OFFSHORE WIND ENERGY

Owner’s requirements and supply from Brittany’s companies

Study conducted by GL Garrad Hassan
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OFFSHORE WIND ENERGY, OWNER’S REQUIREMENTS AND SUPPLY FROM BRITAIN’S COMPANIES

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The offshore wind industry promises enormous potential for delivery of secure future power supplies and business opportunities, with a 10-year investment demand of around €130 bn in northern Europe. In France alone, the tender round of 3GW initiated earlier this year represents an initial investment of €10 bn.

Bretagne Pole Naval has asked GL Garrad Hassan (GLGH) to prepare this report examining the supply chain for (bottom-mounted) offshore wind projects. In conjunction with an analysis of the companies’ capabilities this study may be used to estimate the markets that could potentially be captured by the industry in the Brittany region. GLGH has taken a top-down approach to identifying the contracts involved in the construction of an offshore wind project. Input from a number of experts within GLGH was collated to ensure that all major contracts or work packages were identified.

Section 2 of this report provides background information on the current status of the offshore wind industry.

In section 3, an overview is given of an offshore wind development, illustrating the various components and services that are required, along with an approximate timeline. An introduction to the various forms of contracting structure is also provided.

Section 4 contains a graphical breakdown of one of the possible contracting structures, showing the inter-relationship between the various tiers of contracts. These are split into three phases: pre-construction, construction, and operation. This is only one example of how the contracts may be awarded; in reality, each project will be implemented in a bespoke fashion.

Section 5 presents a mapping of the contracts / work packages that Bretagne Pole Naval members or other Brittany companies could wholly or partially take on in the context of an offshore project.

In this report, the word « foundation » refers to the sub-structure, which extends upwards from the seabed and connects the foundation to the tower, plus the foundation, which transfers the loads acting on the structure into the seabed.
To ensure this work builds upon findings from the numerous publications that have been produced on the offshore wind market, a review of relevant published studies has been completed and key messages drawn from these publications. GLGI’s summary of these findings and its own message on the current status of the offshore wind industry are:

**Offshore wind is some way from being a mature business**

Isolated commercial projects were first built in 2002 (Denmark) and 2003 (UK). Construction activity since then has been sporadic and projects have been (for the most part) at a scale much smaller than is anticipated in the years to come. The wind turbines have been derived directly from onshore designs; they have some way to evolve before reflecting the specific demands of offshore projects. Projects are progressing into deeper waters, farther offshore, which changes both the design and construction characteristics of the balance of plant (BoP), as well as the operation and maintenance methods.

**Previous over-optimism in build forecasts**

The offshore wind business has failed to build at forecast rate for much of the past decade. This under-performance has been due to a variety of factors. That trend has changed in the past two years with delivery according to predictions.

**Dramatic growth in the offshore wind sector**

There are a range of forecasts for build of offshore wind farm projects, in France, the UK, Germany and internationally, all of which show strong growth in the sector. The sector has disappointed in the past, but, in the UK and Germany in particular, it is now showing sustained construction activity.

Political and regulatory support remains necessary for a prosperous offshore wind business, and there is evidence that this support is being maintained in a number of key countries. Indeed, in a few countries, it seems to have intensified as a result of the credit crisis, with a desire to create jobs in the “real” economy on the back of the sustainable energy industry.

**Relatively low content and employment in offshore wind outside Denmark and Germany historically**

The wind industry has its origins in Denmark, and Germany has also provided a solid onshore wind market throughout the past 15 years. This has led to the dominance of Danish and German companies in the offshore wind supply chain, with the result that 80% of the capital value in offshore wind farm projects built outside these two countries has been based on imported goods and services.

**Serious capacity and skill constraints**

The wind sector, in general, has grown quickly from a low base, meaning that skilled people are in short supply across all grades and disciplines. The offshore wind business has also suffered from shortages, across the supply chain, in products and construction services. This pressure has eased in 2010, in part because project activity is at a similar level to 2009, and in part because other industrial sectors (specifically onshore wind, oil and gas, shipping) have suffered from the economic downturn and credit crisis. Skills and capacity constraints provide real opportunities for new entrants with relevant skills and infrastructure located in the vicinity of project sites.
In terms of production volumes, quality and cost, the wind industry falls between the aerospace and automotive industries, as shown in Figure 3-1. Conventional power industries tend to align more closely with the aerospace business, in these respects.

For wind, this is driven by the demands in terms of reliability (especially important offshore), as the value of energy generated by a wind turbine through its lifetime will far exceed its capital cost. Quality is also driven by the very high level of fatigue loading for components along the primary load path, from the tip of the rotor blades to the toe of the foundation. During its operating life, a wind turbine will experience over 108 primary fatigue load cycles, which exerts a significant demand upon designs, materials, fabrication, assembly methods and monitoring.

Entrants in the offshore wind industry should consider not only the products or services that they would hope to provide, but also when these would be required in the lifecycle of an offshore wind project. The typical programme shown in Figure 3-2 shows the times and points when contractual negotiations and works are carried out in the lead up to the operational date of an offshore wind project. This highlights the point at which major first tier contractors will be involved in submitting tenders for projects, and hence when they will be soliciting enquiries from their suppliers and requiring orders to be fulfilled, in order to carry out fabrication and installations.

In France, invitations to tenders will be issued in May 2011 with zone licence winners to be announced about one year later mid 2012. This would correspond to Year -7 in Figure 3-2. Because some of the site investigations and environmental assessments will have been conducted at the bid preparation stage, the first projects may be expected to be complete procurement early 2015 and start up in 2017 for the first phase of these projects.
3-2: Offshore wind costs

A typical breakdown of capital expenditure (CAPEX) costs for a representative 500MW project was derived. The technical characteristics of this project were chosen to represent conditions likely to be experienced at projects scheduled for development in the next 10 years.

This breakdown, presented in Figure 3-3, includes costs incurred for onshore electrical systems. These costs are likely to vary widely from one project to another depending on the existing grid infrastructure in the region of the project and the extent of grid reinforcement required deeper into the grid.

The initial capital expenditure is estimated to represent 70-75% of total lifecycle costs with operational expenditure (OPEX) comprising the remaining 25 to 30%.

3-3: Historical contracting structures

The offshore wind business is a developing industry and, with it, the nature of the supply chain and contracting work packages is also developing. The constituents and relationships within the supply chain are defined by the contracting nature. Over the years, this structure has evolved, covering various contract structures. The fundamental driver to either of these models has been the willingness of the parties involved to accept interface risks, driven in turn by the supply-demand balance.

The following three main forms of contract structure have been used by the offshore wind industry to date.

- **EPCI (Engineering, Procurement, Construction, and Installation)**
  - The contractor to take a single corporate body, a joint venture between two parties, or a consortium of many companies is responsible for the complete works, including Engineering, Procurement & Construction, and Installation of the project for the owner on a turnkey basis. Smaller independent contracts may still be taken by the owner for management of the EPCI contract, owner’s works monitoring, construction insurance, etc.

- **Multi-split EPCI**
  - Multi-split EPCI contracts involve EPCI contracts for each major aspect of the work: foundations, turbines, offshore and onshore electrical systems. In this case, the owner has the task and responsibility of co-ordinating all the works in total, and for ensuring the appropriateness of the interfaces. This co-ordinating role is often assigned, in part, to a Works Management Company. In this instance, the design and engineering responsibilities lie with the respective contractors.

- **Multi-contract**
  - A full multi-contracting structure means that the developer (or appointed Works Management Company) directly contracts each aspect of the supply chain individually, bar some of the smallest contracts which remain the responsibility of subcontractors. The coordination and interfacing task in this case is much larger, and will take significant budget and resources; risk to the project through delays and incompatibilities between contractors is also borne by the developer. On the other hand, some of the contract costs are reduced due to direct interaction with suppliers.

3-4: Contracting trends

In the early years of the commercial offshore wind industry, i.e. years 2000-2005, turbine manufacturers were offering full EPCI contracts, either on their own or in joint-venture with a marine civil contractor, in order to gain a foothold in this market. However from 2006, turbine manufacturers withdrew their EPCI contracts after suffering delays and cost over-run on early projects and exclusively offered turbines delivered “Free Alongside Ship” as per the Incoterm definition. Owners were therefore forced to multi-contract projects and take full interface responsibility. With one notable exception at Greater Gabbard in the UK, the most significant large-scale offshore wind projects completed since 2006 have been completed by means of multi-contracting.

Presently, the entry of large civil or marine construction companies, together with a better understanding of risks both by owners and the supply chain, is pushing the industry toward multi-split EPCI contract structures. Heightened competition amongst turbine manufacturers is also a driving factor behind larger turbine and BoP contracts. This form of contracting is likely to be dominant in the short and medium term and therefore it has been selected as the basis of the detailed contract structure presented in the following section. In France, the tender format and the forming of industrial consortiums is also likely to favour this type of contract structure over others.
4-1: Model contracting structure
An illustrated contract breakdown is presented in the following pages. It is not meant to represent any particular project - past or future, either in France or in northern Europe. The numbering of the contracts follows that of the tier structure, with Tier 2 contract #2.1 representing the first subcontract of Tier 1 contract #2, while the colour coding corresponds to the contracting tier. Contracts are listed firstly by phase; pre-construction, construction then operation. In order to make all meaningful work packages visible for the purpose of this work, the basic principle behind each breakdown has been to show them as individual subcontracts. In practice many would probably be offered together at the same Tier level by a single subcontractor (and eventually subcontracted at Tier 3 level) or combined in the scope of work that the Tier 1 contractor would deliver using their own resources. To aid readability and comprehension, a relatively flat contract structure has been chosen with the majority of contracts shown at Tier 2 level. As a result, the breakdowns presented in the following pages probably display more Tier 2 and fewer Tier 3 contracts during the construction phase than would typically arise in any offshore wind project.

It must be noted that manufacturing opportunities associated with wind turbine sub-components have not been considered in this study. Those have been previously identified in a separate study commissioned by Syndicat des Energies Renouvelables - France Energie Eolienne. GLGH is of the opinion that the wind turbine component manufacturing opportunities and the offshore wind installation and balance of plant fabrication industries are largely decoupled and therefore opportunities and success in one are not dependent on the other.

4-2: Customer identification and procurement process
Pre-construction
In the pre-construction phase, the primary customers for most consultancy, engineering and surveying work are: project owners; project investors; lenders; and main contractors. This area has traditionally been serviced by small and medium companies. Customers tend to be large companies, or special project companies that they own. Key roles (in engineering, environmental, etc.) tend to be filled by specialists in the field.

Procurement is usually competitive closed tender, with pre-qualification in some cases. Advertising of opportunities through OJEU is not obligatory. Direct contact to likely customers through conferences, visits and networking is the most common route to secure bid opportunities.

Construction
Under a multi-EPCI model, the primary customers for most fabrication and installation support roles are likely to be large EPCI contractors (C1, C10, C11 & C12). Procurement is usually competitive, open-tendered, with pre-qualification, unless a joint venture has been set up between the EPCI contractor and key partner contractors to share the risks and reward associated with a single contract or chain of contracts.

As in the pre-construction phase, consultancy and project management support roles will also be available with project owners, project investors and lenders as the main customers.
Operations
In the operational phase, BOP monitoring and maintenance, consultancy and project management support roles will be available from the project owner; this is normally a power utility or special project company, under joint ownership of utilities and financial institutions, with the decision-maker within the utility. Wind turbine manufacturers are typically the main O&M provider for turbine work - offering a two to five-year warranty, operations and maintenance package in association with the wind turbine sale. Five-year extension options are commonly offered, so it is normal for wind turbines to spend the first ten years of their operating life under the care of the turbine manufacturer.

Core activities tend to be undertaken by the wind turbine manufacturer’s own staff, including management and technician staffing. During periods of intense activity, such as summer scheduled service campaigns, supplementary technician support may be used. Some highly specialised tasks, for example rope access for rotor blade cleaning and checking, are also subcontracted. On-site investigation and repair of major sub-components (generators, transformers, gearbox, switchgear, converters) may be subcontracted to the relevant component vendor. Non-core activities, such as transport, vessel provision and crewing, are typically subcontracted by the project owner or the wind turbine manufacturer as the case may be.
OFFSHORE WIND ENERGY, OWNER'S REQUIREMENTS AND SUPPLY FROM BRITAIN'S COMPANIES

4-3: Flowchart contracts
OFFSHORE WIND ENERGY, OWNER'S REQUIREMENTS AND SUPPLY FROM BRITAIN'S COMPANIES
A register of companies with relevant skills and experience that could be applied to offshore wind projects has been prepared by Bretagne Pôle Naval. 71 companies have thus been identified. Through discussions with Bretagne Pôle Naval representatives, those companies were matched according to their skills, know-how and industrial infrastructure with the contracts / work packages identified by GLGH in Section 4. The exact capabilities of these companies have not been individually assessed although interviews were conducted with a number of them in order to better gauge their capabilities, interest and potential positioning in the offshore wind market. The result of this work is presented in the form of a matrix in the following pages.
# Contract / Task

<table>
<thead>
<tr>
<th>Category</th>
<th>Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental Impact Assessment and Surveys</td>
<td>P 1</td>
</tr>
<tr>
<td>Socio Economic Impact Assessment</td>
<td>P 2</td>
</tr>
<tr>
<td>Grid Connection Surveys</td>
<td>P 3</td>
</tr>
<tr>
<td>Owner's Engineering</td>
<td>P 5</td>
</tr>
<tr>
<td>Geotechnical Survey</td>
<td>P 7</td>
</tr>
<tr>
<td>Design / Equip Supp. &amp; Install. (Mat)</td>
<td>P 8.1, 8.4, 8.7</td>
</tr>
<tr>
<td>Maritime Services</td>
<td>P 9</td>
</tr>
<tr>
<td>Geotechnical Survey</td>
<td>P 10</td>
</tr>
<tr>
<td>Project Management Services</td>
<td>C 2</td>
</tr>
<tr>
<td>Certification Services</td>
<td>C 3</td>
</tr>
<tr>
<td>Environmental Monitoring</td>
<td>C 4, C 8</td>
</tr>
<tr>
<td>Marine Warranty Survey</td>
<td>C 5</td>
</tr>
<tr>
<td>H&amp;S Management Survey</td>
<td>C 6, C 9, C 13</td>
</tr>
<tr>
<td>Design Engineering</td>
<td>C 10.1, 11.2, 12.1</td>
</tr>
<tr>
<td>Wind Farm Maintenance</td>
<td>C 10</td>
</tr>
<tr>
<td>Project Operations</td>
<td>O 12</td>
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</table>

**Schedule & Fabrication**

<table>
<thead>
<tr>
<th>Tasks</th>
<th>C codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind Measurement</td>
<td>C 8</td>
</tr>
<tr>
<td>Design Engineering (Met mast)</td>
<td>C 8.1</td>
</tr>
<tr>
<td>Foundation Primary Steelwork (Met mast)</td>
<td>C 8.2</td>
</tr>
<tr>
<td>Foundation Secondary Steelwork (Met mast)</td>
<td>C 8.3</td>
</tr>
<tr>
<td>Mast Fabrication (Met mast)</td>
<td>C 8.5</td>
</tr>
<tr>
<td>Tower Supply</td>
<td>C 11.2</td>
</tr>
<tr>
<td>Ancillaries</td>
<td>C 11.2, 11.3, 11.4</td>
</tr>
<tr>
<td>Foundations EPC</td>
<td>C 10</td>
</tr>
<tr>
<td>Design Engineering (Monopole / jacket)</td>
<td>C 10.1, 11.6</td>
</tr>
<tr>
<td>Primary Steelwork (Monopole / jacket)</td>
<td>C 10.2</td>
</tr>
<tr>
<td>Secondary Steelwork (Monopole / jacket)</td>
<td>C 10.3</td>
</tr>
<tr>
<td>Fabrication &amp; Assembly (Offshore Substation)</td>
<td>C 11.8</td>
</tr>
<tr>
<td>Offshore Substation</td>
<td>C 11.9</td>
</tr>
</tbody>
</table>

**Transmission & Distribution**

<table>
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<th>C codes</th>
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<tr>
<td>Cable Supply</td>
<td>C 11.1, 11.2, 12.6</td>
</tr>
<tr>
<td>Engineering Design (Offshore Substation)</td>
<td>C 11.6</td>
</tr>
<tr>
<td>Equipment Supply</td>
<td>C 11.7, C 12.2</td>
</tr>
<tr>
<td>finale (Offshore Substation)</td>
<td>C 11.9</td>
</tr>
<tr>
<td>Engineering Design (Onshore Substation)</td>
<td>C 12.1</td>
</tr>
<tr>
<td>Building Fin-Out (Offshore Substation)</td>
<td>C 12.5</td>
</tr>
<tr>
<td>Equipment Supply (Grid Reinforcement)</td>
<td>C 13.1</td>
</tr>
<tr>
<td>Mechanical Maintenance</td>
<td>O 8.8</td>
</tr>
</tbody>
</table>

Other equipment (duals, anodes, jack) & service (metal cutting, painting, inspection)
The offshore wind industry is a growing sector, which has suffered for some years from capacity constraints. It also has a culture of multiple sourcing; hence, there is openness to new entrants. As a result, suppliers offering relevant products and services, with excellent quality, delivery ability and competitive pricing, can find a role in this sector. The review of the skills, know-how and industrial infrastructure of companies in Brittany reveals several key areas where these capabilities can be applied to offshore wind projects.

In the pre-construction phase:
- Environmental, engineering and surveying services are traditionally delivered by small to medium local companies. A number of companies in Brittany are well suited to these roles;
- A few companies also have relevant capabilities and ambitions to design, fabricate and install meteorological masts for projects.

In the construction phase:
- Bar turbine nacelles, tower fabrication is the most significant fabricator role in the turbine EPCI where at least one Brittany company has the required know-how; however new infrastructure is required for fabrication and storage of large towers;
- Companies with steel fabrication backgrounds in shipbuilding or other industries have very relevant skills for BoP fabrication. Fabrication of offshore substation jacket foundations or topside structures is one area which lends itself well to new entrants with industrial infrastructure close to project sites, and is perhaps the most promising area for Brittany companies;
- Substation topside steel fabrication, equipment integration and fit-out has a lot of commonalities with large ship construction. A few Brittany companies with this background are well placed to provide the full (mechanical and electrical) substation topside fabrication scope, working with their established subcontractors and T&D equipment manufacturers;
- Fabrication of wind turbine steel foundations in tens to hundreds of units is another area of very high value, although it is likely that some investment is required for serial manufacturing and storage of primary or secondary steelwork in order for Brittany companies to be competitive as pure fabricators;
- Most of the onshore support roles - logistics, carriage and quay-side assembly - can be fulfilled by Brittany companies, most likely as subcontractors to an EPCI or a large local fabricator acting as a Tier 2 contractor; along with substation foundation and topside fabrication, this is a promising area for local companies.

In the operational phase:
- Wind turbine maintenance is set to be carried out by the OEM initially with staff established locally and dedicated to the project. After the warranty period, the owner may choose to take over maintenance which will open up opportunities for local subcontractors with mechanical and electrical maintenance experience;
- A number of Brittany companies have the required skills to undertake inspection and maintenance roles associated with BoP electrical systems and steel structures;
- Continued environmental and scientific monitoring during the operational phase will generate significant activity for local companies established locally.

Installation and support vessels:
- Logically, Brittany shipyards have the capabilities to engineer and fabricate the full range of installation and support vessels involved in the pre-construction, construction and operation phase of offshore wind projects. European shipyards tend to focus on complex, high value added cruise or military vessels and as a result specialised installation jack-up barges have all been contracted in the Far East in the last decade. Many support vessels have been produced locally in northern Europe, although a line of vessels have been imported from North America.
- Vessel maintenance activities tend to be carried out locally and many Brittany companies have extensive capabilities and experience in this area.

Notably absent from the above are marine construction companies, which are an important piece of the overall picture in the offshore wind business. Given the trend to large multi-EPCI contracts, forward vertical integration in installation or JV / partnership with experienced marine contractors may be an important strategic move for fabricators, in particular with respect to turbine foundations.

Given the overall market size and capacity constraints, it is still likely that we will see increased use of framework agreements or long-term arrangements, among other reasons to encourage industrialisation and standardisation, as well as limit the procurement burden for both project owners and contractors.

Therefore rigorous structuring of the combined supply potential of local companies within Brittany and most likely further afield is seen as a crucial success factor by GLGH, not only for French offshore wind projects but also with a view to Round 3 projects in southern England. This has already partially taken place through the Brittany offshore wind cluster, however further organization of consortiums or JV around key leaders and collaboration with companies beyond Brittany is seen as essential.

The industry does suffer from a shortage of experienced personnel, so approaches to potential customers, be it project owners or incumbent / potential EPCI contractors must be well-prepared and focused, if business is to result. The basic rules of business apply in offshore wind. These involve:
- Trusting relationship
- Right product or service
- Understand your customer
- Prepare for competition
- Get it right first time

Again, this calls for structuring and preparation, both technically and commercially, for local companies to be successful. Brittany companies have very relevant capabilities that can be applied to offshore wind projects. Some have already gone a long way in assessing their current capabilities and developing the marginal capabilities that would allow them to compete in this sector. If this trend continues this bodes well for the future development of these companies in the offshore wind sector.
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