

**OFFSHORE WIND ENERGY SUPPLY  
CHAIN OPPORTUNITIES**



Project part financed by the European Regional development Fund under the European Sustainable Competitiveness Programme for Northern Ireland

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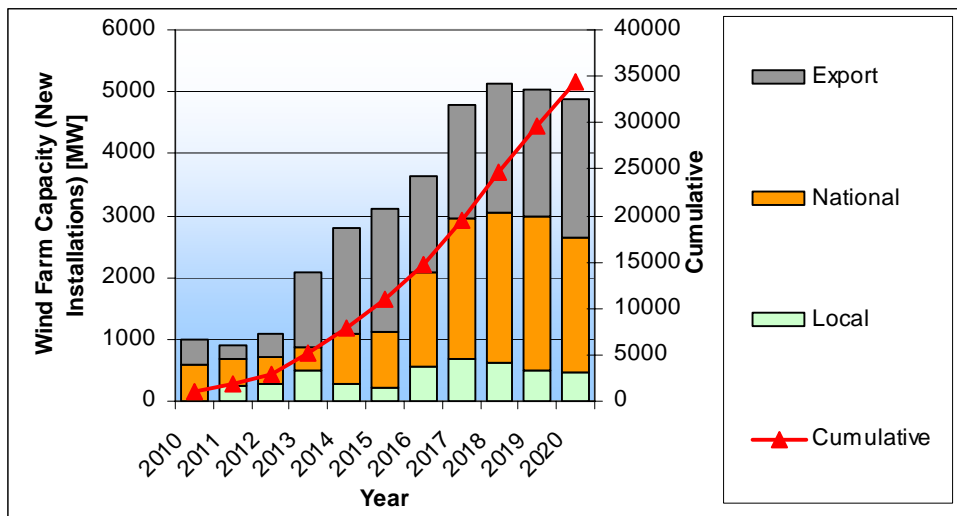
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## EXECUTIVE SUMMARY

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 £100 bn. This report aims to highlight the reality of that opportunity for Northern Ireland businesses over the short (5-years), medium (5-10 years) and longer terms (10+ years).

The report is based around a build scenario for offshore wind which GH has developed aiming for a realistic picture – important for those looking to invest time, money and resources in this new opportunity. This market scenario has then been broken down according to proximity to Northern Ireland, as shown below, and according to specific areas of the industry value chain.



The *potential annual value of the market*, summing spend in the development, construction and operational phase of projects is estimated in the following table.

Maximum potential value (£m/annum)	Project proximity to NI		
	Local	National	Export
2010 – 2015	800	1,957	3,166
2016-2020	1,862	7,046	6,479
2021 onwards	1,610	7,256	7,452

The potential supply chain values have been further investigated by delving into areas identified as clear possibilities for NI businesses:

- Consulting and advisory services
- Offshore wind turbine operations and maintenance (O&M)
- Wind turbine rotor blade manufacture
- Wind turbine cooling and hydraulic systems
- Diesel generating sets
- Offshore wind turbine GBS foundations

Ports also have a real opportunity here, on which a specific parallel study has been focused.

Finally, this report aims to serve as a reference source for businesses looking to engage in the offshore wind sector, providing:

- Signposting of current published offshore wind market intelligence – Section 2;
- Introduction to the components of a typical offshore wind project – Section 4;
- Introduction to the offshore wind supply chain structure – Section 5; and
- Practical advice on engagement with the offshore wind sector – Section 7.

## 1 INTRODUCTION

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 £100 bn.

This report provides an assessment and quantification of the opportunities for Northern Ireland (NI) businesses to supply goods and services into the offshore wind energy sector.

The study considers opportunities in markets radiating out from NI over the short (5-years), medium (5-10 years) and longer terms (10+ years).

The study also signposts other information with which interested businesses should be familiar, and provides advice on engagement strategies for NI businesses that wish to proactively explore opportunities in this sector.

Additionally, the report includes a listing of wind farm developers, their Tier 1 suppliers of wind turbines, and balance of plant components and services, as well as active sub-suppliers within the supply chain.

## 2 BACKGROUND INFORMATION

To ensure this work does not replicate findings or produce information already publicly-available, a review of relevant published studies has been completed. The following are most relevant:

- Crown Estate: UK Offshore Wind Report 2010  
[http://www.thecrownestate.co.uk/uk\\_offshore\\_wind\\_report\\_2010.pdf](http://www.thecrownestate.co.uk/uk_offshore_wind_report_2010.pdf)

This report gives an overall introduction to the UK offshore wind programme from Crown Estate, the landowner of the seabed, who drives the leasing process.

- Crown Estate: A guide to an offshore wind farm, 2010  
[http://www.thecrownestate.co.uk/guide\\_to\\_offshore\\_windfarm.pdf](http://www.thecrownestate.co.uk/guide_to_offshore_windfarm.pdf)

A detailed breakdown of the anatomy of an offshore wind farm, and identification of the main current suppliers to the sector.

- UK Offshore Wind: Staying on Track, British Wind Energy Association, 2009  
<http://www.bwea.com/pdf/publications/CapReport.pdf>

Delivery of offshore wind capacity, to date, and forecast for the period 2010-2015.

- UK Offshore Wind: Charting the Right Course, British Wind Energy Association, 2009  
<http://www.bwea.com/pdf/publications/ChartingtheRightCourse.pdf>

Analysis of the current capital costs in offshore wind, their drivers, and a forecast for the period 2010-2015.

- UK Offshore Wind Ports Prospectus, DECC, 2009  
[http://www.decc.gov.uk/en/content/cms/what\\_we\\_do/uk\\_supply/energy\\_mix/renewable/business\\_dev/uk\\_ports/uk\\_ports.aspx](http://www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/renewable/business_dev/uk_ports/uk_ports.aspx)

- Offshore renewable energy in Ireland, presentation by Dept. of Enterprise, Trade and Investment, February 2010.

Proposed 2020 targets for NI waters of 600MW (offshore wind) and 300MW (wave and tidal combined).

Other reports that are less directly relevant, but are useful background:

- UK Offshore Wind: Moving Up a Gear, British Wind Energy Association, Winter 2007  
<http://www.bwea.com/pdf/offshore/movingup.pdf>

Pre-cursor to the 2009 BWEA studies, above, which also drilled into supply chain issues in some more detail.

- 
- Wind Energy – the Facts, European Wind Energy Association, 2009  
<http://www.wind-energy-the-facts.org/>  
Basic introduction to offshore wind energy, the technology, economics and other aspects.
  - BTM Consult – Supply Chain Assessment 2010 (commercial product)  
<http://www.btm.dk/reports/supply+chain+assessment+2010>  
Annual report on status of the supply chain – heavily focussed on the wind turbine.
  - British Wind Energy Association (BWEA) briefing note 2010: What does the Round 3 announcement mean?  
<http://www.bwea.com/pdf/Round3Briefing.pdf>  
BWEA (recently renamed Renewable UK) are the UK trade association for the wind business and proactively lobby the Government for the needs of the sector, in general, and its members, in particular. It has staff with dedicated responsibility for offshore wind, including for specific issues in offshore wind and for supply chain support.
  - Towards Round 3: Building the Offshore Wind Supply Chain, Crown Estate, 2009  
[http://www.thecrownestate.co.uk/round3\\_supply\\_chain\\_gap\\_analysis.pdf](http://www.thecrownestate.co.uk/round3_supply_chain_gap_analysis.pdf)  
Pre-cursor to the 2010 Crown Estate publications (above).
  - POWER: Pushing Offshore Wind Energy Regions – transnational offshore wind supply chain study, POWER Project, 2007  
<http://www.offshore-power.net/Files/Dok/2007-06%20power%20-%20transnational%20study%20update.pdf>
  - Employment opportunities and challenges in the context of rapid industry growth, British Wind Energy Association., 2008  
[http://www.bwea.com/pdf/publications/Bain%20Brief\\_Wind%20Energy%202008\\_FINAL.pdf](http://www.bwea.com/pdf/publications/Bain%20Brief_Wind%20Energy%202008_FINAL.pdf)
  - Today's investment - tomorrow's asset – skills and employment in the wind, wave and tidal sectors, British Wind Energy Association, 2008  
<http://www.bwea.com/pdf/publications/BWEA%20Skills%20Report%20FINAL%2016oct.pdf>
  - European Offshore Wind Energy Market Report, Garrad Hassan, 2009 (commercial product)  
<http://www.garradhassan.com/reports/offshoremarket/>
  - Scroby Sands – Supply Chain Analysis, Renewables East, 2005  
<http://www.berr.gov.uk/files/file20840.pdf>  
Case study for the second of the UK Round 1 offshore wind farms to be built; identifying the composition and (specifically) the local, regional and national economic value of the project.

Key messages drawn from these publications:

***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 driving into deeper waters, farther offshore, which changes both the design and construction of the balance of plant, as well as the operation and maintenance methods.

***Dramatic growth in the offshore wind sector***

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

Political and regulatory support remains necessary for a prosperous offshore wind business, and there is evidence that this support is being maintained. Indeed, in the UK, 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 UK content and employment in the offshore wind sector 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 German and Danish companies in the offshore wind supply chain, with the result that 80% to 90% of the capital value in UK offshore wind farm projects 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.

***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. Perhaps the main factor is that forecasts are primarily used to show the potential of the industry in lobbying for effective support measures, and when those support measures fall short of assumptions, the forecasts are not achievable. That trend has changed in the past two years with delivery according to predictions.

### 3 MARKET SCALE

#### 3.1 Wind capacity

The recent reports identified above, mainly those by Crown Estate, have given a forecast for the construction programme for future offshore wind farm projects in the UK. These forecasts show, Figure 3-1, build ramping up through to 2015, with a substantial step-up for the 5 to 10 years thereafter.

The activity after 2015 is dominated by projects from the recent Round 3 (R3) and Scottish Territorial Waters (STW) leasing rounds, and is based on the programmes put forward by project developers tendering for those leases. By its nature, this sort of process yields aggressive build programmes. Figure 3-2 looks at an industry build, which takes a programme considered to be more realistic as a baseline. This Baseline forecast is taken from the GL Garrad Hassan Offshore Wind Farms database and is built up from individual project plans, with each project having a nominal operational date, build programme and associated probabilities for successful build and programme slippage. All publicly identified global wind farms are included in the database.

The baseline forecasts are compared to the published Crown Estate forecasts, below. It is noted that the current Crown Estate forecasts do not include the 600MW NI target identified in Section 2. Throughout this report, where project dates are presented, these refer to the year of the relevant activity or spend.

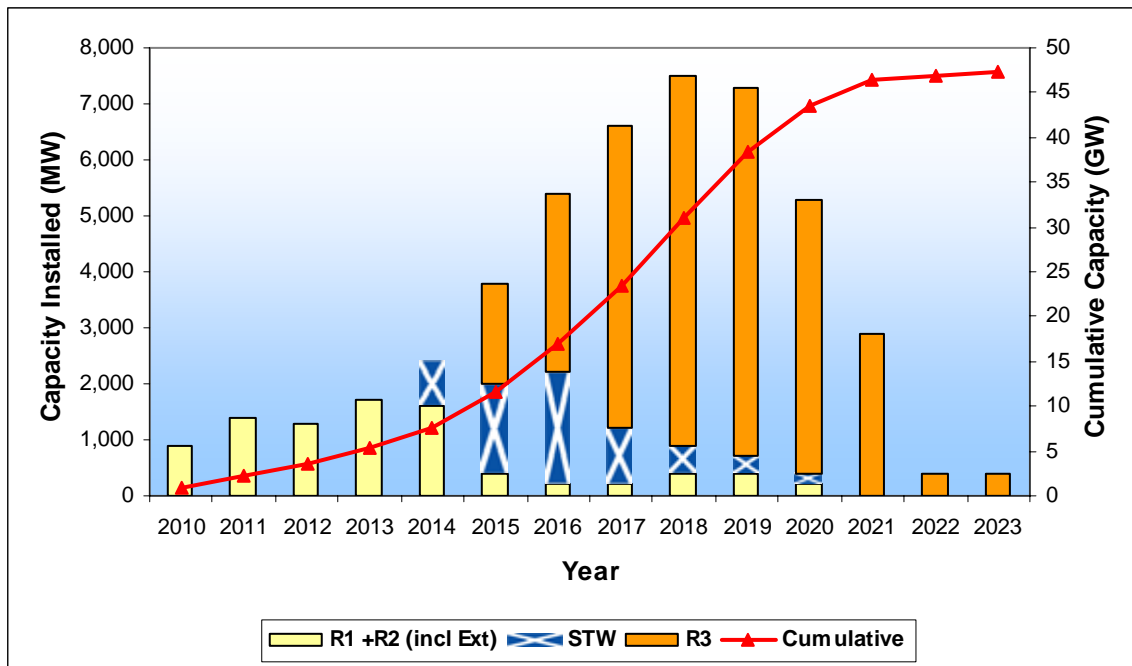
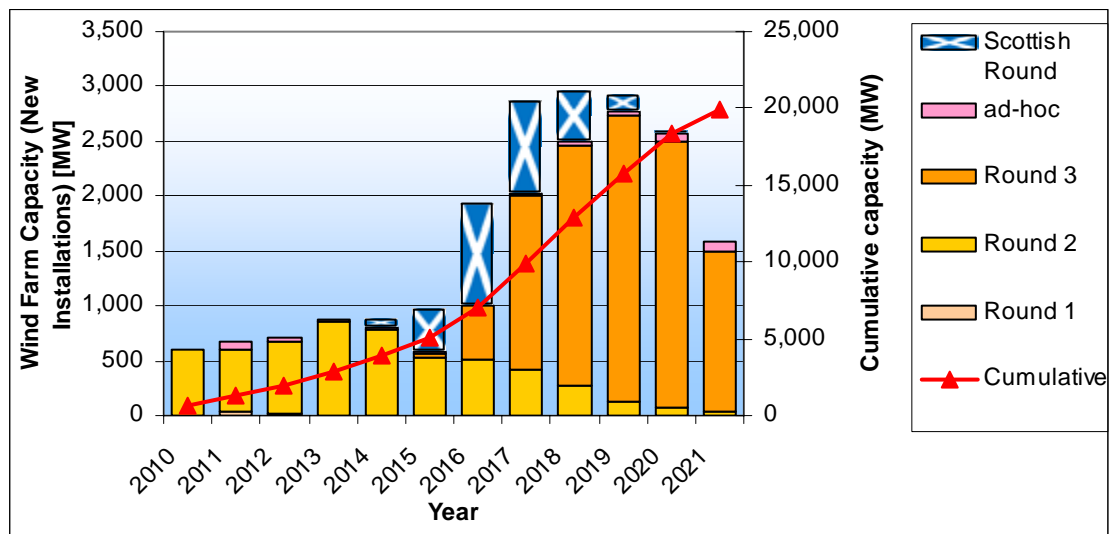


Figure 3-1: Crown Estate market projection

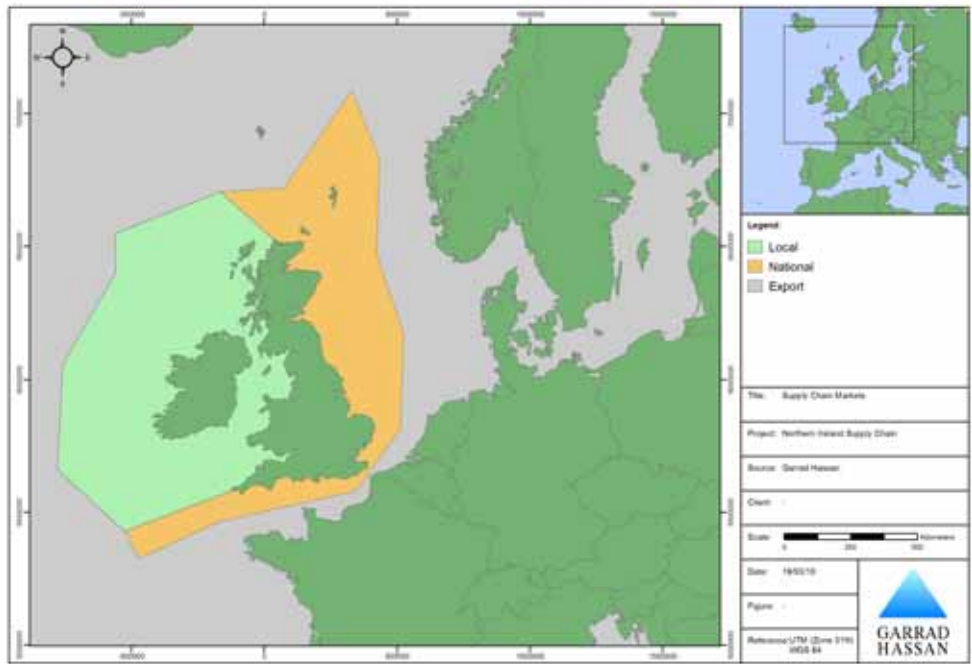


**Figure 3-2: Baseline market projection**

This comparison suggests that the upside potential if Crown Estate forecasts are achieved is, in terms of average annual installed capacity, around double the Baseline used here – with 2 GW per annum during 2010-2015 and 6 GW per annum during 2016-2020.

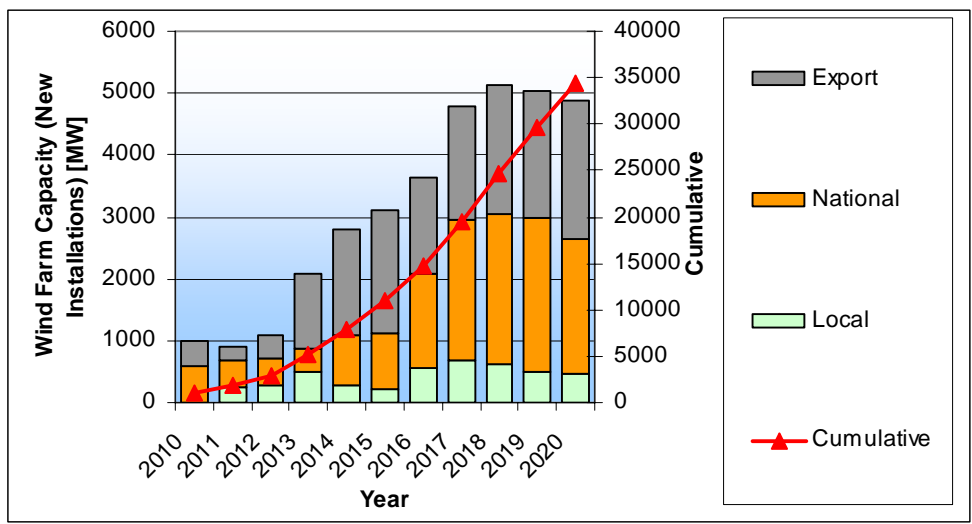
Post-2020, any forecasts are highly speculative as the projects which could form the bulk of activity have yet to be identified. In the UK, Crown Estate has stated that they anticipate further leasing rounds will follow hence the drop-off in Figure 3-1 is misleading. In the Baseline figures this drop-off is less marked as probabilistic delays are applied to announced plans.

The analyses below are all based on the Baseline build programme; corresponding logic has been applied to non-UK projects.



**Figure 3-3: Market definition**

In the context of Northern Ireland businesses, the market can also be considered geographically: “local” meaning Irish Sea and Scottish West Coast; “national” meaning the rest of the UK; and, “export” which is likely to be dominated by the other Northern European countries, as assumed here.



**Figure 3-4: Projected annual build rate (MW) – GH baseline**

### 3.2 Economic values

The economic values associated with this activity can be categorised as development, construction and operational. In the economic values stated here, no assumptions are made about the ability, or otherwise, of NI businesses to access the three market categories – so these must be interpreted as maximum “potential” estimates.

#### *Development (or DEVEX)*

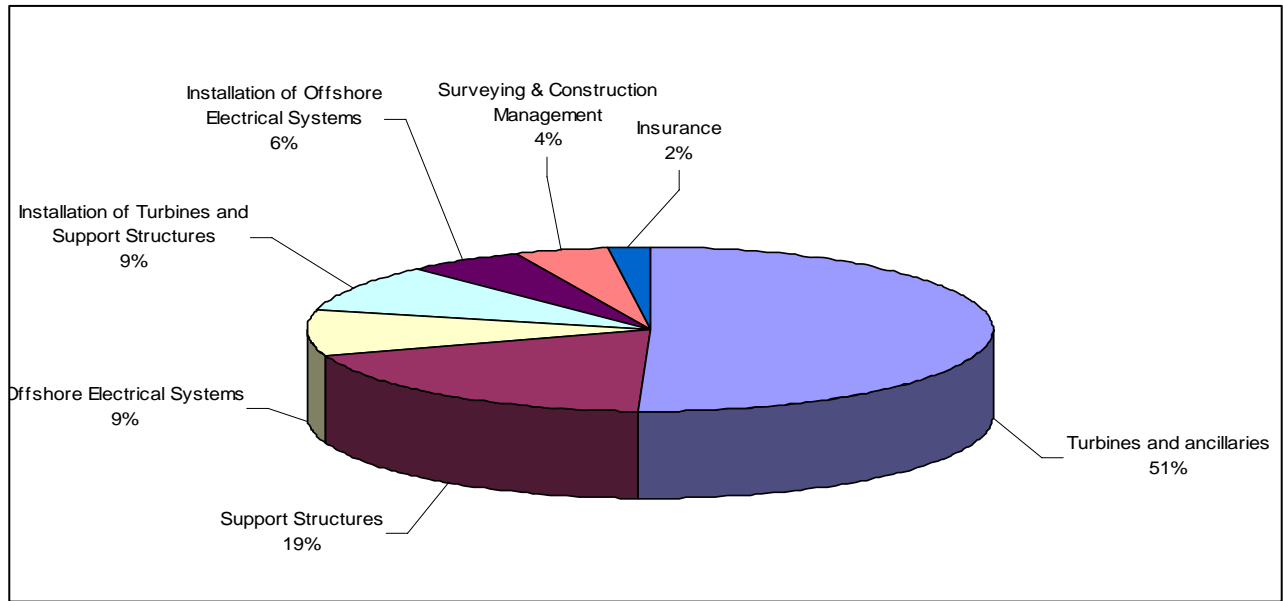
Covers the expenditure up to the point where the major construction contracts are signed for any project or project phase. This includes: environmental assessment; outline design; site investigations and modelling; construction planning; development of specifications; procurement; public relations; fund-raising; front-end engineering; land and lease negotiations; negotiating grid connection; and, consenting and corporate legal activities. Whilst this is a reasonably protracted phase (mainly due to the environmental assessment work), the spend rate for the overall scheme is modest, assumed here to be £45m, per GW of capacity, and occurring 3 to 4 years prior to project operation.

	Location		
	Local	National	Export
2010 – 2015	21	62	78
2016-2020	21	101	98
2021 onwards	21	98	100

**Table 3-1: Average annual DEVEX [£m / annum]**

#### *Construction (CAPEX)*

This covers the major construction costs, including procurement of all the generating plant and infrastructure. The costs here have also been taken to include the project specific transmission assets which, in the future, will mainly be delivered by a third party and not by the project developer. CAPEX is assumed here to be £3m, per MW of capacity. An indicative breakdown of costs, by component, is given below:



**Figure 3-5: Indicative breakdown of offshore wind farm capital costs**

	Location		
	Local	National	Export
2010 – 2015	743	1792	2968
2016-2020	1700	6514	5866
2021 onwards <sup>1</sup>	1409	6546	6671

<sup>1</sup> Assumed steady at 2020 rates

**Table 3-2: Average annual CAPEX [£m / annum]**

***Operational (OPEX)***

While a wind farm project has no fuel costs, it does require significant ongoing expenditure, in terms of management, operation and maintenance (scheduled service and unscheduled repair), insurances and other business overheads. OPEX is assumed here to be £200k/annum per wind turbine unit.

	Location		
	Local	National	Export
2010 – 2015	36	103	120
2016-2020	141	431	515
2021 onwards <sup>1</sup>	180	612	681

<sup>1</sup> Assumed steady at 2020 rates

**Table 3-3: Average annual OPEX [£m / annum]**

### 3.3 Demand for wind turbines

The offshore wind turbines used will be a mix of different products from different suppliers, with different unit capacities. Products of 3MW and 3.6MW dominate in the near-term projects, although 5MW units are entering the market commercially. The following statistics show the anticipated volumes of wind turbines to be constructed.

	Location		
	Local	National	Export
2010 – 2015	59	154	236
2016-2020	109	426	398
2021 onwards <sup>1</sup>	83	416	422

<sup>1</sup> Assumed steady at 2020 rates

**Table 3-4: Average annual demand for wind turbine units**

### 3.4 Demand for foundations

The wind turbine foundations are anticipated to use a mixture of engineered concepts. Historically, large diameter monopile foundations have dominated, with some concrete gravity bases and recent use of steel jacket structures, as well as proposals for new innovations. The concept choice will be driven

on each project by a combination of factors, including wind turbine size, water depth and environmental loading. The analysis here has identified the proportion of foundations for which monopiles are seen as viable in the in-situ condition (based on stiffness considerations). The remainder of the foundations will demand an alternative concept. Additionally, installation difficulties issues for monopiles (difficult ground conditions) will mean that alternatives may make inroads to the proportion identified as viable for monopiles.

	Location		
	Local	National	Export
2010 – 2015	34	130	84
2016-2020	29	69	120
2021 onwards <sup>1</sup>	15	12	80

1. Assumed steady at 2020 rates

**Table 3-5: Average annual demand for monopile units**

	Location		
	Local	National	Export
2010 – 2015	34	40	169
2016-2020	83	363	290
2021 onwards <sup>1</sup>	66	223	318

1. Assumed steady at 2020 rates

**Table 3-6: Average annual demand for non-monopile units**

### 3.5 Demand for subsea cables

Offshore wind farms require on-site array cables and export cables. Array cables link the turbines, have link lengths of the order of 1km, and operating voltage up to 36kV (usually). Export cables are for the transmission of power to shore, typically operating at 132kV AC (HVAC) presently; increasingly, these will use high voltage DC (HVDC) technology for larger, more remote, projects.

	Location		
	Local	National	Export
2010 – 2015	56	139	216
2016-2020	109	416	385
2021 onwards <sup>1</sup>	84	321	405

1. Assumed steady at 2020 rates

**Table 3-7: Average annual demand for array cables [km]**

	Location		
	Local	National	Export
2010 – 2015	20	99	179
2016-2020	48	207	356
2021 onwards <sup>1</sup>	28	167	411

1. Assumed steady at 2020 rates

**Table 3-8: Average annual demand for export cables [km]**

### 3.6 Demand for offshore substations / accommodation platforms

All but the smallest offshore wind farms require an on-site substation, to transform between collection and transmission voltages, and increasingly to convert from AC to DC. These are typically steel jacket structures, with a large topside structure containing all the electrical equipment. Many projects will have several on-site substations. It is assumed here that any project over 100MW in capacity, or 10km from shore, will have a substation, and a substation can serve up to 350MW in the case of HVAC and 600MW in the case of HVDC. It is assumed that projects either over 1000MW in capacity, or further than 80km offshore, will use HVDC export systems rather than HVAC.

	Location		
	Local	National	Export
2010 – 2015	1	2	4
2016-2020	2	6	7
2021 onwards <sup>1</sup>	1	5	8

1. Assumed steady at 2020 rates

**Table 3-9: Average annual substation installations**

Accommodation platforms will also be required for many future projects, as either permanently or seasonally manned bases. These may be combined with the offshore substations or stand-alone structures. These have not been the norm, to date, and it is only the remoteness and size of future projects that makes their use probable. As some of the drivers are shared, a sensible preliminary assumption is that there will be half as many accommodation platforms as there will be offshore substations.

### 3.7 Demand for crane vessels

It is assumed that crane vessels are required for the following tasks: turbine installation, monopile and jacket installation, and some wind turbine repairs. Each wind turbine installation has been modelled as taking 2 days in benign conditions – longer in harsher climates. Jackets are predicted to take 4 days to install, while monopiles take 3 days – again varying with climate and ground conditions.

Furthermore, it has been assumed that the vessels market is 80% efficient. This takes into account such factors as suitable vessels being tied up in other work; vessels being in a distant location and requiring time to relocate; vessel breakdowns; and, repair times.

With these parameters, average crane vessel utilisation has been derived.

	Location		
	Local	National	Export
2010 – 2015	2	4	5
2016-2020	3	11	10
2021 onwards <sup>1</sup>	2	9	10

1. Assumed steady at 2020 rates

**Table 3-10: Average annual crane vessel demand [vessel years]**

### 3.8 Demand for O&M crew vessels

The craft used to transport technicians have traditionally been 12-man work boats and for projects close to shore these are likely to persist.



Courtesy: Windcat Workboats

**Figure 3-6: 12-man access vessel**

For projects further offshore, larger vessels may be employed as may helicopters. Some indicative vessel numbers are given below based on an assumption of one vessel for every 30 operating wind turbines.

	Location		
	Local	National	Export
2010 – 2015	6	17	20
2016-2020	23	72	86
2021 onwards <sup>1</sup>	30	102	113

1. Assumed steady at 2020 rates

**Table 3-11: Average annual O&M vessel demand [vessels]**

### 3.9 Risks to build programme

The Baseline data used here was based on an aggregated view on the degree of programme slippage likely for each cluster of projects, or individual project. The factors that are likely to drive any programme slippage are highlighted, below. These refer, where necessary, to the UK programme, but are (mostly) generally applicable.

Risk	Impact	Likelihood	Comment / Assessment
<b>Widespread consenting delays</b>	<b>High</b>	<b>Medium</b>	<b>A number of UK Round 1 and Round 2 offshore wind projects have been subjected to significant delays, generally during stages under the control of the developer.</b>
<b>Insufficient offshore wind electricity tariff (market price; ROCs)</b>	<b>Very High</b>	<b>Medium</b>	<b>Risk-reward for offshore wind remains challenging and requires strong government commitment, combined with generous financial subsidies; perceived or actual insufficient government support, or associated uncertainty, will delay project development.</b>
<b>Retrospective change to tariff</b>	<b>High</b>	<b>Medium</b>	<b>Negative impact on market confidence and future build.</b>

<b>Risk</b>	<b>Impact</b>	<b>Likelihood</b>	<b>Comment / Assessment</b>
<b>General reduced developer appetite</b>	<b>High</b>	<b>Medium</b>	<p>Round 3 lease conditions include timing requirements, however degree of coercion and impact of penalty will be ineffective if development risk-reward is insufficient; Round 2 leases also included timing requirements, however the ability of Crown Estate to enforce has clearly been limited; ultimate sanction of confiscation of development licence ineffective.</p> <p>Recent evidence includes the hiatus in Round 2 development activity in the first months of 2009, prior to the announcement of 2 × ROCs for offshore wind.</p> <p>Hence, developer appetite is uncertain and can be considered an aggregate result (of the above risks).</p>
<b>Inability to procure (sufficient) wind turbines</b>	<b>Potentially High</b>	<b>Medium</b>	<p>Deep waters will require larger turbine sizes than are currently available in sufficient numbers. Several turbine suppliers, as well as new entrants, are developing new turbine models; however, up-scaling risks remain.</p>
<b>Inability to procure (sufficient) support structure</b>	<b>Potentially High</b>	<b>Medium</b>	<p>Deep waters and large turbines will require new support structure types, as well as (potentially) the need to extend the utilisation envelope of existing support structure concepts. Further development and demonstration of foundation types suitable for deep water is necessary.</p>
<b>Weaker Pound</b>	<b>High</b>	<b>Low</b>	<p>Capital costs rise further, causing economics of projects to deteriorate (due to high imported goods content), and delaying investment. In the long term, would further improve prospects for UK suppliers.</p>
<b>Boom in onshore wind</b>	<b>High</b>	<b>Medium</b>	<p>Onshore wind has been booming over a decade, causing shortages of wind turbines and price escalation in offshore wind, especially. This has cooled in 2008-2010, but a renewed boom is possible as credit markets unfreeze.</p>

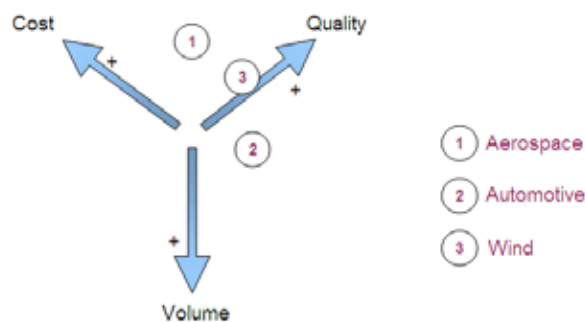
<b>Risk</b>	<b>Impact</b>	<b>Likelihood</b>	<b>Comment / Assessment</b>
<b>Pick up in activity in oil and gas and construction sectors</b>	<b>Medium</b>	<b>Medium</b>	<b>At present, offshore wind is attracting contractor competition from these sectors and that is reducing prices, improving project economics and supporting fast deployment of future projects. In the next 5 years, it is expected the sector will develop enough inertia to ride through the effects of these other cyclical industries.</b>
<b>Widespread delays in gaining a grid connection offer</b>	<b>High</b>	<b>Medium</b>	<b>Fundamental issue will be consenting of onshore transmission assets.  Widespread opinion that currently proposed OFTO regime is not yet fit for purpose and will cause inherent critical path programme delay. Expect the Government to act in the short term, to remedy.</b>
<b>Grid commercial connection conditions onerous (OFTO)</b>	<b>High</b>	<b>Medium</b>	<b>UK grid connection regime is under development, and subject to change.</b>

## 4 ANATOMY OF AN OFFSHORE WIND PROJECT

An offshore wind farm demands input from a large number of contractors and other stakeholders, the various components and activities being presented in *A Guide to an offshore wind farm* [[http://www.thecrownestate.co.uk/guide\\_to\\_offshore\\_windfarm.pdf](http://www.thecrownestate.co.uk/guide_to_offshore_windfarm.pdf)], published by the Crown Estate.

It is important to appreciate the production volumes and levels of quality for the various components, and to match those to one's company's own capabilities. Within a wind farm, there is a diverse range of products and services, from project specific bespoke designed single items, to multiple, mass-produced generic parts.

In terms of production volumes, quality and cost, the wind industry falls between the aerospace and automotive industries, as shown in Figure 4-1. Conventional power industries tend to align more closely with the aerospace business, in these respects.



**Figure 4-1: Cost, quality, volume positioning**

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  $10^8$  primary fatigue load cycles, which exerts a significant demand upon designs, materials, fabrication, assembly methods and monitoring.

Interested companies 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 programme shown in Figure 4-2 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 at which point major first tier contractors will be involved in creating tenders for projects, therefore at what point they will be soliciting enquiries from their suppliers and at what point those orders will be required to be fulfilled, in order for them to carry out fabrications and installations.

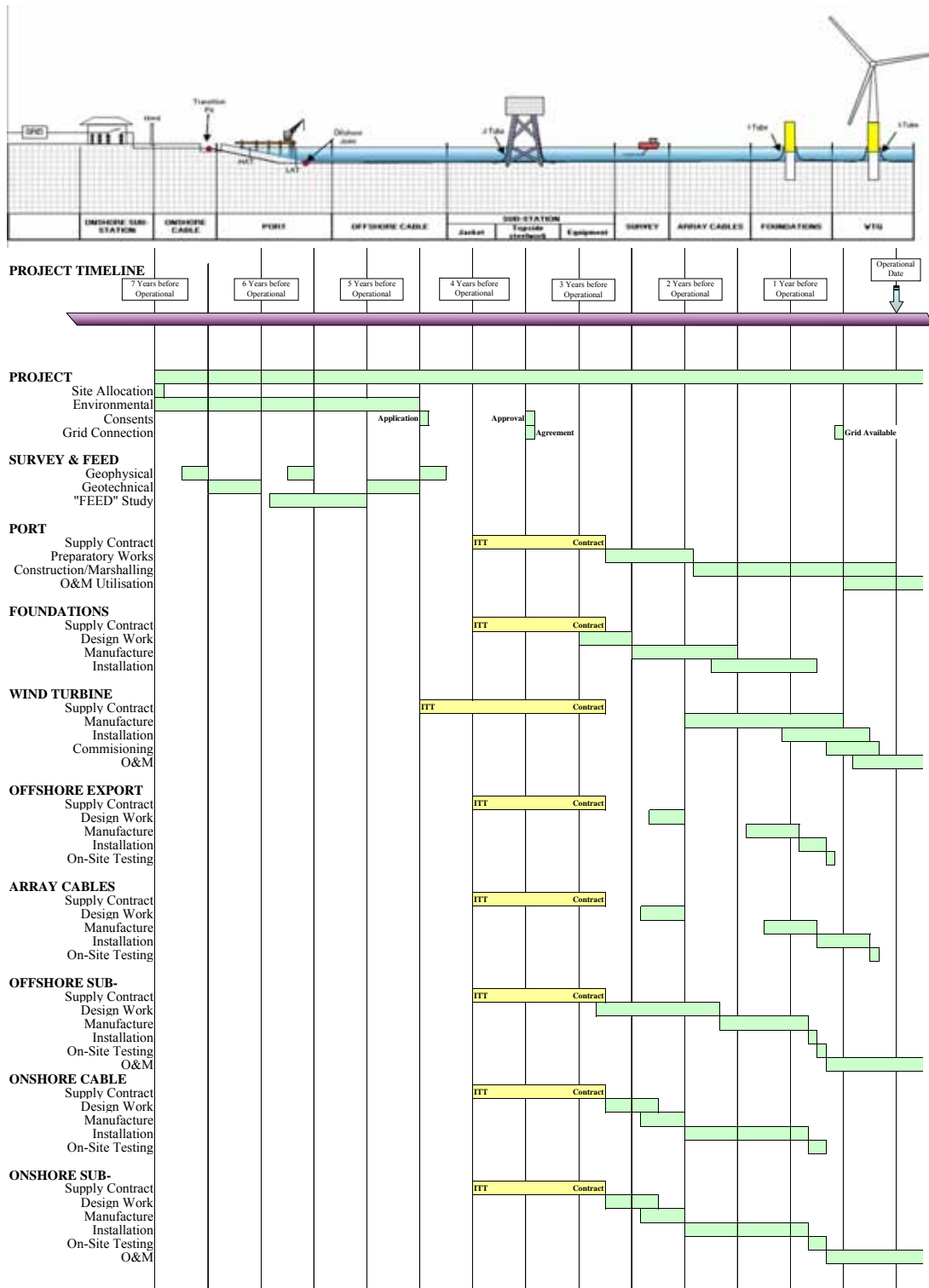


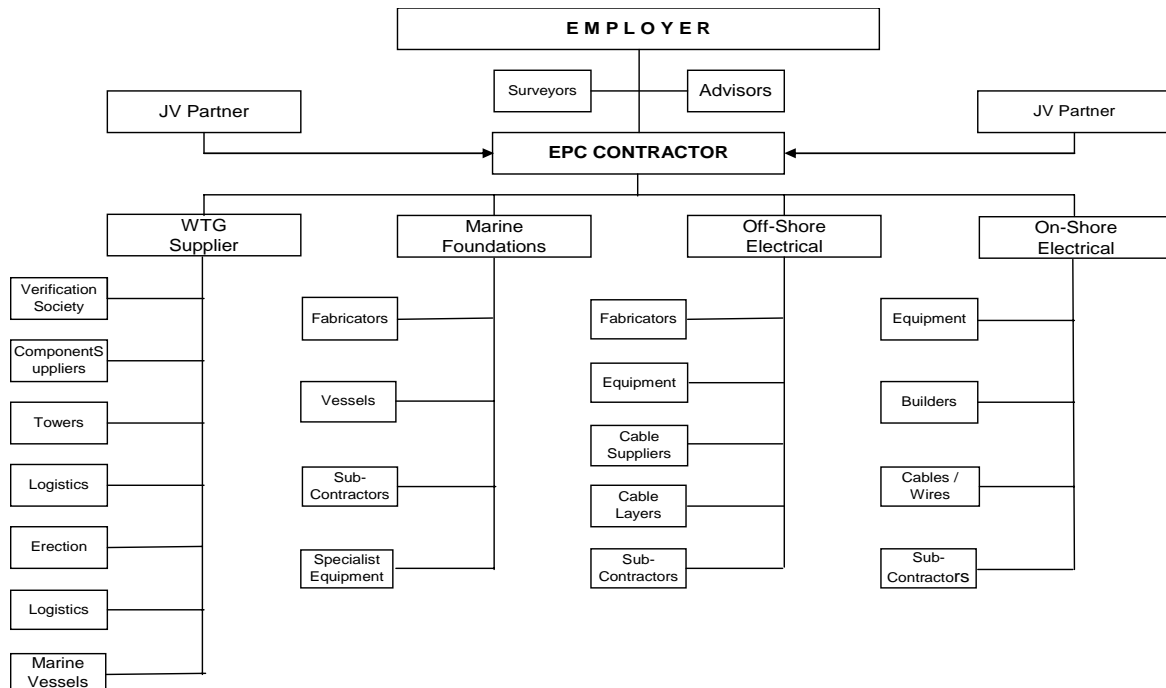
Figure 4-2: Project Implementation Programme

## 5 ANATOMY OF THE SUPPLY CHAIN

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, with two basic forms. 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. Interested parties should be aware of the contractual structure that they are entering into, and should ensure they are optimally placed to take advantage of business opportunities.

### 5.1 EPC Contracts

Under the arrangement shown in Figure 5-1, the contractor – be that 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 delivery of the project to the owner on a turnkey basis.

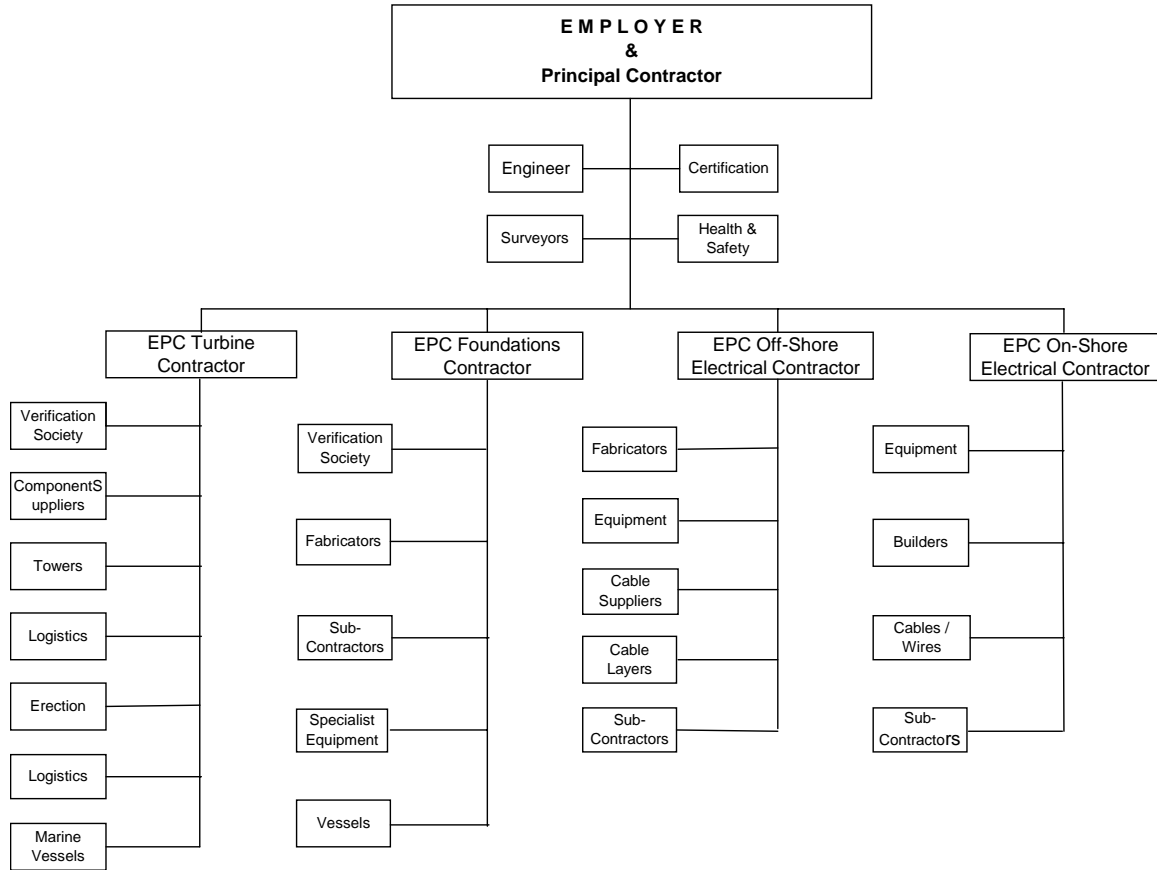


**Figure 5-1: EPC/Turnkey Contract Structure**

### 5.2 Multi-split EPC Contracts

Multi-split EPC contracts, shown in Figure 5-2, involve EPC 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 these 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 are with the respective contractors.



**Figure 5-2: Multi-Split EPC Contract Structure**

**5.3 Possible future trends**

There are some trends which could affect the offshore wind business, in particular, how UK sub-suppliers view the market.

***Wind turbine manufacture in the UK***

It is anticipated that the large scale of the UK offshore wind market will cause some increase in the national content of future UK projects. Historically, the UK content of wind turbines has been very low and this is likely to change. This may happen in several ways:

- Wind turbine manufacturers locating their main assembly facilities in the UK;

- Wind turbine manufacturers locating their component assembly facilities in the UK (for example rotor manufacture); and
- UK sub-suppliers being selected to provide supplies to facilities based in mainland Europe.

Just as important is the identity of any wind turbine supplier. The offshore wind business has three established wind turbine suppliers:

- Vestas Offshore A/S, based in Denmark;
- Siemens Wind Power, based in Denmark; and
- REpower Systems, based in Germany.

Two recent entrants are:

- Areva–Multibrid, based in Germany; and
- Bard Engineering, based in Germany.

The offshore wind market has also led to further new entrants bringing offshore-specific products through the development process, with a view to having a commercial offering by 2015.

Of these, the most likely to locate a major assembly facility in the UK are the new entrants, as the more established suppliers have mostly set up coastal facilities on mainland Europe, served by an existing set of sub-suppliers. Those announcing interest in a UK base, to date, are:

- Mitsubishi Power Systems;
- GE Energy; and
- Clipper Windpower.

The focus for these, and others, is on a North Sea port, as that gives direct access to the main Northern European market and ready access to sub-suppliers on mainland Europe.

### ***Increased WTG component sourcing in UK***

Many wind turbine suppliers are primarily designers and assemblers, with as much as 70% of the capital value of the wind turbine in bought-in components. Most wind turbine suppliers have a policy of multiple sourcing (2-4 sub-suppliers) as a means of maintaining cost-competition, building capacity flexibly and reducing the risk of serial failure in any one component.

Where turbine suppliers have onshore and offshore products, most component suppliers are common across the whole product range. The offshore products are produced in much smaller volumes than onshore products from the same family. Therefore, successful entry to the supply chain for the offshore product potentially offers a much broader opportunity.

***Balance of plant sourcing from within UK***

The non-turbine elements of an offshore wind farm are characterised by contracts awarded by tender, from project to project. It is also more practical for many aspects of the balance of plant works to be UK-sourced than it is for wind turbine components to be supplied, although the modest success level of UK businesses, to date, shows that it is by no means essential. The current low value of sterling and a promising market makes for a favourable investment by new entrants, as well as incumbents.

There is evidence of loose supplier-customer teams having developed over recent years, which represents an obstacle to new entrants; although, given the scale of the future market growth forecast, this is not necessarily a serious obstacle.

***Gravity base foundations***

The foundation supply and installation represents around 20% of the project capital costs. The industry preference is to use monopiles, although the technical feasibility of monopiles will come under increasing pressure as turbines become larger, water depths increase and (as in the Irish Sea) driving conditions are difficult. Concrete gravity bases may find a role here due to the increased installation cost of piles – they also bring the advantage of much reduced exposure to steel price and currency volatility. However, gravity bases have their own challenges regarding fabrication and installation, although they would very likely be made relatively local to the project site, hence there is a significant opportunity for UK sourcing.

## 6 FOCUS AREAS FOR NI BUSINESSES

### 6.1 Consulting and advisory services

#### 6.1.1 Supply opportunities

The development phase of an offshore wind project, running for at least three years before construction procurement commences, is dominated by provision of advisory and consulting services to the project owner and to project investors. In this phase, the focus is on environmental assessment and preliminary engineering works. The consulting input ramps up significantly, throughout the procurement and construction phase, although it becomes a relatively small component of the overall project costs. Following construction completion, it ramps down to monitoring and inspection services. Figure 6-1 shows the main categories of consulting support provided to projects.

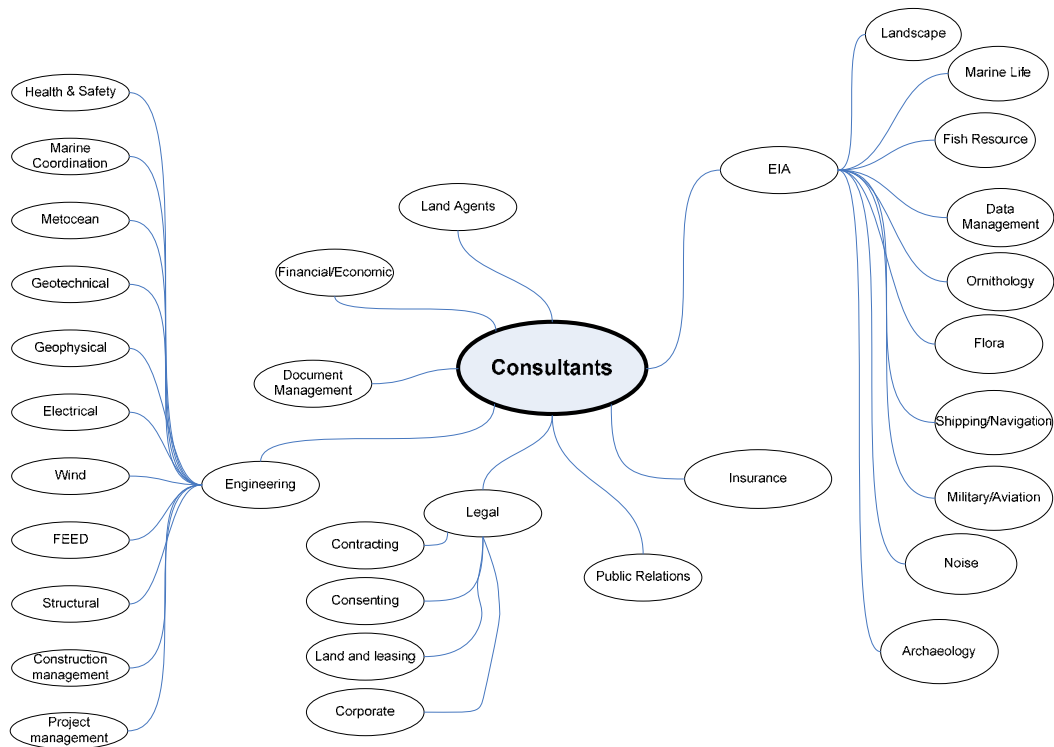


Figure 6-1: Consultancy services for project owners

#### 6.1.2 Economic value

Predicted spend on this category of services is presented in the table below.

	Location		
	Local	National	Export
2010 – 2015	83	204	328
2016-2020	179	692	626
2021 onwards	149	694	707

**Table 6-1: Average annual consultancy service spend [£m]**

### 6.1.3 Customers and competitors

The primary customers for this work are: project developers; project investors; lenders; and main contractors. There are also subcontract opportunities.

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. The number of specialist companies have grown significantly in recent years, through activity in renewables, so they are now sizeable consultancies and, in some cases, part of much larger multi-industry groups.

Opportunity exists both to enter into those key roles, and to enter in support of them. Annex 1 (Contacts Directory) identifies the main players in the key roles. Taking one of these roles demands a highly competent and focussed organisation, with good access to skilled resources and competitive pricing. There is a subcontracting culture in many of the organisations identified, particularly in the environmental assessment process and in the construction management process, which offers opportunities to a wide range of companies and individuals.

There is a trend towards utility owners of projects bringing some of these skills in-house, although in all cases this will continue to be complemented substantially by consultancy support.

### 6.1.4 Procurement processes

Procurement is usually competitive closed tender, with pre-qualification exercises in many cases, and advertising of UK opportunities through OJEU is not obligatory, although it occurs from time to time, including for consultancy support. Direct contact to likely customers through conferences, visits and networking is the most common route to secure bid opportunities.

### **6.1.5 Applicable standards and norms**

This is dominated by the need to evidence capability and experience in delivering similar works.

Basic corporate certifications for quality, health and safety and environmental performance are common, although not always mandatory - particularly for subcontract roles.

## **6.2 Offshore wind turbine operations and maintenance (O&M)**

### **6.2.1 Supply opportunities**

Wind turbine suppliers are typically the O&M Provider of offshore wind farms – offering a 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 supplier. Third party O&M Providers and in-house O&M owners, by project, are both common in onshore wind, but have no presence in offshore wind, as yet.

Primary activities within wind turbine O&M are: scheduled service (annual or semi-annual); project base provision; unscheduled fault-finding and repair; remote monitoring; major repairs; retrofit; spares handling at project base; operational reporting; and spares sourcing.

Core activities tend to be undertaken by wind turbine staff, including management and technician staffing. During periods of intense activity, such as summer scheduled service campaigns, supplementary technician support can be used. Non-core activities, such as transport, vessel provision and crewing, are typically subcontracted by the O&M Provider. Some highly specialised tasks are also subcontracted. For example, roped access to rotor blade cleaning and checking, or on-site investigation and repair of major sub-supplied components (generators, transformers, gearbox, switchgear, converters), for which the relevant sub-suppliers will be subcontracted.

There are around three indirect jobs for every direct job in the operation of an offshore wind farm, so with one direct post for approximately every 10-20 turbines installed, there are diverse business support opportunities. These would be focussed around the project service base, the location of the spares providers, transport and vessel providers and monitoring base (this could be anywhere in the world).

Project owners, in addition to employing a main O&M Provider, will also typically maintain an overview management and monitoring function, which would involve having staff dedicated to the project, both at the service base and in their headquarters.

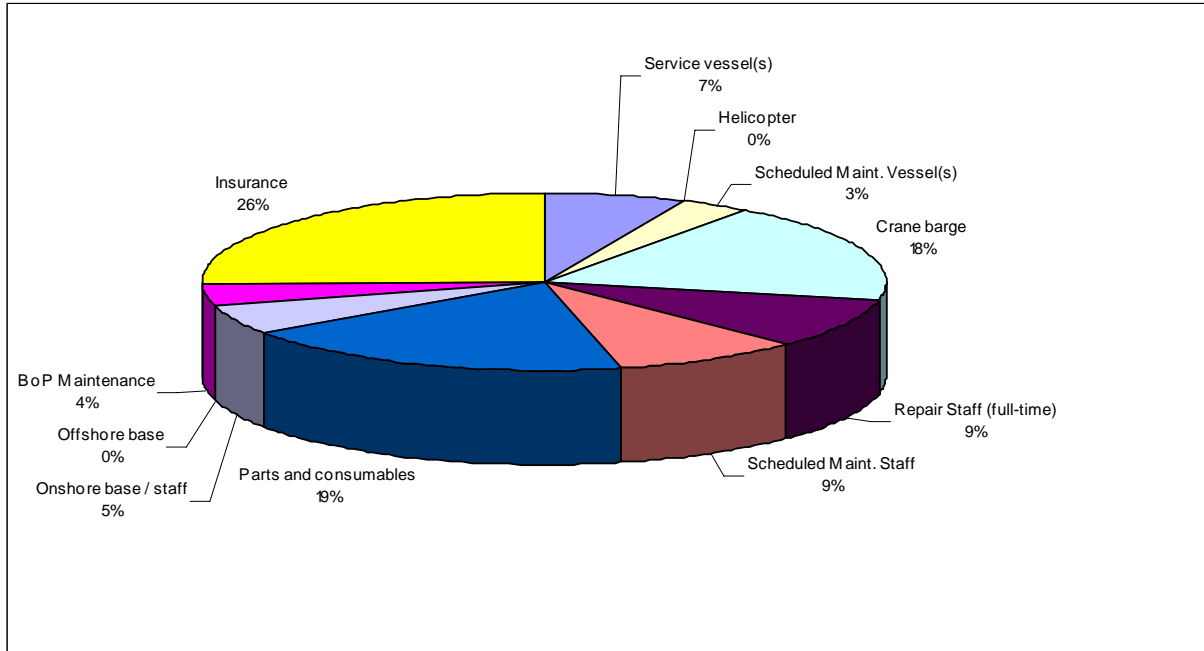
For future projects, the approach to O&M will change significantly from that on current projects, owing to their increasing size and isolation. This is likely to result in more manned accommodation platforms on the project sites, and more widespread use of helicopters for movement of technicians to and around the field.

**6.2.2 Economic value**

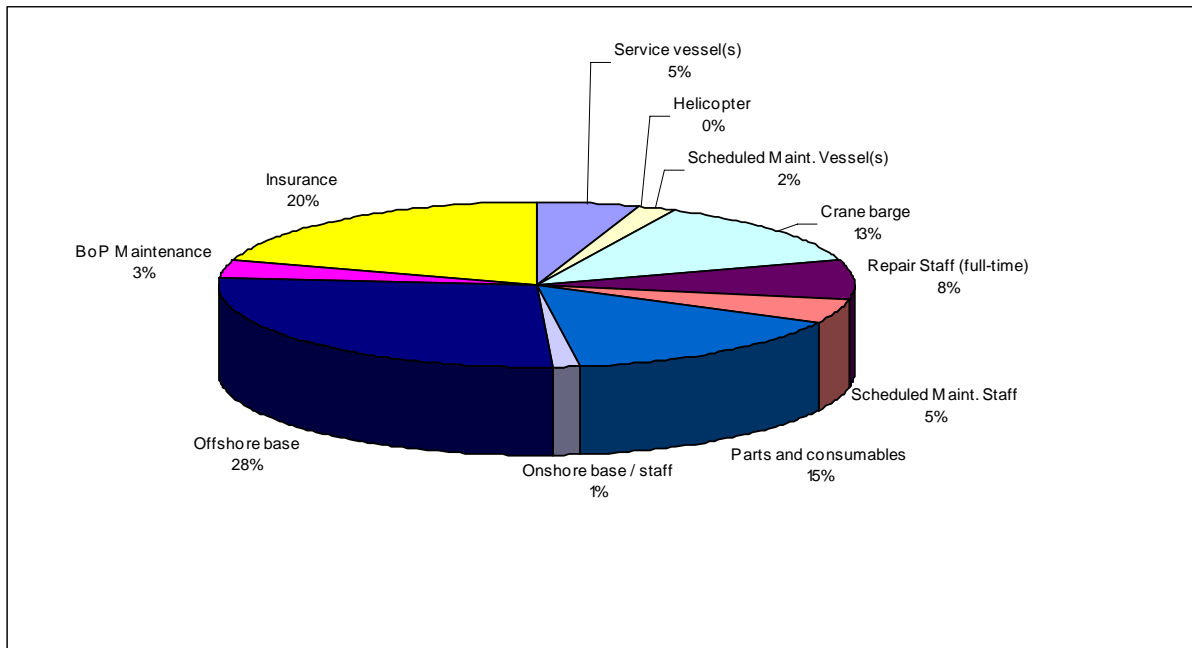
	Location		
	Local	National	Export
2010 – 2015	36	103	120
2016-2020	141	431	515
2021 onwards	180	612	680

**Table 6-2: Average annual wind turbine O&M spend [£m]**

The breakdown of the O&M spend (including for balance of plant) is represented, below, for a simulated 750MW offshore project, with two separate access strategies – one in which the crew are based on an offshore platform and one in which daily helicopter pickups and drop-offs are used.



**(a) Shore-based maintenance**



**(b) Maintenance from offshore platform base**

**Figure 6-2: Breakdown of O&M spend**

**6.2.3 Customers and competitors**

The project owner is the ultimate customer for wind turbine O&M; in offshore wind, this is a normally a power utility or special project company, under joint ownership of utilities and finance houses, with the decision-maker within the utility.

Main O&M Providers are the wind turbine suppliers to the projects, all but new-start-ups are classified as Large Companies.

Project owners, or third party providers, may (in time) start to undertake more O&M in-house, as many of them do in onshore wind farms. Those third-party providers in onshore wind tend to be Small or Medium-sized companies.

**6.2.4 Procurement processes**

The selection of O&M Provider for the first five years is an integrated part of the wind turbine selection process.

After the initial five-year period, the project owner may go out to tender (possibly public, but more commonly, closed) for follow-on periods.

### 6.2.5 Applicable standards and norms

Core competences and requirements for O&M Providers are:

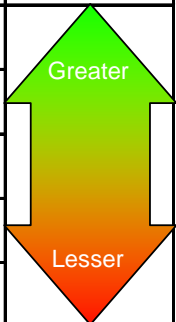
- Technical resources, with a qualification to maintain the wind turbines in question, for which each manufacturer has its own in-house training course and systems;
- Relevant safety training of all site operatives (working at height, electrical authorisations, offshore safety, confined space working);
- Access to spares supplies;
- Monitoring and fault-finding capability;
- Management and reporting competence; and
- Financial strength to support plant availability warranties.

## 6.3 Wind turbine rotor blade manufacture

### 6.3.1 Supply opportunities

This section presents the wind turbine suppliers, working back to their blade suppliers; this approach is considered appropriate, given that a number of leading manufacturers of offshore wind turbines manufacture their blades in-house.

The wind turbine manufacturers have been categorised into five groups, A through E, depending on their current involvement in the offshore wind market. These categories have been defined, as follows:

<i>Category</i>	<i>Description</i>	<i>Relevance</i>
A	“Blue Chip” Offshore WTG Suppliers	
B	Other Established Offshore WTG Suppliers	
C	Non-established Offshore WTG Suppliers with current turbine offerings	
D	Non-established Offshore WTG Suppliers with turbines under development	
E	Potential New Entrants (with wind energy pedigree)	

**Table 6-3: Offshore WTG (1<sup>st</sup> Tier) Supplier Classification System.**

Some blade suppliers and potential turbine manufacturers, who have a background only in onshore wind, are not mentioned here.

With this classification, the key offshore wind turbine suppliers and (in turn) their principal blade suppliers are presented in Figure 6-3:



Figure 6-3: Overview map of offshore wind turbine blade supply.

Of the suppliers identified in Figure 6-3, only **Siemens** and **Vestas** have significant track records in offshore wind. More recently, **Repower**, **Areva** and **Sinovel** have each installed multi-turbine commercial-scale offshore projects, and **Bard Engineering** is currently in the process of doing the same.

It should be noted generally that, among identified Category A and B offshore WTG manufacturers, there is strong tendency toward in-house production of wind turbine blades, which is considered to reflect the development of a relatively mature product.

The following discussion details the blade supply chain scenario for each offshore WTG supplier. It should be noted that, in some cases, incomplete information is available.

#### Category A

Both **Vestas** and **Siemens** produce blades exclusively in-house.

#### Category B

Of the Category B suppliers, **Areva** produces blades in-house (through its purchase of PN Rotor GmbH in mid-2009), whilst **Repower** is developing its own production capability at present, through a joint venture with SGL Rotec (formerly AR Rotec); at the time of writing, Repower continues to outsource blade supply for its offshore turbine models to LM Glasfiber Group, whilst its in-house capability is being developed.

Of the other Category B suppliers, **Bard Engineering** announced in December 2009 that it had signed a supply agreement with SGL Rotec, while **Sinovel** Wind Group Co., Ltd is understood to source blades from Sinomatech (although not necessarily exclusively<sup>1</sup>).

#### Category C

**Clipper** has very recently announced the “ground-breaking” construction of its first offshore WTG blade manufacturing facility, to be located in Northeast England. It is understood that the facility will be owned and operated by Clipper, and that it will manufacture blades for its 10MW “Britannia” turbine model.

GH understands that **Goldwind** Science and Technology Co., Ltd outsources its blade production, with both HT Blade and LM Glasfiber being known suppliers.

#### Category D

**Mitsubishi Heavy Industries** is understood currently to be developing a large-scale offshore WTG product, which is likely to enter commercial production in the short term (up to 2015). Separately, the company has an established blade production joint-venture with TPI Composites, which operates under the name of Vientek. However, this JV has not been named explicitly, as the supplier of blades to the proposed offshore wind turbine.

A joint venture between **American Superconductor** and **Dongfang Turbine Co. Ltd.** (a subsidiary of Dongfang Electric Corporation) announced, in January 2010, that it is developing a 5.0MW offshore wind turbine model. Neither the state of advancement of development works, nor the likely blade supply chain, is known at this time.

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<sup>1</sup> GH experienced some difficulty in obtaining definitive information on key supply-chain relationships for Chinese manufacturers, due to the absence of public reporting requirements for many of the companies, and the highly-fluid state of the Chinese wind market generally.

In September 2009, **GE Energy** announced that it had acquired Scanwind, a Norwegian offshore WTG supplier. This deal announced the re-entry of GE Energy into the offshore WTG supply market, having previously withdrawn from the market, subsequent to its development of Arklow Bank, a seven-turbine offshore wind energy development in Irish waters. GE has traditionally out-sourced its blade production.

#### Category E

Of the Category E turbine suppliers, **Acciona**, **Alstom** (Ecotecnia) and **Gamesa** are all Spanish, with significant financial resources and extensive wind energy expertise; all three are expected to expand into the offshore wind turbine supply market in the medium-term, particularly as the Spanish offshore wind sector opens up.

In the case of Gamesa, it is noted that, whilst a small percentage of the company's blade supply is outsourced to LM Glasfiber, all blade design is undertaken in-house by Gamesa; the company's strategy appears to be based on the use of independent blade supply as a short-term means of levelling differences between demand and in-house production capability.

**Enercon** has an operational offshore prototype installed at Emden (Germany), despite having no stated intention of entering the offshore WTG supply market. The company's reputation for supplying high-quality reliable wind turbine products is likely to ensure it gains a significant market share, should it choose to expand into offshore supply.

**Samsung Heavy Industries** is understood to harbour aspirations to enter the offshore WTG supply market. Whilst Samsung does not have a long history of involvement in the wind energy sector, its reputation for engineering excellence across a broad range of sectors, its experience in heavy industry, and its significant financial resources, are all likely to position it well to gain a market share, should it enter the offshore wind turbine market.

**Dewind**, a medium-scale German wind turbine manufacturer with significant in-house wind expertise, was recently bought by Daewoo Shipbuilding & Marine Engineering Co., Ltd. (DSME). It is expected that, with DSME, new designs of larger machines will be launched in the near future. It is not clear whether any (or all) of these products will be marketed for offshore deployment; however, given the background of DSME, it is expected that it will aim to enter the offshore market. It is understood that Sinoi GmbH supply blades for the largest model (the D8.2) in Dewind's current range.

The UK has historically had a small amount of wind turbine blade manufacturing, originally using staff skills deriving from the yacht-building industry, around Southampton. There is recognition within the wind industry that the UK has a good engineering skills base in composites, centred around aerospace and the yacht-building industry clusters.

However, Vestas closed its Isle of Wight factory in 2009, which was producing blades for wind turbines up to 2MW. It relocated to the USA, which was the main market for its products.

This represents a trend in the industry to locate rotor blade manufacture closer to market, motivated by:

- Reduction of transportation and handling of these bulky, but delicate items (a rotor blade for an offshore wind turbine will be over 50 m long, with carefully engineered tips and trailing edges), with a mass of 10 to 15 Tonnes;
- Increasing employment in the end-market, for political reasons, given that rotor blade manufacture is the largest single employment opportunity in wind turbine manufacture; and
- Avoiding production in high labour cost areas.

The compelling need to optimise aerodynamic efficiency means that manufacturing compromises to the blade outer shell are not usually acceptable. Within this envelope, there are diverse approaches to design and manufacture, which also feed through to the supply chain, sitting behind a blade manufacturer:

- Reinforcing fibre selection – primarily glass fibre, some designers use a small proportion of carbon fibre, limited by cost and concerns over cost volatility;
- Resin system; and
- Wet lay-up, or use of pre-impregnated fibre matting.

### 6.3.2 Economic value

Rotor blades constitute 10-15% of the capital value of a wind turbine, so an individual blade for an offshore wind turbine will have value ranging from £150,000 to £300,000, split equally between raw materials, and staffing and facilities.

	Location		
	Local	National	Export
2010 – 2015	37	90	148
2016-2020	85	326	293
2021 onwards	70	327	334

**Table 6-4: Wind turbine rotor blade manufacture [£m/annum]**

### **6.3.3 Customers and competitors**

The customers for a rotor blade manufacturer will be the wind turbine manufacturer, for all but the new start-ups classified as Large Companies.

Once brought in-house, blade manufacture is unlikely to be outsourced to any great extent, so the primary customers for independent blade manufacture are those with an out-sourcing approach; these are identified in the previous section.

There are several established competitors, with a wide selection of these identified in the previous section.

### **6.3.4 Procurement processes**

As a high value component, wind turbine manufacturers look for competitive pricing and ongoing cost reduction. However, quality is paramount in rotor blades, as there is little tolerance for manufacturing defect and the impact of rotor blade failures is very serious. Additionally, a high degree of design interaction is needed between the turbine and blade manufacturer. For these reasons, the building-supplier relationship is a long-term venture.

The positive side of this is that once relationships are built, considerable business can result, provided that good technical and commercial service is also provided.

Although this report focuses on the offshore wind turbine market, a good supplier of offshore blades could also find that it is very well-placed to service a much larger onshore market.

### **6.3.5 Applicable standards and norms**

Design of wind turbine rotor blades is now mature, and is subject to both the IEC 61400 series for structural load definition and a good deal of established industry practice in detailed design and manufacture.

All blades will be subject to full-scale load testing of initial production examples, including extreme and accelerated lifetime fatigue tests, in a test facility, and field tests on a prototype.

Standard health and safety measures, relevant to the handling of hazardous composites (including COSHH), will apply, as will environmental legislation on emissions and disposal.

## **6.4 Wind turbine cooling and hydraulic systems**

### **6.4.1 Supply opportunities**

Wind turbine nacelles have several cooling and hydraulic system demands, including:

- Gearbox oil cooling;
- Generator and converter cooling;
- Rotor braking and locking; and
- Yaw control, either electromechanical or hydraulic.

Combined cooling demands on a large wind turbine could well be in excess of 100 kW. In an offshore wind turbine, this must be achieved without exposing the nacelle internal components to risk of condensate from marine air.

The approach of most wind turbine manufacturers is to design these systems largely in-house and build them up from bought-in components. This means that there is a very limited supply chain, with some companies having made a speciality out of supporting the wind turbine suppliers in these subsystems.

#### 6.4.2 Economic value

	Location		
	Local	National	Export
2010 – 2015	4	9	15
2016-2020	8	33	29
2021 onwards	7	33	33

**Table 6-5: Wind turbine cooling and hydraulic systems [£m/annum]**

#### 6.4.3 Customers and competitors

Customers: wind turbine manufacturers.

Competitors: Hydac ( [www.hydac.com](http://www.hydac.com) ); PMC Windsyn ( [www.pmcwindsyn.com](http://www.pmcwindsyn.com) ); extensive in-house manufacture.

#### **6.4.4 Procurement processes**

Closed competitive tender as product is developed, typically leading to three sub-supplier options.

#### **6.4.5 Applicable standards and norms**

Normal machinery and manufacturing standards.

### **6.5 Diesel generating sets**

#### **6.5.1 Supply opportunities**

Diesel back-up power is needed in several situations on offshore wind farms:

- Temporary supply to power wind turbine auxiliaries:

To avoid deterioration, wind turbines cannot sustain extended periods without power supply to their auxiliary systems, as may occur if there is a delay in making the grid connection to the turbines during construction, or if there is an electrical system fault during operations. Any disruption of more than 1-2 weeks is likely to demand a back-up power supply is installed on the wind turbine platform. Demands on the set deployed: rated power ~50kVA; long re-fuelling interval; weatherproof enclosure.

It is impractical to locate the back-up power on a central substation, owing to the high magnetising current demand of the wind farm cable system.

- Back-up supply to offshore substation and accommodation platform:

A Single unit, or a small number of units, with rated power ~300kVA, permanently located, for the event of outages in the grid connection to these remote offshore platforms.

- Supplies to construction vessels and onshore marshalling sites:

Standard construction activity demand.

#### **6.5.2 Economic value**

Temporary power to wind turbines: if needed, this is likely to be on a hire basis, for a few months, with a minimum of ten units (one cable string faulted), and a maximum of one on all wind turbines at the wind farm. The customer may also choose to hold a small number in reserve, as a buffer, before having to go to the hire market.

Offshore substations or accommodation platforms: two units, per platform.

Construction site units: similar to any construction activity of the same scale.

### **6.5.3 Customers and competitors**

Customers: wind turbine suppliers, wind turbine O&M Providers, main electrical EPC contractors, and other installation contractors.

These services tend to be sourced locally, as and when required, although established relationships may be called upon, when time is of the essence.

### **6.5.4 Procurement processes**

Purchase of stock units and procurement of hire services will be sourced by competitive tender, unless requirement is unforeseen, when time will be of the essence.

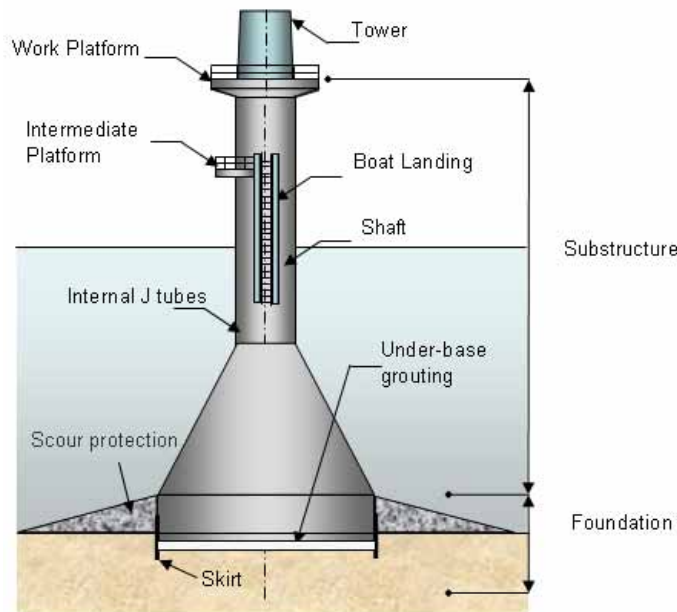
### **6.5.5 Applicable standards and norms**

No industry-specific standards, but a focus on spillage avoidance and reliability.

## **6.6 Offshore wind turbine GBS foundations**

### **6.6.1 Supply opportunities**

Structures to support offshore wind turbines come in various concepts, shapes and sizes. Monopiles have been chosen for most of the installed offshore wind farms, to date. Concrete gravity base structures have also been used on several projects. As wind turbines get larger, are located in deeper water, and stiffer structure forms are demanded, the market share of monopiles will reduce. Jacket structures are expected to become more attractive, but concrete gravity base structures (GBS) are also an option, as are less well-developed structure forms.



**Figure 6-4 : Typical GBS form for a wind turbine**

GBSs for offshore wind turbines are massive structures, typically weighing 3,000 to 5,000 tonnes, with a footprint of perhaps 30m across. They offer a range of advantages, when compared to jackets and monopiles, in terms of: stiff concept; corrosion resistance; extended lifetime; not affected by difficult pile driving conditions; insensitive to volatility in steel price and currency (if made in the UK); and promising economics.

Looking at the main UK offshore wind areas, there are distinct characteristics that have implications for the foundation concepts:

#### *UK North Sea*

Characterized by good driving conditions and relatively shallow water depths, for projects to be developed in next 5 years; getting deeper towards 2020. Likely to be dominated by monopiles, with a proportion of jacket structures increasing towards 2020. Innovations in monopiles will serve to slow this loss of share.

#### *Irish Sea / Scottish West Coast*

Characterized by poor driving conditions and rather deeper water than in the North Sea (due to high tidal range). Gravity bases may find a role here, due to the increased installation cost of piles. However, as gravity bases have their own challenges to overcome, it is anticipated that monopiles and jackets will also seize a substantial Irish Sea market share.

The main obstacle to the competitive roll out of GBSs is solving the logistics of constructing and installing them, which requires a substantial investment of resources in advance of tendering for a project.

### 6.6.2 Economic value

	Location		
	Local	National	Export
2010 – 2015	111	269	445
2016-2020	255	977	880
2021 onwards	211	982	1001

**Table 6-6: Wind turbine foundation values – all concepts [£m/annum]**

### 6.6.3 Customers and competitors

Customers: offshore wind farm developers.

Competitors: established foundation EPC contractors.

### 6.6.4 Procurement processes

Competitive, open-tendered, with pre-qualification.

### 6.6.5 Applicable standards and norms

Industry specific design standards:

- IEC 61400-3: 1999, Wind Turbines – Part 3: Design requirements for offshore wind turbines;
- Germanischer Lloyd Rules for offshore wind turbines; and
- Det Norsk Veritas DNV-OS-J-101 Design of offshore wind turbine structures.

A raft of other design standards from other industries cascade from the above. Construction and marine, including safety standards, are also relevant, but these are not sector-specific.

## **7 MARKET ENTRY PRACTICALITIES**

### **7.1 Market approach**

In essence, suppliers offering relevant products and services, with excellent quality, delivery ability and competitive pricing, can find a role in the offshore wind industry. It 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.

However, the industry does suffer from a shortage of experienced personnel, so approaches to potential customers must be well-focussed, if business is to result. The basic rules of business apply in offshore wind:

#### ***Trusting relationship***

Firms are mostly looking to build relationships with companies who can support them into the future, so new entrants are treated with some caution, especially if it is evident that they are only interested in diversifying into wind from a sector which is in a cyclical dip.

#### ***Right product***

Tick all the boxes on function, quality, delivery and pricing, but also the product or service must be one which is clearly needed, at or near the time offered.

#### ***Understand your customer***

Develop an awareness of (corporate or national) cultural differences between supplier and customer, to avoid these becoming an issue. Regardless of the mechanised approach implied by procurement databases (see below), personal contact remains crucial.

#### ***Prepare for competition***

Developing an understanding of the customer's requirements and what the decisive factors are, before getting involved in a formal procurement process.

#### ***Get it right first time***

Second chances may not be given, so when issues arise, deal with them effectively.

### **7.2 Procurement processes**

Procurement processes will always be company-specific, but some general guidance is given here.

Pre-qualification exercises are common for shortlisting companies meeting minimum criteria, primarily in terms of:

- Financial strength;

- Quality;
- Health and safety;
- Environmental management;
- Capability; and
- Relevant experience.

UK wind projects are not required to procure in accordance with the EU Utilities Directive, although some choose to do so. Non-UK European projects are required to comply with the directive, but compliance is, at best, patchy. Registration for notification of tenders is free:

<http://ted.europa.eu/>

Some project developers use the UK Utility Vendors Database (Achilles) for selection of suppliers, or in some cases require that sub-suppliers are registered. Basic registration for suppliers costs £500, currently:

<http://www.achilles.com/en/uk/>

For most companies, procurement will be by competitive tendering from a shortlist of at least three potential suppliers, unless there is an exceptional reason for non-competitive tendering, such as innovation advantage or the market situation. The nature of the process can vary markedly if it is for project-specific, as opposed to product-specific, works.

### ***Project procurement***

To date, most procurement, other than for wind turbine supply, has been on a project-by-project basis, with competitive tendering each time – from the wind farm developer, right down through the supply chain. Indeed, project delays have caused multiple tendering on some projects. Despite this, loose teams have started to develop, with specific developers selecting the same Tier 1 suppliers repeatedly.

There have been some supply bottlenecks, which has driven some roll-outs of framework agreements and other long-term arrangements (for example vessel charters), across the sector. For the most part, framework agreements are greeted with some scepticism in the supply chain and are (rightly) seen as a ploy to avoid supply constraint and price increases for projects.

The market has softened in 2010, but it is still likely that we will see increased use of framework agreements, for other reasons:

- Projects are becoming larger, lending themselves to long-term arrangements;

- There is recognition that the sector needs to be “industrialized”, with as many processes as possible becoming standard, allowing products and services to be streamlined;
- The Round 3 programme projections indicate a probable return to a tighter procurement environment, in the medium-term; and
- Developers and Tier 1 contractors see the internal benefit of limiting burden on their procurement and sanction teams through “same-again” commercial arrangements.

Various developers have advised that the long-term arrangements could be rolled out across a wider range of goods and services than previously.

### ***Product procurement***

A large component of an offshore wind farm’s value is in fairly standard products. Obviously, this includes the wind turbines, but also subsea cables and electrical equipment (transformers, switchgear, power factor correction equipment). The product manufacturers, or assemblers of these items, operate production line systems and therefore look for a stable, long-term supply base.

As with most stable product manufacture situations, there is a tendency for the supply chain to be flattened out, with the product manufacturer seeing the management of many sub-suppliers (hundreds in the case of the wind turbine) as part of their core business.

For goods and services feeding into the end-product, long-term contracts are the norm, locking down commercial conditions - specifically pricing delivery and warranties. For major sub-assemblies, warranties are a key issue as the product manufacturer will be looking to back its own warranties with those from sub-suppliers, as far as possible.

Multiple-sourcing of sub-supplies remains common – even in products particularly favoured by some wind turbine manufacturers – serving to maintain competitive commercial conditions and mitigating the risk of serial defect in components. Conversely, some wind turbine manufacturers have shown long-term commitment to their major system sub-suppliers, as a business principle - even when they have provided unreliable equipment from time to time.

Provision of consumables, tooling and facilities will, by its nature, be more ad hoc and open to entry than inputs to the end-product.

### **7.3 Market information – trade associations**

Companies should consider joining the UK trade association (Renewable UK previously named British Wind Energy Association - BWEA), who provide good information on developments in the market, including a regular magazine and email bulletins:

<http://www.bwea.com/>

The trade associations in Scotland and the Republic of Ireland are smaller organisations, but serve a similar role, Ireland having recently formed an association dedicated to offshore wind:

<http://www.iwea.com/>

<http://www.nowireland.ie/>

<http://www.scottishrenewables.com/>

#### **7.4 Market information – trade press**

There are many trade magazines which report on the offshore wind sector, including project status. Some are free, others are subscription-based and come out bi-weekly or monthly:

[www.renews.biz](http://www.renews.biz)

[www.windpowermonthly.com](http://www.windpowermonthly.com)

[www.energyengineering.co.uk](http://www.energyengineering.co.uk)

[www.rechargenews.com](http://www.rechargenews.com)

[www.offshorewind.biz](http://www.offshorewind.biz)

[www.windtech-international.com](http://www.windtech-international.com)

In general, offshore wind is well-publicised, so a “Google Alert” for “offshore wind” gives ample and diverse market information.

#### **7.5 Conferences and trade fairs**

There are a plethora of events targeting offshore wind. The most well-established of these are run by trade associations, but most are run by specialist event organisers and some are run by established firms, who organise promotional and networking events.

##### ***European Wind Energy Conference***

<http://www.ewea.org/>

Main wind events (onshore and offshore) in Europe, run annually. The location varies throughout Europe. Major trade exhibitions, as well as conferences (including significant technical streams).

##### ***European Offshore Wind Conference***

<http://www.ewea.org/>

Main offshore wind event in Europe, run bi-annually. The next event will be in 2011. The location varies throughout Europe. Major trade exhibitions, as well as conferences (including significant technical streams).

### ***Husum Wind***

<http://www.husumwindenergy.com/content/en/>

Major trade fair for onshore and offshore wind. Run bi-annually, in Husum, northern Germany.

### ***UK Offshore Wind Conference***

<http://www.bwea.com/offshore/conference2010.html>

Main UK offshore wind event. Run annually, the location within the UK varies. Conference and fast growing trade exhibition.

### ***Renewable UK Annual Conference***

<http://www.renewable-uk.com/events/annual-conference/index.html>

Main UK wind event, run by Renewable UK, and previously known as BWEA 31 (in 2009). Run annually, the location within the UK varies. Conference and trade exhibition.

### ***All-Energy Renewables Show***

<http://www.all-energy.co.uk/>

Trade exhibition and growing conference for wind, wave, tidal and other renewables. Run annually, in Aberdeen (May).

Commercial organisers of events tend to target specific specialist areas and are predominantly conferences rather than trade fairs. Useful links:

Wind Energy Update [www.windenergyupdate.com](http://www.windenergyupdate.com)

Windpower Monthly <http://www.windpowermonthly.com/>

Hanson Wade <http://www.hansonwade.com/energy-industry.php>

GL Garrad Hassan [http://www.germanlloyd.org/presse/events\\_16186.php](http://www.germanlloyd.org/presse/events_16186.php)

LBC <http://www.enabling-offshore-wind-supply-chain-2010.com/>

Greenpower <http://www.greenpowerconferences.com/index.html>

## **7.6 Contacts Directory**

Appendix 1 contains a directory of Tier 1 organisations (i.e. those likely to have a major contract, direct from the project developer), and many of the Tier 2 and Tier 3 organisations (i.e. subcontractors). Direct individual contacts have been identified for many of these organisations, although they have asked that these only be released to appropriate businesses, rather than published.

## **APPENDIX 1**

### **Contacts Directory**

**[13 pages]**

**Wind Turbine Manufacturers**

Vestas	<a href="http://www.vestas.com/">http://www.vestas.com/</a>
Siemens	<a href="http://www.energy.siemens.com/">www.energy.siemens.com/</a>
Enercon	<a href="http://www.enercon.de/">www.enercon.de/</a>
MHI	<a href="http://www.mpshq.com/products_wind.htm">http://www.mpshq.com/products_wind.htm</a>
REpower	<a href="http://www.repower-uk.co.uk/">www.repower-uk.co.uk/</a>
GE	<a href="http://www.gepower.com/">http://www.gepower.com/</a>
Nordex	<a href="http://www.nordex-online.com/">www.nordex-online.com/</a>
Clipper	<a href="http://www.clipperwind.com/">www.clipperwind.com/</a>
BARD	<a href="http://www.bard-offshore.de/">www.bard-offshore.de/</a>
Areva Multibrid	<a href="http://www.multibrid.com/">www.multibrid.com/</a>
Darwind	<a href="http://www.xemc-darwind.org">http://www.xemc-darwind.org</a>

**Consultants****Engineering**

Mott Macdonald	<a href="http://www.mottmac.com">www.mottmac.com</a>
Natural Power / SeaRoc	<a href="http://www.naturalpower.com">www.naturalpower.com</a>
Wind Prospect	<a href="http://www.windprospect.com">www.windprospect.com</a>
Sgurr	<a href="http://www.sgurrenergy.com">www.sgurrenergy.com</a>
GL Garrad Hassan	<a href="http://www.gl-garradhassan.com">www.gl-garradhassan.com</a>
Senergy	<a href="http://www.senergyworld.com">www.senergyworld.com</a>
PMSS	<a href="http://www.pmss.co.uk">www.pmss.co.uk</a>
SKM	<a href="http://www.skmconsulting.com">www.skmconsulting.com</a>
BVG	<a href="http://www.bvgassociates.co.uk">www.bvgassociates.co.uk</a>
BMT	<a href="http://www.bmt.org">www.bmt.org</a>
Halcrow	<a href="http://www.halcrow.com">www.halcrow.com</a>
PB Power	<a href="http://www.pbworld.co.uk">www.pbworld.co.uk</a>
8.2	<a href="http://www.8p2.de">www.8p2.de</a>
IMS Ingenieurgesellschaft	<a href="http://www.ims-ing.de">www.ims-ing.de</a>
Ramboll	<a href="http://www.ramboll.com">www.ramboll.com</a>
3E	<a href="http://www.3econsult.com">www.3econsult.com</a>
Ecofys	<a href="http://www.ecofys.com">www.ecofys.com</a>
TNEI	<a href="http://www.tnei.co.uk">www.tnei.co.uk</a>
Scott Wilson	<a href="http://www.scottwilson.com">www.scottwilson.com</a>
Atkins	<a href="http://www.atkinsglobal.com">www.atkinsglobal.com</a>
KBR	<a href="http://www.kbr.com">www.kbr.com</a>
Offshore Design Engineering (ODE)	<a href="http://www.ode-ltd.co.uk">www.ode-ltd.co.uk</a>
K2 Management	<a href="http://www.k2management.dk/">www.k2management.dk/</a>
Setech (Gardline)	<a href="http://www.setech-uk.com">www.setech-uk.com</a>
Metoc	<a href="http://www.metoc.co.uk">www.metoc.co.uk</a>
J P Kenny	<a href="http://www.jpkenney.com">www.jpkenney.com</a>
Clarksons	<a href="http://www.clarksons.com/">www.clarksons.com/</a>
EPC Management	<a href="http://www.epcmanagement.com">www.epcmanagement.com</a>
Tripod / COWI	<a href="http://www.cowi.com">www.cowi.com</a>
Mojo Maritime	<a href="http://www.mojomaritime.com">www.mojomaritime.com</a>
Grontmij - Carl Bro	<a href="http://www.grontmij-carlbro.com">www.grontmij-carlbro.com</a>
RPS	<a href="http://www.rpsgroup.com">www.rpsgroup.com</a>

**Environmental**

Atmos Consulting	<a href="http://www.atmosconsulting.com">www.atmosconsulting.com</a>
Metoc	<a href="http://www.metoc.co.uk">www.metoc.co.uk</a>
RPS	<a href="http://www.rpsgroup.com">www.rpsgroup.com</a>
RSK	<a href="http://www.rsk.co.uk">www.rsk.co.uk</a>
Royal Haskoning	<a href="http://www.royalhaskoning.co.uk">www.royalhaskoning.co.uk</a>
Halcrow	<a href="http://www.halcrow.com">www.halcrow.com</a>
ERM	<a href="http://www.erm.com">www.erm.com</a>
PMSS	<a href="http://www.pmss.co.uk">www.pmss.co.uk</a>

**Insurance Brokers / Advisors**

Marsh	<a href="http://www.marsh.co.uk">www.marsh.co.uk</a>
Aon	<a href="http://www.aon.co.uk">www.aon.co.uk</a>
Dexia	<a href="http://www.dexia.com">www.dexia.com</a>
Delta Lloyd	<a href="http://www.deltalloydgroep.com">www.deltalloydgroep.com</a>
GCube	<a href="http://www.gcube-insurance.com/">http://www.gcube-insurance.com/</a>

JLT

[www.jltgroup.com](http://www.jltgroup.com)**Wind Turbine Erection****Full Installation**

A2SEA	<a href="http://www.a2sea.com/">http://www.a2sea.com/</a>
DEME	<a href="http://www.deme.be/index.asp">http://www.deme.be/index.asp</a>
Ballast Nedam	<a href="http://www.ballast-nedam.com/">http://www.ballast-nedam.com/</a>
MPI Offshore	<a href="http://www.mpi-offshore.com/">http://www.mpi-offshore.com/</a>
SMIT	<a href="http://www.smit.com/">http://www.smit.com/</a>
Fugro Seacore	<a href="http://www.seacore.com/">http://www.seacore.com/</a>
Seaway Heavy Lifting	<a href="http://www.seawayheavylifting.nl/index.php">http://www.seawayheavylifting.nl/index.php</a>
Hochtief	<a href="http://www.hochtief-construction.co.uk/marine_projects.shtml">http://www.hochtief-construction.co.uk/marine_projects.shtml</a>
GeoSea (DEME)	<a href="http://www.geosea.be/">http://www.geosea.be/</a>
Marine Construct	<a href="http://www.marineconstruct.nl/">http://www.marineconstruct.nl/</a>
Windcarrier (Fred Olsen)	<a href="http://www.windcarrier.com/">www.windcarrier.com/</a>
OLCS (RWE)	<a href="http://www.rwe.com/web/cms/en/250908/rwe-npower-renewables/">http://www.rwe.com/web/cms/en/250908/rwe-npower-renewables/</a>
BARD Engineering	<a href="http://www.bard-offshore.de/">www.bard-offshore.de/</a>

**Crane Vessel Only**

Seajacks	<a href="http://www.seajacks.com/index.php">http://www.seajacks.com/index.php</a>
Jack Up Barges	<a href="http://www.jackupbarge.com/">http://www.jackupbarge.com/</a>
Master Marine	<a href="http://www.master-marine.no/">http://www.master-marine.no/</a>
Scaldis	<a href="http://www.scaldis-smc.com/index.htm">http://www.scaldis-smc.com/index.htm</a>
Atlantic Marine Services	<a href="http://www.atlanticoilfieldservices.com">http://www.atlanticoilfieldservices.com</a>
BAM	<a href="http://www.bam.nl">http://www.bam.nl</a>
Superior Energy	<a href="http://www.superiorenergy.com/">http://www.superiorenergy.com/</a>
Muhibbah Marine	<a href="http://www.muhibbah.de">http://www.muhibbah.de</a>

**Wind turbine foundation contractors / fabricators****Monopiles and Transition Pieces**

Bladt	<a href="http://www.bladt.dk/About_Bladt.asp">http://www.bladt.dk/About_Bladt.asp</a>
Corus	<a href="http://www.corusgroup.com/en/">http://www.corusgroup.com/en/</a>
Isleburn	<a href="http://www.isleburn.com/">http://www.isleburn.com/</a>
Skycon Towers	<a href="http://www.wtowers.com/">http://www.wtowers.com/</a>
Smulders	<a href="http://www.smulders-projects.com/">http://www.smulders-projects.com/</a>
SIF	<a href="http://www.sif-group.com/index2.html">http://www.sif-group.com/index2.html</a>
Barnshaw Section Benders	<a href="http://www.barnshaws.com/">http://www.barnshaws.com/</a>

**Gravity Base**

MT Hojgaard	<a href="http://www.mth.com/">http://www.mth.com/</a>
Aarsleff	<a href="http://www.aarsleff.com/">http://www.aarsleff.com/</a>
Seatower	<a href="http://www.seatower.com/">http://www.seatower.com/</a>

**Jacket**

Bifab	<a href="http://www.bifab.co.uk/">http://www.bifab.co.uk/</a>
Heerema	<a href="http://www.heerema.com/">http://www.heerema.com/</a>
Bladt	<a href="http://www.bladt.dk/About_Bladt.asp">http://www.bladt.dk/About_Bladt.asp</a>
Smulders	<a href="http://www.smulders-projects.com/">http://www.smulders-projects.com/</a>
CB&I	<a href="http://www.cbi.com/services/construction.aspx">http://www.cbi.com/services/construction.aspx</a>
Weserwind GmbH	<a href="http://www.weserwind.de/englisch/">http://www.weserwind.de/englisch/</a>
Technip	<a href="http://www.technip.com/english/index.html">http://www.technip.com/english/index.html</a>
Saipem	<a href="http://www.saipem.it/site/Home.html">http://www.saipem.it/site/Home.html</a>
Bechtel	<a href="http://www.bechtel.com/home.html">http://www.bechtel.com/home.html</a>
Lamprell	<a href="http://www.lamprell.com/lamprell/">http://www.lamprell.com/lamprell/</a>
Sheffield Forgemasters	<a href="http://www.sheffieldforgemasters.com/">http://www.sheffieldforgemasters.com/</a>
Harland and Wolff	<a href="http://www.harland-wolff.com">www.harland-wolff.com</a>
Swan Hunter	<a href="http://www.swanhunter.com">http://www.swanhunter.com</a>
OWLships	<a href="http://www.owlships.com">http://www.owlships.com</a>
Aker Solutions	<a href="http://www.akersolutions.com">www.akersolutions.com</a>
Hendricks Industries ApS	<a href="http://uk.hendricks-industries.com">uk.hendricks-industries.com</a>
HSM Steel Structures	<a href="http://www.hsm.nl">www.hsm.nl</a>

**Foundation Erection**

MT Hojgaard	<a href="http://www.mth.com/">http://www.mth.com/</a>
Ballast Nedam	<a href="http://www.ballast-nedam.com/">http://www.ballast-nedam.com/</a>
GeoSea	<a href="http://www.geosea.be/">http://www.geosea.be/</a>
Marine Construct	<a href="http://www.marineconstruct.nl/">http://www.marineconstruct.nl/</a>
MPI Offshore	<a href="http://www.mpi-offshore.com/">http://www.mpi-offshore.com/</a>
Scaldis	<a href="http://www.scaldis-smc.com/index.htm">http://www.scaldis-smc.com/index.htm</a>
Master Marine	<a href="http://www.master-marine.no/">http://www.master-marine.no/</a>
Hochtief	<a href="http://www.hochtief-construction.co.uk/marine_projects.shtml">http://www.hochtief-construction.co.uk/marine_projects.shtml</a>
Biffinger Berger	<a href="http://www.bilfingerberger.de/">http://www.bilfingerberger.de/</a>
Eiffel	<a href="http://eiffel.fr/?LANG=EN">http://eiffel.fr/?LANG=EN</a>
Van Oord	<a href="http://www.vanoord.com">http://www.vanoord.com</a>
Fugro Seacore	<a href="http://www.seacore.com/">http://www.seacore.com/</a>
A2SEA	<a href="http://www.a2sea.com/">http://www.a2sea.com/</a>
DEME	<a href="http://www.deme.be/index.asp">http://www.deme.be/index.asp</a>

**Subsea cable manufacturer****Up to 36kV**

ABB	<a href="http://www.abb.com/">http://www.abb.com/</a>
Nexans	<a href="http://www.nexans.co.uk/">http://www.nexans.co.uk/</a>
Prysmian	<a href="http://www.prysmian.com/">http://www.prysmian.com/</a>
JDR	<a href="http://www.jdrcables.com/Default.aspx">http://www.jdrcables.com/Default.aspx</a>
Parker Scanrope	<a href="http://www.scanrope.no/">http://www.scanrope.no/</a>
Norddeutsche Seekabel Werke	<a href="http://www.nsw.com/">http://www.nsw.com/</a>
DRAKA	<a href="http://www.draka.no">http://www.draka.no</a>
NKT	<a href="http://www.nktcables.com">http://www.nktcables.com</a>

**36kV and Over**

ABB	<a href="http://www.abb.com/">http://www.abb.com/</a>
Nexans	<a href="http://www.nexans.co.uk/">http://www.nexans.co.uk/</a>
Prysmian	<a href="http://www.prysmian.com/">http://www.prysmian.com/</a>
NKT	<a href="http://www.nktcables.com">http://www.nktcables.com</a>

**Cable Protection**

Trelleborg	<a href="http://www.trelleborg.com/en/offshore/">www.trelleborg.com/en/offshore/</a>
Tekmar	<a href="http://www.tekmar.co.uk/">www.tekmar.co.uk/</a>

**Cable installation**

Global Marine-UK	<a href="http://www.globalmarinesystems.com/">http://www.globalmarinesystems.com/</a>
MIKA	<a href="http://www.mika.no/">http://www.mika.no/</a>
MPI Offshore	<a href="http://www.mpi-offshore.com/">http://www.mpi-offshore.com/</a>
Nexans	<a href="http://www.nexans.co.uk/">http://www.nexans.co.uk/</a>
Prysmian	<a href="http://www.prysmian.com/">http://www.prysmian.com/</a>
Subocean	<a href="http://www.suboceangroup.com/">http://www.suboceangroup.com/</a>
Peter Madsen	<a href="http://www.peter-madsen.dk">www.peter-madsen.dk</a>
Norddeutsche Seekabel Werke	<a href="http://www.nsw.com/">http://www.nsw.com/</a>
Power CSL	<a href="http://powercsl.com/">http://powercsl.com/</a>
DEME Tideway	<a href="http://www.tideway.nl">http://www.tideway.nl</a>
Visser & Smit	<a href="http://www.volkerinfra.co.uk">http://www.volkerinfra.co.uk</a>

**Electrical Contractors**

Areva T&D	<a href="http://www.areva-td.com/">http://www.areva-td.com/</a>
Siemens T&D	<a href="http://www.siemens.co.uk/entry/en/">http://www.siemens.co.uk/entry/en/</a>
ABB	<a href="http://www.abb.co.uk/">http://www.abb.co.uk/</a>
Schneider Electric	<a href="http://www.schneider-electric.co.uk/">http://www.schneider-electric.co.uk/</a>
Pauwels	<a href="http://www.pauwels.com">http://www.pauwels.com</a>
EDF	<a href="http://www.edfenergy.com/products-services/infrastructure/contracting-services/">http://www.edfenergy.com/products-services/infrastructure/contracting-services/</a>
Morrison Construction / GallifordTry	<a href="http://www.gallifordtry.co.uk">http://www.gallifordtry.co.uk</a>
McNicholas	<a href="http://www.mcnicholas.co.uk">http://www.mcnicholas.co.uk</a>
Powerteam Electrical Services	<a href="http://www.powerteam-es.com/">http://www.powerteam-es.com/</a>

**Offshore HV Substation Installation**

Scaldis	<a href="http://www.scaldis-smc.com/index.htm">http://www.scaldis-smc.com/index.htm</a>
SMIT	<a href="http://www.smit.com/">http://www.smit.com/</a>
Seaway Heavy Lifting	<a href="http://www.seawayheavylifting.nl/index.php">http://www.seawayheavylifting.nl/index.php</a>
Bonn & Mees	<a href="http://www.bonn-mees.com/">http://www.bonn-mees.com/</a>
DBB	<a href="http://www.dbbsalvage.dk/">http://www.dbbsalvage.dk/</a>
Ballast Nedam	<a href="http://www.ballast-nedam.com/">http://www.ballast-nedam.com/</a>
Acergy	<a href="http://www.acergy-group.com/">http://www.acergy-group.com/</a>
Heerema	<a href="http://www.heerema.com/">http://www.heerema.com/</a>
Saipem	<a href="http://www.saipem.it/site/Home.html">http://www.saipem.it/site/Home.html</a>
Jumbo Shipping	<a href="http://www.jumboshipping.nl/">http://www.jumboshipping.nl/</a>
Master Marine	<a href="http://www.master-marine.no/">http://www.master-marine.no/</a>

**Workboat Vessel Manufacturers**

Windcat	<a href="http://www.windcatworkboats.com">www.windcatworkboats.com</a>
Almarintech	<a href="http://www.almaritec.co.uk">www.almaritec.co.uk</a>
Fintry Marine / Kockums	<a href="http://www.fintry-marine.com/mpv.html">http://www.fintry-marine.com/mpv.html</a>
South Boats Special Projects Ltd	<a href="http://www.southboatssp.co.uk">www.southboatssp.co.uk</a>
Damen Shipyards	<a href="http://www.damen.nl">www.damen.nl</a>

**Workboat Vessel Operators**

Windcat Workboats	<a href="http://www.windcatworkboats.com">www.windcatworkboats.com</a>
MPI Offshore	<a href="http://www.mpi-offshore.com/workboats-projects">www.mpi-offshore.com/workboats-projects</a>
Offshore Wind Power Marine Services	<a href="http://www.offshorewindpower.co.uk">http://www.offshorewindpower.co.uk</a>

**Access Systems Manufacturers**

Ampelmann	<a href="http://www.ampelmann.nl">http://www.ampelmann.nl</a>
OAS	<a href="http://www.offshore-solutions.nl/en/">http://www.offshore-solutions.nl/en/</a>
Reflex Marine	<a href="http://www.reflexmarine.com">http://www.reflexmarine.com</a>

**WTG Sub-components****Nacelle****Bedplate**

Felguera Melt	<a href="http://www.durofelguera.com">www.durofelguera.com</a>
Fonderia Vigevanese	<a href="http://www.vigevanese.it">www.vigevanese.it</a>
Metso	<a href="http://www.metso.com">www.metso.com</a>
Meuselwitz	<a href="http://www.meuselwitz-guss.de/index.php?id=365&amp;L=1">www.meuselwitz-guss.de/index.php?id=365&amp;L=1</a>
Rolls Royce Foundary	<a href="http://www.rolls-royce.com">www.rolls-royce.com</a>
Siempelkamp	<a href="http://www.siempelkamp.com/index.php">www.siempelkamp.com/index.php</a>
Vestas	<a href="http://www.vestas.com">www.vestas.com</a>
CAS	<a href="#">Requires more specific definition</a>
Eisengiesserei Torgelow	<a href="http://www.eisengiesserei-torgelow.de">www.eisengiesserei-torgelow.de</a>
Siempelkamp Giesserei	<a href="http://www.siempelkamp.de/Giesserei.716.0.html">www.siempelkamp.de/Giesserei.716.0.html</a>
Gusstec	<a href="http://www.gusstec.de">www.gusstec.de</a>
Wilhelm Engineering & Projektmanagement	<a href="http://www.w-g-p.de">www.w-g-p.de</a>

**Main Bearing**

FAG	<a href="http://www.fag.com">www.fag.com</a>
IMO	<a href="http://www.imo.de">www.imo.de</a>
Liebherr	<a href="http://www.liebherr.com">www.liebherr.com</a>
NSK	<a href="http://www.nsk.com">www.nsk.com</a>
NTN	<a href="http://www.ntn.co.jp">www.ntn.co.jp</a>
Rollix	<a href="http://www.rollix.com">www.rollix.com</a>
Rothe Erde	<a href="http://www.rotheerde.com">www.rotheerde.com</a>
Kaydon	<a href="http://www.kaydon.com">www.kaydon.com</a>
SKF	<a href="http://www.skf.com">www.skf.com</a>
Timken	<a href="http://www.timken.com">www.timken.com</a>
KOYO(JTEKT)	<a href="http://www.koyo.co.uk">www.koyo.co.uk</a>
Luoyang LYC	<a href="http://www.lycbearing.com">www.lycbearing.com</a>

**Main Shaft**

Bruck	<a href="http://www.bruck-uk.com">www.bruck-uk.com</a>
Euskal	<a href="http://www.euskalforging.com">www.euskalforging.com</a>
Thyssen	<a href="http://www.thyssenkrupp.com">www.thyssenkrupp.com</a>
Forgiatura Mame	<a href="http://www.forgiaturamame.it">www.forgiaturamame.it</a>
Celsa Huta Ostrowiec	<a href="http://www.celsaho.com">www.celsaho.com</a>

**Gearbox**

Bosch-Rexroth	<a href="http://www.boschrexroth.com">www.boschrexroth.com</a>
Eickhoff	<a href="http://www.eickhoffcorp.com">www.eickhoffcorp.com</a>
Hansen	<a href="http://www.hansentransmissions.com">www.hansentransmissions.com</a>
Moventas	<a href="http://www.moventas.com">www.moventas.com</a>
Winergy	<a href="http://www.winergy-ag.com/index.php">www.winergy-ag.com/index.php</a>
Renk	<a href="http://www.renk.de">www.renk.de</a>
Voith Turbo	<a href="http://www.voithturbo.com">www.voithturbo.com</a>
Ishibashi	<a href="http://www.ishibashi-mfg.com">www.ishibashi-mfg.com</a>
David Brown	<a href="http://www.davidbrown.com">www.davidbrown.com</a>

Jahnel Kestermann [www.jake-gear.com](http://www.jake-gear.com)  
Wikov MGI [www.wikov.com](http://www.wikov.com)  
Dalian Heavy Industry [www.dhidcw.com](http://www.dhidcw.com)

**Generator**

Leroy Somer [www.leroy-somer.co.uk](http://www.leroy-somer.co.uk)  
ABB [www.abb.co.uk](http://www.abb.co.uk)  
Vestas [www.vestas.com](http://www.vestas.com)  
Siemens [www.siemens.co.uk](http://www.siemens.co.uk)  
VEM [www.vem-group.com](http://www.vem-group.com)  
Enercon [www.enercon-eng.com](http://www.enercon-eng.com)  
Ingeteam [www.ingeteam.eu/ingles/productos\\_servicios/energia/eolica.asp](http://www.ingeteam.eu/ingles/productos_servicios/energia/eolica.asp)  
Cantarey [www.cantarey.com](http://www.cantarey.com)  
Toshiba [www.toshiba.com](http://www.toshiba.com)  
Weier [www.weier-electric.de](http://www.weier-electric.de)  
Elin [www.elinmotoren.at/Home.12.0.html?&no\\_cache=1&L=1](http://www.elinmotoren.at/Home.12.0.html?&no_cache=1&L=1)  
Winergy [www.winergy-ag.de/index.php](http://www.winergy-ag.de/index.php)  
The Switch [www.theswitch.com](http://www.theswitch.com)  
Converteam [www.converteam.com](http://www.converteam.com)

**Power Take-off****Power Converters**

ABB [www.abb.co.uk](http://www.abb.co.uk)  
Alstom [www.alstom.com](http://www.alstom.com)  
GE [www.ge.com](http://www.ge.com)  
Enercon [www.enercon-eng.com](http://www.enercon-eng.com)  
Ingeteam [www.ingeteam.eu/ingles/productos\\_servicios/energia/eolica.asp](http://www.ingeteam.eu/ingles/productos_servicios/energia/eolica.asp)  
AMSC [www.amsc.com](http://www.amsc.com)  
Converteam [www.converteam.com](http://www.converteam.com)  
The Switch [www.theswitch.com](http://www.theswitch.com)  
Winergy [www.winergy-ag.de/index.php](http://www.winergy-ag.de/index.php)  
PCS [www.pcs-converter.co](http://www.pcs-converter.co)  
KK Electronic [www.kkelectronics.co.uk#](http://www.kkelectronics.co.uk#)  
Windtec [www.amsc-windtec.com](http://www.amsc-windtec.com)

**Transformers**

ABB [www.abb.co.uk](http://www.abb.co.uk)  
GE [www.ge.com](http://www.ge.com)  
CG (Pauwels) [www.pauwels.com](http://www.pauwels.com)  
Schneider [www.schneider-electric.co.uk](http://www.schneider-electric.co.uk)  
Siemens [www.siemens.co.uk](http://www.siemens.co.uk)  
SGB [www.powersystempartners.com](http://www.powersystempartners.com)  
Maschinenfabrik  
Reinhausen [www.reinhausen.com](http://www.reinhausen.com)  
Areva T&D [www.areva-td.com](http://www.areva-td.com)

**Switchgear**

Areva T&D [www.areva-td.com](http://www.areva-td.com)  
CG (Pauwels) [www.pauwels.com](http://www.pauwels.com)  
S&C [www.sandc.com](http://www.sandc.com)

Siemens [www.siemens.co.uk](http://www.siemens.co.uk)

### **Cabling**

Nexans [www.nexans.co.uk/eservice/UK-en\\_GB/navigate\\_-20/Global\\_expert\\_in\\_cables\\_and\\_cabling\\_system.html](http://www.nexans.co.uk/eservice/UK-en_GB/navigate_-20/Global_expert_in_cables_and_cabling_system.html)

Prysmian [www.prysmian.com](http://www.prysmian.com)

DRAKA [www.draka.com](http://www.draka.com)

### **Control System**

Bachmann [www.bachmann.com](http://www.bachmann.com)

DEIF [www.deif.com](http://www.deif.com)

Vestas [www.vestas.com](http://www.vestas.com)

KK - Electronic [www.kkelectronics.co.uk](http://www.kkelectronics.co.uk)

GE [www.ge.com](http://www.ge.com)

Enercon [www.enercon-eng.com](http://www.enercon-eng.com)

Ingeteam [www.ingetteam.eu/ingles/productos\\_servicios/energia/eolica.asp](http://www.ingetteam.eu/ingles/productos_servicios/energia/eolica.asp)

REpower [www.repower.de](http://www.repower.de)

DeWind [www.dewind.de](http://www.dewind.de)

Ecotecnia [www.ecotecnia.com](http://www.ecotecnia.com)

Mitsubishi [www.mitsubishi.com](http://www.mitsubishi.com)

Mita Teknik [www.mita-teknik.com](http://www.mita-teknik.com)

### **Yaw System**

ABB [www.abb.co.uk](http://www.abb.co.uk)

Bosch Rexroth [www.boschrexroth.com](http://www.boschrexroth.com)

Bonfiglioli [www.bonfiglioliuk.co.uk](http://www.bonfiglioliuk.co.uk)

VEM [www.vem-group.com](http://www.vem-group.com)

### **Yaw Bearing**

IMO [www.imo.de](http://www.imo.de)

Liebherr [www.liebherr.com](http://www.liebherr.com)

Rollix [www.rollix.com](http://www.rollix.com)

Rothe Erde [www.rotheerde.com](http://www.rotheerde.com)

### **Nacelle Auxiliary Systems**

#### **Brakes**

Svendborg [www.svendborg-brakes.com](http://www.svendborg-brakes.com)

Stromag [www.stromag.com](http://www.stromag.com)

Siegerland [www.sibre.de](http://www.sibre.de)

#### **Cooling**

Hydac [www.hydac.co.uk](http://www.hydac.co.uk)

Windsyn [www.windsyn.com](http://www.windsyn.com)

#### **Anemometry**

Climatronics [www.climatronics.com](http://www.climatronics.com)

Gill Instruments [www.gill.co.uk](http://www.gill.co.uk)

FT Technologies [www.fttech.co.uk](http://www.fttech.co.uk)

NRG Systems [www.nrgsystems.com](http://www.nrgsystems.com)

Vector Instruments [www.windspeed.co.uk](http://www.windspeed.co.uk)

**Fire Protection**

Danfoss	<a href="http://www.danfoss-semco.com">www.danfoss-semco.com</a>
Firetrace	<a href="http://www.firetrace.co.uk">www.firetrace.co.uk</a>
Minimax	<a href="http://www.minimax.de">www.minimax.de</a>

**UPS**

AKI Power Systems	<a href="http://www.aki-usv.com">www.aki-usv.com</a>
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**Internal Service Crane**

Effer	<a href="http://www.effer.it">www.effer.it</a>
Hiab	<a href="http://www.hiab.co.uk">www.hiab.co.uk</a>
Liftra	<a href="http://www.liftra.com">www.liftra.com</a>
Palfinger Marine	<a href="http://www.palfinger.com">www.palfinger.com</a>

**Nacelle Cover**

Bach Composites	<a href="http://www.bach-ci.dk">www.bach-ci.dk</a>
Eikboom	<a href="http://www.eikboomgmbh.de">www.eikboomgmbh.de</a>

**Fasteners**

August Friedberg	<a href="http://www.august-friedberg.com/unternehmen/unternehmen_e.asp">www.august-friedberg.com/unternehmen/unternehmen_e.asp</a>
Cooper & Turner	<a href="http://www.cooperandturner.co.uk">www.cooperandturner.co.uk</a>
Fuchs & Sanders	<a href="http://www.fuchs-sanders.de/fus/opencms/html/de/index.html">www.fuchs-sanders.de/fus/opencms/html/de/index.html</a>
Gexpro Services	<a href="http://www.gexproservices.com/gexproservices/">www.gexproservices.com/gexproservices/</a>
Wind-Fix	<a href="http://www.multifixgroup.nl">www.multifixgroup.nl</a>

**Condition Monitoring Systems**

WTG Manufacturers	
Bruel & Kjaer Vibro	<a href="http://www.bkvibro.com">www.bkvibro.com</a>
Gram & Juhl	<a href="http://gramjuhl.dk">gramjuhl.dk</a>
SKF	<a href="http://www.skf.com">www.skf.com</a>
SecondWind	<a href="http://www.secondwind.com">www.secondwind.com</a>

**Rotor****Blades**

Siemens	<a href="http://www.energy.siemens.com">www.energy.siemens.com</a>
Vestas	<a href="http://www.vestas.com">www.vestas.com</a>
LM Glasfiber	<a href="http://www.lmglassfiber.com">www.lmglassfiber.com</a>
Tecsis	<a href="http://www.tecsis.com">www.tecsis.com</a>
GE	<a href="http://www.ge.com">www.ge.com</a>
Enercon	<a href="http://www.enercon.de">www.enercon.de</a>
Euros	<a href="http://www.euros.de">www.euros.de</a>
Polymarin	<a href="http://www.polymarin.com">www.polymarin.com</a>
Mitsubishi	<a href="http://www.mitsubishi.com">www.mitsubishi.com</a>
Suzlon	<a href="http://www.suzlon.com">www.suzlon.com</a>
Euros GmbH	<a href="http://www.euros.de">www.euros.de</a>
Umoe Group	<a href="http://www.umoe-blades.com">www.umoe-blades.com</a>
SGL Rotec	<a href="http://www.sglrotec.de">www.sglrotec.de</a>
SINOI Ltd	<a href="http://www.sinoi.de">www.sinoi.de</a>
Zhongfu lianzhong	<a href="http://www.lzfrp.com">www.lzfrp.com</a>
Huiteng	<a href="http://www.htblade.com">www.htblade.com</a>

**Hub Casting**

Felguera Melt	<a href="http://www.durofelguera.com">www.durofelguera.com</a>
Fonderia Vigevanese	<a href="http://www.vigevanese.it">www.vigevanese.it</a>
Metso	<a href="http://www.metso.com">www.metso.com</a>
Meuselwitz	<a href="http://www.meuselwitz-guss.de/index.php?id=365&amp;L=1">www.meuselwitz-guss.de/index.php?id=365&amp;L=1</a>
Rolls Royce	<a href="http://www.rolls-royce.com">www.rolls-royce.com</a>
Siempelkamp	<a href="http://www.siempelkamp.com/index.php">www.siempelkamp.com/index.php</a>
Vestas	<a href="http://www.vestas.com">www.vestas.com</a>
Rolls Royce Foundry	<a href="#">See above</a>
CAS	<a href="#">Requires more specific definition</a>
Eisengiesserei Torgelow	<a href="http://www.eisengiesserei-torgelow.de">www.eisengiesserei-torgelow.de</a>
Siempelkamp Giesserei	<a href="http://www.siempelkamp.de/Giesserei.716.0.html">www.siempelkamp.de/Giesserei.716.0.html</a>
Gusstec	<a href="http://www.gusstec.de">www.gusstec.de</a>
Wilhelm Guss- Engineering & Projektmanagement	<a href="http://www.w-g-p.de">www.w-g-p.de</a>
Heavycast Karistad	<a href="http://www.heavycast.se">www.heavycast.se</a>

**Blade Bearings**

IMO	<a href="http://www.imo.de">www.imo.de</a>
Liebherr	<a href="http://www.liebherr.com">www.liebherr.com</a>
Rollix	<a href="http://www.rollix.com">www.rollix.com</a>
Rothe Erde	<a href="http://www.rotheerde.com">www.rotheerde.com</a>
SKF	<a href="http://www.skf.com">www.skf.com</a>
Roballo	<a href="http://www.roballo.co.uk">www.roballo.co.uk</a>

**Pitch Systems****Hydraulic**

AVN Hydraulic	<a href="http://www.avn.dk">www.avn.dk</a>
Bosch Rexroth	<a href="http://www.boschrexroth.com">www.boschrexroth.com</a>
Fritz Schur	<a href="http://www.fst.dk">www.fst.dk</a>
MOOG	<a href="http://www.moog.com">www.moog.com</a>
Parker	<a href="http://www.parker.com">www.parker.com</a>

**Electric**

MOOG	<a href="http://www.moog.com">www.moog.com</a>
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**Spinner**

Bach Composites	<a href="http://www.bach-ci.dk">www.bach-ci.dk</a>
Eikboom	<a href="http://www.eikboomgmbh.de">www.eikboomgmbh.de</a>

**Rotor Auxillary Systems****Automatic Lubrication Systems**

Lincoln	<a href="http://www.lincolnindustrial.com">www.lincolnindustrial.com</a>
SKF	<a href="http://www.skf.com">www.skf.com</a>

**Blade Load Sensing**

Insensys	<a href="http://www.insensys.com">www.insensys.com</a>
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**Tower**

Ambau	<a href="http://www.ambau-gmbh.com">www.ambau-gmbh.com</a>
BiFab	<a href="http://www.bifab.co.uk">www.bifab.co.uk</a>
Bladt	<a href="http://www.bladt.dk">www.bladt.dk</a>
SIAG	<a href="http://www.siag.de">www.siag.de</a>
Vestas	<a href="http://www.vestas.com">www.vestas.com</a>
Skycon Towers	<a href="http://www.wtowers.com">www.wtowers.com</a>
Gamesa	<a href="http://www.gamesacorp.com">www.gamesacorp.com</a>
Suzlon	<a href="http://www.suzlon.com">www.suzlon.com</a>
Mitsubishi	<a href="http://www.mitsubishi.com">www.mitsubishi.com</a>
DMI	<a href="http://www.dmimfg.com">www.dmimfg.com</a>
Valmont	<a href="http://www.valmont.com">www.valmont.com</a>
Hendricks Industries	<a href="http://www.hendricks-industries.com">www.hendricks-industries.com</a>
DS SM	<a href="http://www.ds-sm.dk">www.ds-sm.dk</a>
Win & P	<a href="http://www.winnp.co.kr">www.winnp.co.kr</a>

**Steel Suppliers**

Corus	<a href="http://www.corusgroup.com/en">www.corusgroup.com/en</a>
Dilinger Hutte	<a href="http://www.dillinger.de/dh/index.shtml.en">www.dillinger.de/dh/index.shtml.en</a>
Ilsenburger	<a href="http://www.ilsenburger-grobblech.de">www.ilsenburger-grobblech.de</a>
Rukki	<a href="http://www.ruukki.com">www.ruukki.com</a>
Salzgitter	<a href="http://www.salzgitter-ag.de/en/">www.salzgitter-ag.de/en/</a>
Thyssen	<a href="http://www.tkmna.thyssenkrupp.com/tkmna/index.htm">www.tkmna.thyssenkrupp.com/tkmna/index.htm</a>
Hempel	<a href="http://www.hempel-metals.com">www.hempel-metals.com</a>

**Ports**

Medway - Port of Sheerness	<a href="http://www.medwayports.com/sheerness">www.medwayports.com/sheerness</a>
Medway - Isle of Grain	<a href="http://www.peelports.co.uk">www.peelports.co.uk</a>
Harwich - Harwich International	<a href="http://www.harwich.co.uk/">www.harwich.co.uk/</a>
Great Yarmouth - Outer Harbour	<a href="http://www.eastportuk.co.uk">www.eastportuk.co.uk</a>
Killingholme –Able Humber Port Facility	<a href="http://www.ableuk.com">www.ableuk.com</a>
Humber - ABP Humber	<a href="http://www.humber.com">www.humber.com</a>
Hartlepool - Hartlepool Port	<a href="http://www.pdports.co.uk">www.pdports.co.uk</a> <a href="http://www.pdoffshore.com">www.pdoffshore.com</a>
Hartlepool, Teesside - Able Seaton Port	<a href="http://www.ableuk.com">www.ableuk.com</a>
Teesside - Able Middlesborough Port	<a href="http://www.ableuk.com">www.ableuk.com</a>
Tyneside - Offshore Technology Park	<a href="http://www.shepherdoffshore.com">www.shepherdoffshore.com</a>
Blyth - Port of Blyth	<a href="http://www.portofblyth.co.uk/">www.portofblyth.co.uk/</a>
Leith Ports - Forth Ports PLC	<a href="http://www.forthports.co.uk">www.forthports.co.uk</a>
Methil - Fife Energy Park	
Tayside - Port of Dundee	<a href="http://www.forthports.co.uk">www.forthports.co.uk</a>
Tayside - Port of Montrose	<a href="http://www.montroseport.co.uk">www.montroseport.co.uk</a>
Peterhead Bay Harbour - North Base	<a href="http://www.peterheadport.co.uk">www.peterheadport.co.uk</a>
Cromarty Firth - Nigg Yard	<a href="http://www.niggyard.com">www.niggyard.com</a>
Cromarty Firth - Highland Deephaven	
Firth of Clyde - Hunterston Terminal	<a href="http://www.clydeport.co.uk">www.clydeport.co.uk</a>
Port of Belfast	<a href="http://www.belfast-harbour.co.uk">www.belfast-harbour.co.uk</a>
Belfast - Harland and Wolff	<a href="http://www.harland-wolff.com">www.harland-wolff.com</a>
Barrow-in-Furness - Port of Barrow	<a href="http://www.abports.co.uk">www.abports.co.uk</a>
Dee Estuary - Port of Mostyn	<a href="http://www.portofmostyn.co.uk">www.portofmostyn.co.uk</a>
Milford Haven - Pembroke Port	<a href="http://www.mhpa.co.uk">www.mhpa.co.uk</a>
West Glamorgan - Port of Swansea and Port Talbot	<a href="http://www.abports.co.uk">www.abports.co.uk</a>
Portland - Port of Portland	<a href="http://www.portland-port.co.uk">www.portland-port.co.uk</a>
Southampton - ABP Southampton	<a href="http://www.abports.co.uk">www.abports.co.uk</a>
Newhaven - Port of Newhaven	<a href="http://www.newhavenferryport.co.uk">www.newhavenferryport.co.uk</a>

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**APPENDIX 2****Definition of Company Size****[1] pages**

Definition of company size is as normally used by the European Commission in its programmes:

<b>Enterprise category</b>	<b>Headcount</b>	<b>Turnover</b>	<b>or</b>	<b>Balance Sheet Total</b>
Large	>250	> € 50 million		> €43 million
Medium-sized	< 250	≤ € 50 million		≤ € 43 million
Small	< 50	≤ € 10 million		≤ € 10 million
Micro	< 10	≤ € 2 million		≤ € 2 million



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