Blyth Demonstrator Project

Construction and Installation of 5No. Gravity Base Foundations for offshore wind turbines

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Blyth Demonstrator Project

Provide support to 5No. x 8.3MW turbines

Combined output of 41.5MW: sufficient to power 34,000 homes
Location of Blyth Offshore Wind Farm

Array 2
Under construction
~38m water depth
~5.6km from shore

Array 3A
~45m water depth
~11km from shore

Array 4
~55m water depth
~14km from shore
Blyth Offshore Demonstrator Ltd (“BOD”) – Array 2 – Client: EDF

<table>
<thead>
<tr>
<th><strong>Capacity</strong></th>
<th>41.5 MW</th>
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<tbody>
<tr>
<td><strong>Water depth</strong></td>
<td>~38m</td>
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<tr>
<td><strong>Turbine type</strong></td>
<td>5 x MHI Vestas V164-8.3MW</td>
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<td><strong>Soil Conditions</strong></td>
<td>Sand, silt and clay</td>
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<td><strong>Balance of Plant</strong></td>
<td>5 x Gravity Base Foundations 66kV electrical system Onshore substation</td>
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<td><strong>Cable route</strong></td>
<td>~11km offshore (array and export) 1.5km onshore</td>
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<td><strong>Location</strong></td>
<td>~5.6km off the coast of Blyth</td>
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<td><strong>Planning Permission</strong></td>
<td>Granted in October 2013</td>
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<tr>
<td><strong>Grid connection</strong></td>
<td>Old Blyth power station site, Blyth</td>
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<td><strong>Commercial Operations</strong></td>
<td>October 2017</td>
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Typical offshore wind farm foundation methods
Design Principal

- Effectively a monopile with a heavy weight attached
- Relies on the dead weight alone to resist overturning and sliding
- Concrete base filled with sand to achieve required mass
- Sits on a prepared gravel bed on the sea floor
- Floats in temporary condition to allow low cost transportation & installation
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BAM scope

- Design,
- Fabrication,
- Seabed preparation, and
- Installation of 5 Gravity Base Foundations ("GBF’s").

Key facts

- 26 Year design life
- Constructed in a dry-dock on Tyneside
- Over 1,800 m$^3$ of concrete per foundation
- Over 500 tonnes of steel per foundation for concrete reinforcement
- Over 600 tonnes for each of the steel shafts
- Most of the GBF built inside the dry-dock. A ballast concrete was poured after floating and pulling out the GBF, prior to the installation offshore
Reinforced Concrete Base

Approx 30m diameter, 1.1 m depth
Reinforcement ~ 212T
Volume of concrete ~ 800m$^3$
Slipform Walls

- Reinforcement ~ 186T
- Concrete ~ 350m³
- Continuous operation: 100mm per hour of rise = approx. 10 hours of strength.
- Approx. 3 ½ days to construct 8m high structure.
Slipform Walls
Steel shafts

60m total length, 7.5m diameter, wall diameter ~70mm
2 sections, each 330 Tonne
Fabricate (Hoboken, Belgium) & transport horizontally by barge
Blyth Demonstrator Project

Steel shafts – Lower section

30m length, 7.5m diameter
330 Tonne
Fabricate (Hoboken, Belgium) & transport horizontally by barge
Upend on site & install
Roof segments

- 6 No Precast segments to form each conical roof.
- Each segment approx. ~125 Tonne
- Cast on site horizontal
- Incline to 40 degree installation angle
- Insitu “stitch” concrete.
Upper shaft – Field weld

- 70mm wall thickness
- 2 – sided Weld: internal access & ventilation required
- Bare steel – no requirement for protective coating.

SACP
Steel shafts - Protection

External

- Splash zone & Atmospheric: Norsok C5M environment – coating Interzone 954 (3 x 250 micron) + Interthane 990 (80 micron)

- Fully immersed: Norsok IM2 environment
  Bare steel – SACP AlZn
Steel shafts - Protection

Internal

- Atmospheric: Norsok C4 environment
  Interzone 954 (2 x 200 micron)

- Fully immersed: Norsok IM2 / IM3 environment
  Bare steel – SACP Zn
Steel shafts: Pre-coating Inspection
Steel shafts – Coating application & testing
Float and Submerge installation

Tolerances after installation

- Flange connection horizontality: 0-0.5 degrees (max 0.1 degrees)
- Height: $19.3 < 19.5 < 20.5\text{m LAT}$ ($20.3-20.5$)
- Orientation: +/-6 degrees (max 4 degrees)
- Position: +/- 2m (max 0.6m)
Stage 1 – Design, Modelling & Certification

- Integrated load analysis with turbine designer, incl. development of specific parametric model
- Numerical and physical model testing - floating condition
- Bespoke geotechnical design for each location
- Permanent works design aligned with construction and installation methodology
- Integrated 3D CAD model for all permanent & temporary works, plus management of interfaces with other contractors
- Detailed review of the design by EDF ER (Client) and DNV GL (Certifier)
Stage 2a – Build the structure on land
Stage 2b – Sea bed preparation
Stage 3 – Floating structure: “Ship”

Floating stability:
- Additional ballast concrete (7000T)
- Centre of Gravity
- Centre of buoyancy
- Metacentric height
Stage 4 – Immersion: “Submarine”

- Addition of water ballast to control the immersion process:
  - Maintain neutral buoyancy
Stage 5 – Increased Mass / Stability

- Additional
  - Water ballast
  - Sand ballast
  - Total immersed (effective) weight circa 12000 Tonne
  - Rock armour scour protection
Stage 6 – “Turbine” (by others)

- Tower
- Narcelle
- Blades
- Cabling
- Commissioning
Stage 7 – Provide upto 41.5MW Power for 26 years
Thank you

Any Questions?