pre-qualified tenderers.	Competition through pre-qualified tenderers
Procurement		Navantia	Competition through prequalified tenderers	Single Source or competition through prequalified tenderers	Competition through prequalified tenderers				
Fabrication									
Installation/transport Offshore/onshore	Marine Operation						Separate cable installation contract. Competition		
Trenching and backfilling							Option in cable installation contract		
Seabed intervention						Competition or Call off Frame agreements			
Filling of ballasting material						Competition or Call off Frame agreements			
Fairlead chain stopper		Company provided item to substructure contract. Single Source							
Commissioning	Siemens								
RFO/Start up		Statoil							
O&M	Statoil and Siemens	Statoil							

- Multi-contracting strategy to minimise CAPEX and maximize market effects
- Building on Hywind Demo, Sheringham and Dudgeon experience
- Reuse existing supplier relations, where possible
- Ensure competition where possible
- Bundling explored
- Synergies with other Statoil projects for inshore heavy lift & marine operations
- Synergies with vessels on long-term hire for Statoil
- Enable Scottish content
- Interfaces

Statoil

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
- Concept selection (DG2) March 2015
- Consent Q4 2015
- FID (DG3) Q4 2015
- Final commissioning (DG4) Q3 2017
- Energy production approx. 0,13 TWh/yr
- Lifetime 20 years operation



Statoil

THANK YOU FOR YOUR ATTENTION.

Knut Erik Steen

Statoil ASA

www.statoil.com

Statoil