Supply chain structure
<table>
<thead>
<tr>
<th>Year</th>
<th>Environmental and geophysical survey</th>
<th>Year</th>
<th>Met station design and installation</th>
<th>Year</th>
<th>Geotechnical survey</th>
<th>Year</th>
<th>Contracting</th>
<th>Year</th>
<th>Foundation installation</th>
<th>Year</th>
<th>Cable laying</th>
<th>Year</th>
<th>Turbine installation and commissioning</th>
<th>Year</th>
<th>Electrical substation installation and commissioning</th>
<th>Year</th>
<th>Operations and maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>-5</td>
<td>Red</td>
<td>-4</td>
<td>Red</td>
<td>-3</td>
<td>Red</td>
<td>-2</td>
<td>Red</td>
<td>-1</td>
<td>Blue</td>
<td>0</td>
<td>Blue</td>
<td>0</td>
<td>Blue</td>
<td>0</td>
<td>Blue</td>
<td>0</td>
<td>Blue</td>
</tr>
<tr>
<td>Year</td>
<td>Operations</td>
<td>Year</td>
<td>Operation</td>
<td>Year</td>
<td>Operation</td>
<td>Year</td>
<td>Operation</td>
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<td>Year</td>
<td>Operation</td>
<td>Year</td>
<td>Operation</td>
<td>Year</td>
<td>Operation</td>
</tr>
</tbody>
</table>
Project history

• Apr 01 – First Project Heads of Terms
• Dec 03 – Crown Estate agreement for Round 2 lease
• Jun 05 – Consent applications submitted
• Jun 06 – Local authority rejected substation
• Dec 06 – Offshore consents granted
• Mar 07 – Substation public inquiry - decision Aug 07
• Jul 08 – Shell sold its share to DONG (50%) and E.ON (50%)
• Oct 08 – E.ON sold 40% of its share to Masdar
• Apr 09 – UK Government assistance for Round 2 projects
• May 09 – Investment decision & turbine contract
• Jul 09 – Construction of onshore substation started
• Mar 11 – Offshore construction started
Sourcing categories

- Commodities and raw materials
- Catalogue
- Subcontract ‘make to print’
- Design win
- Project sourced
- Project contract
- Framework agreements
- Strategic investments and relationships
Project development and consenting: Procurement

Development and consenting

- Met station
  - Fabrication
  - Sensors
  - Installation
- Surveys
  - Vessels
  - Equipment
  - Crews
- Professional services
  - Environmental
  - Engineering
  - Legal
  - Financial
### Project development and consenting

<table>
<thead>
<tr>
<th>Elements</th>
<th>Description</th>
<th>Skills required</th>
<th>Typical cost (500MW farm)</th>
<th>Procurement model (typical)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development services</td>
<td>Feasibility, licensing, planning and radar</td>
<td>Environmental, engineering and legal</td>
<td>£15 million</td>
<td>Project sourced</td>
</tr>
<tr>
<td>Environmental surveys and analysis</td>
<td>Activities undertaken to understand and address the environmental impact of the wind farm to generate an environmental impact assessment</td>
<td>Environmental</td>
<td>£2 million</td>
<td>Project sourced</td>
</tr>
<tr>
<td>Coastal process surveys</td>
<td>Impact of the wind farm development on sedimentation and erosion of the coastline</td>
<td>Engineering and numerical modelling</td>
<td>£3 million</td>
<td>Project sourced</td>
</tr>
<tr>
<td>Met station supply and install</td>
<td>To monitor and analyse all aspects of meteorological and oceanographic conditions at the site</td>
<td>Engineering services, offshore installation</td>
<td>£8 million</td>
<td>Project contract</td>
</tr>
<tr>
<td>Sea bed surveys</td>
<td>Analyse the sea floor of the proposed wind farm site to assess its conditions and characteristics. Involve geophysical surveys of features, bathymetry and geotechnical surveys of the sea bed characteristics</td>
<td>Geotechnical engineering, specialist vessel operation and survey equipment supply</td>
<td>£8 million</td>
<td>Project sourced</td>
</tr>
<tr>
<td>Front-end engineering and design</td>
<td>Address areas of technical uncertainty and develop the concept of the wind farm in advance of contracting</td>
<td>Engineering</td>
<td>£1 million</td>
<td>Project sourced</td>
</tr>
<tr>
<td>Human impact studies</td>
<td>Impacts on the community living near the wind farm. This includes visual, noise and socio-economic impacts.</td>
<td>Environmental, engineering and economic</td>
<td>£0.1 million</td>
<td>Project sourced</td>
</tr>
</tbody>
</table>
Project development and consenting

- **Met masts**: Often awarded as a single supply and install contract. Contractor often not the fabricator.

- **Surveys**: Geophysical and geotechnical the main cost.

- In general, no particular reason to use a local supplier – but no reason not to.
Turbine supply: procurement

**Turbine**

- **Blades**
  - Resin
  - Glass fibre
  - Tooling
  - Handling

- **Hub**
  - Fabrication
  - Castings
  - Fasteners
  - Electrical drives

- **Gearboxes**
  - Steel
  - Castings
  - Precision engineering

- **Electrical and control**
  - Medium voltage
  - Power electronics
  - Sensors
  - Monitoring

- **Nacelle**
  - Cover
  - Bearings
  - Auxiliary drives
  - Precision engineering

- **Tower**
  - Steel plate
  - Welding
  - Coatings
  - Internals
## Turbine supply: procurement

<table>
<thead>
<tr>
<th>Elements</th>
<th>Description</th>
<th>Skills required</th>
<th>Typical cost (500MW farm)</th>
<th>Procurement model (typical)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blades</td>
<td>Aerodynamic component of the turbine that captures wind’s kinetic energy</td>
<td>Composites knowledge and complex handling</td>
<td>£100 million</td>
<td>In house, design win or subcontracted</td>
</tr>
<tr>
<td>Hub casting</td>
<td>The mounting for the blades that houses the pitch system and connects the rotor to the drive train</td>
<td>Engineering systems</td>
<td>£50 million</td>
<td>Subcontracted</td>
</tr>
<tr>
<td>Gearbox</td>
<td>Where present, the gearbox converts low speed hub rotation into high or medium speed shaft driving the generator.</td>
<td>Drive train and gearbox experience</td>
<td>£130 million</td>
<td>Design win</td>
</tr>
<tr>
<td>Generators</td>
<td>Converting rotation into electrical output</td>
<td>Large (MW scale) generators</td>
<td></td>
<td>Design win</td>
</tr>
<tr>
<td>Electrical power and control systems</td>
<td>Systems for safety, power output regulation, turbine control, remote monitoring and condition monitoring</td>
<td>Electrical and control engineering</td>
<td>£110 million</td>
<td>Design win</td>
</tr>
<tr>
<td>Nacelle cover and spinner</td>
<td>Composite covers for the nacelle and hub and other mechanical and electrical components within the nacelle</td>
<td>Composites and composite tooling</td>
<td>£60 million</td>
<td>Design win or subcontracted</td>
</tr>
<tr>
<td>Tower</td>
<td>Conical tube made of welded steel sections supporting the nacelle and rotor</td>
<td>Metal rolling, welding and handling</td>
<td>£85 million</td>
<td>Subcontracted</td>
</tr>
<tr>
<td>Blades</td>
<td>Aerodynamic component of the turbine that captures wind’s kinetic energy</td>
<td>Composites and complex handling</td>
<td>£100 million</td>
<td>In house, design win or subcontracted</td>
</tr>
</tbody>
</table>
Turbine – who’s who offshore

Proven track record

- **SIEMENS**
  Siemens Wind Power

- **Vestas**
  No. 1 in Modern Energy

Offshore installed turbines

- **BARD**
- **SINOWEL**

Ambitious newcomers offshore

- **ALSTOM**
- **SAMSUNG HEAVY INDUSTRIES**
- **MITSUBISHI HEAVY INDUSTRIES, LTD.**
- **Gamesa**

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Procurement approach

Balance of plant

- Foundations
  - Steel
  - Fabrication
  - Assembly

- Electrical
  - Onshore civil
  - Transformers
  - Switchgear
  - Control
  - Offshore structure

- Cables
  - Core extrusion
  - Insulation
  - Accessories
  - Protection

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## Balance of plant manufacture

<table>
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<th>Typical cost (500MW farm)</th>
<th>Procurement model (typical)</th>
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</thead>
<tbody>
<tr>
<td>Foundations</td>
<td>Sea bed mounting for the wind turbine or substation. May be of monopile, jacket (steel lattice) or concrete design</td>
<td>Large structures and complex handling</td>
<td>£260 million</td>
<td>Project contract</td>
</tr>
<tr>
<td>Substation</td>
<td>Offshore substation with high voltage transformer and switchgear and possibly HVDC conversion equipment. Offshore substation platform and foundation. Offshore substation platform and foundation. Onshore buildings and civil works</td>
<td>High voltage electrical engineering Large structure fabrication</td>
<td>£155 million</td>
<td>Project contract</td>
</tr>
<tr>
<td>Subsea cables</td>
<td>Production of medium voltage AC and high voltage AC or DC cable to interconnect turbines or export power to shore</td>
<td>Specialist manufacturing and assembly</td>
<td>£90 million</td>
<td>Project contract</td>
</tr>
</tbody>
</table>
Foundations – who’s who?

Monopiles
- Sif Group
- SMULDERS
- BLADT INDUSTRIES
- EEW
- ZPMC
- TAG Energy Solutions LTD
- DILLINGER HÜTTE

Jackets and tripods
- BARD
- WeserWind GmbH
- EEW
- OGN GROUP
- STX
- SMULDERS GROUP

“Other” steel
- AMBAU
- harland and wolff
- Keystone Engineering INC.
- SPT Offshore

Concrete
- GRAVITAS OFFSHORE
- HOCHTIEF / COSTAIN / ARUP
- SKANSKA
- seatower

EPC
- MTHøjgaard
- Ballast Nedam
- Van Oord

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Substations and cable – who’s who?

Electrical

- Siemens
- Alstom
- ABB
- CG Power Solutions

Subsea cables

- Prysmian
- ABB
- Nexans
- NKT Cables
- JDR
- Parker
- LS Cable
- NSW

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Substation contracting

Developer X

- Electrical supply
  - Topside fabrication
  - Foundation fabrication
  - Offshore substation installation
  - Onshore substation civil engineering

DONG

- Transformer supply
- Switchgear supply
- Reactors
- Topside fabrication
- Foundation fabrication
- Offshore substation installation
- Onshore substation civil engineering
Procurement approach

Installation and commissioning

- Assembly
  - Port services
  - Lifting
  - Mechanical assembly and joining

- Vessels
  - Manufacture and fit-out
  - Tooling supply

- Commission
  - Electrical testing
  - Mechanical testing

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## Installation and commissioning

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Turbines</td>
<td>Specialist vessels supplied to handle turbines</td>
<td>Offshore installations and vessel operation</td>
<td>£130 million</td>
<td>Project or framework contract</td>
</tr>
<tr>
<td>Foundations</td>
<td>Specialist vessels supplied to handle space frames and monopile foundations</td>
<td>Offshore installations and vessel operation</td>
<td>£90 million</td>
<td>Project or framework contract</td>
</tr>
<tr>
<td>Offshore electrical</td>
<td>Specialist vessels supplied to handle offshore substations</td>
<td>Offshore installations and vessel operation</td>
<td>£10 million</td>
<td>Project or framework contract</td>
</tr>
<tr>
<td>Subsea cable</td>
<td>Specialist cable lay vessels or barges used along with ploughs and ROVs</td>
<td>Offshore trenching and cable vessel operation</td>
<td>£130 million</td>
<td>Project or framework contract</td>
</tr>
<tr>
<td>Vessels and equipment supply</td>
<td>Charter of specialist tooling, equipment and vessels for specific tasks</td>
<td>Large scale engineering services</td>
<td>Included in above costs</td>
<td>Project or framework contract</td>
</tr>
<tr>
<td>Construction port services</td>
<td>Port used to prepare and load components onto installation vessels to be taken to the wind farm</td>
<td>Complex assembly and loading with heavy lift</td>
<td>Included in above costs</td>
<td>Strategic agreement or project contract</td>
</tr>
</tbody>
</table>
Installation – who’s who?

Turbines/foundations

A2 SEA
powered by knowhow

mpi offshore
Powering the future

seaJacks

Substation

Seaway Heavy Lifting
offshore installation

SWIRE BLUE OCEAN

Ballast Nedam

SCALDIS
SALVAGE & MARINE CONTRACTORS N.Y.

Cables

PRYSMIAN CABLES & SYSTEMS

Nexans

Global Marine
Systems

REEF SUBSEA
Visser & Smit Marine Contracting

DEEPOCEAN

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Offshore wind installation vessel construction
Procurement approach

Operations and maintenance

- Operations
  - Health and safety
  - Asset management

- Remote monitoring
  - Condition monitoring
  - SCADA Control centre

- Maintenance
  - Vessels Engineering services

- Port
  - Logistics
  - Facilities management
  - Vessel servicing
  - Lifting

- Spares and refurb
  - Storage
  - Logistics
  - Engineering services
## Operations and maintenance

<table>
<thead>
<tr>
<th>Elements</th>
<th>Description</th>
<th>Skills required</th>
<th>Typical cost (500MW farm)</th>
<th>Procurement model (typical)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remote monitoring</td>
<td>Collection and analysis of data to monitor performance and influence operational decisions</td>
<td>SCADA, condition monitoring</td>
<td>Included in below</td>
<td>Framework agreement or warranty</td>
</tr>
<tr>
<td>Operations management</td>
<td>Day-to-day management of wind farm operation</td>
<td>Offshore operations, facilities management</td>
<td>£150 million</td>
<td>In house framework agreement or warranty</td>
</tr>
<tr>
<td>Port services</td>
<td>Provision of facilities and quayside space to enable repair and refurbishment tasks to be completed</td>
<td>Port services Stevedoring Engineering services</td>
<td>£300 million</td>
<td>Framework agreement or warranty</td>
</tr>
<tr>
<td>Maintenance (spares, repairs and replacement)</td>
<td>Activities carried out at the wind farm to maximise continuous operation of the turbines and balance of plant including significant refurbishment carried out onshore requiring storage and workshop space</td>
<td>Crew vessel operation, engineering services, lifting and assembly</td>
<td>£380 million</td>
<td>Framework agreement or warranty</td>
</tr>
</tbody>
</table>

- These activities are undertaken by asset owners or contractors, frequently with a significant role for the turbine manufacturer.