

A GUIDE TO **OFFSHORE WIND**

and Oil & Gas Capability



Foreword



Adrian Gillespie
Director, Energy & Low Carbon Technologies
Scottish Enterprise

The development of the offshore wind market offers significant and long-term opportunities for Scotland, based around some of the most abundant renewable energy resources in Europe. Indeed Scotland has been estimated to have around a quarter of Europe's offshore wind capacity.

The Scottish Government supports the development of offshore wind and has introduced some of the most challenging renewable electricity generation targets in Europe, namely 100% of Scotland's electricity consumption to be produced by renewable sources by 2020, and the equally ambitious climate change target of an 80% reduction in CO₂ emissions by 2050.

Scottish Enterprise, along with Scottish Development International, Highlands and Islands Enterprise and other partners are seeking to maximise the economic benefit of offshore wind for Scotland.

As with many emerging sectors, it is commonly agreed that there is a requirement to reduce the cost of developing offshore wind projects. The presence of the oil and gas sector in Scotland, built up over 40 years, can play a significant role in helping to reduce costs, through the application of their skills and knowhow of marine operations to shorten project development timescales, reduce operational downtime and add significant value through application of their knowledge.

Many of the elements required to develop an offshore wind project have already been developed by the oil

and gas sector such as installation, risk management, personnel transfer and operational and maintenance activity. There are already many examples of firms from the oil and gas sector that are successfully operating in offshore wind, putting their expertise to use.

The purpose of the guide is two-fold. Firstly, it provides detailed information to the oil and gas supply chain on those areas of the offshore wind project life cycle where there is the greatest opportunity for oil and gas involvement and growth opportunity. It also demonstrates to offshore wind project developers the potential for the oil and gas supply chain to reduce offshore wind project costs.

The guide suggests that the oil and gas supply chain has the potential to reduce the cost of offshore wind operation by around 20%, based on the most significant areas of cross over and through the application of their knowledge and expertise.

We at Scottish Enterprise look forward to working with industry and other organisations to ensure that the emerging opportunities in offshore wind are exploited to the maximum benefit for Scotland. We are convinced that the oil and gas sector can play a leading role in its development and we hope that this guide, along with other sources of information and support, clearly demonstrates that opportunity.

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Key Messages

Scotland aims to generate an ambitious 100 percent of domestic electricity consumption from renewable energy sources by 2020, and offshore wind is set to be a key component of this future low carbon power generation mix. Beyond 2020, construction of offshore wind projects will continue as major markets in Europe and further afield seek to increase renewable energy production.

This guide highlights the significant market opportunities available to the oil and gas supply chain in the offshore wind sector. It is part of a larger report undertaken to examine the complete lifecycle of an offshore wind project and looks at a wide range of opportunities where the oil and gas supply chain can add greatest value, with calculations based around a generic 500MW offshore wind project.

Examples of how cross sector transfer of products and services already taking place are highlighted by a number of case studies throughout the document. These businesses have already invested in the offshore wind sector and are well placed to take advantage of the opportunity. However the future scale of deployment and move to deeper waters also means there are additional opportunities for new entrants.

In this guide a number of specific areas within the offshore wind project lifecycle have been identified as showing particularly high potential for transfer of skills from oil and gas (Table 1). Improvements in these high and medium priority areas could reduce the initial capital expenditure and operational expenditure for offshore wind, by almost 20% as well as increasing wind farm utilisation levels.

Table 1 | High Potential Opportunities

Highlights from Areas of Opportunity

Development services (P1.1) – Expertise and experience in managing offshore construction from concept to production. Skills in turnkey contractors and specialist niche consultancies

Support structures (B1.2) -This represents one of the highest value opportunities. Existing capability to manufacture ancillary components and deep sea structures.

Offshore substations (B1.5) -Oil and gas expertise in detailed design, fabrication and project management. Many of the challenges associated with designing and fabricating offshore production facilities are shared with offshore substations.

Support structure installation (I1.1) Large offshore construction contractors have bases in Scotland and have major construction assets at their disposal. Specialist expertise in areas such as structural grouting and scour protection around the base of support structures is highly applicable.

Array cable-lay (I1.3) & Export Cable Lay (I1.4) The oil and gas sector has leading capabilities to lay and bury both cables and umbilicals - cable-lay is perceived by offshore wind developers, insurers and financiers as one of the greatest areas of risk in the installation phase.

Replacement equipment (O1.1) This is an excellent area for skills transfer. The oil and gas sector already operates a large service and logistics operation covering the North Sea region.

Personnel transfer (O1.2) A wide range of solutions for safe access and egress to both fixed and floating rigs have been developed to service the North Sea sector.

Skilled technicians (O1.3) Inspection and repair activity is high within the North Sea sector with a high number of skilled and experienced technicians. A number of training providers offer accredited training; subjects that indicate cross-over opportunities include offshore survival and specialist equipment training.

O&M ports (O1.5) Ports around Scotland have been playing an important role in the development and upkeep of the North Sea oil and gas assets. A number of locations, with deep water facilities, extensive quay side and adjoining lay down areas have been identified by National Renewables Investment Plan (NRIP) as being potential construction bases while others will engage in O&M activities.

Vision

“Scotland is blessed with abundant natural energy sources, particularly in our seas, where Scotland is estimated to have a quarter of Europe’s potential wind and tidal energy capacity and a tenth of its wave resource.”

Rt Hon Alex Salmond, First Minister of Scotland



Introduction

Scotland is already on track to exceed its interim target of 31% of electricity generation from renewable sources by the end of 2011^[1]. Offshore wind is a key component of this low carbon power generation mix, with planned investment levels of £100 billion in the UK over the next ten years.^[2] This offers significant opportunities for Scottish companies with existing offshore energy expertise.

In the next four years alone, almost 11GW of new offshore wind capacity is forecast to be added around the world, compared to 2.5GW installed over the previous five years. In global terms, the UK, Germany and China are the three largest offshore wind markets and together will install almost 83% of this total global capacity.

With 4.4GW of new capacity coming online, the UK is forecast to be the largest market over the 2011 to 2015 period. Growth will be high in 2015 as the UK completes the first phase of projects linked to the Scottish Territorial Waters (STW) and Crown Estate Round 3 licence awards. Five STW sites are currently in the planning stage with a potential capacity of almost 5GW. Nine Round 3 zones have been awarded to various project consortia representing over 30GW of new installed capacity and are so large that the majority have been split into multiple phases and site survey contracts are already being awarded in many cases.

Not only is the offshore wind sector set to grow rapidly, but it also offers significant synergies with Scotland's long established offshore oil and gas sector. Scottish Enterprise and other public sector agencies are working to ensure that Scotland captures maximum economic benefit from this growth and that the existing business and industry supply chain capitalises on these emerging opportunities.

Scotland has an established base of large national and international energy companies supported by a well developed supply chain offering a wide range of operations, services and technologies. These companies bring additional supply chain capacity to the offshore wind sector and their expertise – developed over the past forty years in exploiting

North Sea oil and gas reserves – will be invaluable in offshore wind applications, helping to reduce and manage risk in many areas of the project lifecycle.

Recognising the enormous potential for the transfer of experience, in late 2010, a Ministerial Summit was held in Aberdeen to bring together senior leaders from both the offshore wind and oil and gas sectors to discuss issues around collaboration to maximise the opportunities that will arise from the development of offshore wind. A number of action points were agreed including the need to provide detailed information that would assist both sectors to understand the necessary requirements and capabilities.

The purpose of this guide is to provide information to both oil and gas supply chain companies and offshore wind developers. It examines the lifecycle of an offshore wind project from planning and development through to the operational phase and highlights areas of cross-sector transfer potential and indicates future business opportunities, their possible value and barriers to market entry. The guide also demonstrates examples of successful cross-sector transfer of products and services which have already occurred through a variety of case studies.

In order to develop this guide, background research on the market and industry participants has been carried out, drawing upon publicly available information and industry expertise. The analysis of costs in this guide is based upon an extensive database of offshore wind projects.

Identification and analysis of opportunities has been achieved through a combination of quantitative and qualitative analysis. In particular, the cost of energy metric has been used in order to compare opportunities. The assessment of cross sector potential is based on experience of working in and with the oil and gas sector.

¹<http://www.scotland.gov.uk/News/Releases/2010/09/23134359>

²Offshore Wind Key Facts, Scottish Enterprise, 2010

Background

Challenges for cross-sector transfer

The upstream oil and gas sector remains one of the key sectors of the UK economy, generating around £20 billion of turnover every year, £12.8 billion of Gross Value Added (GVA) and supporting direct, indirect and induced employment of more than 190,000 people in Scotland³.

Today, after forty years of development, the United Kingdom Continental Shelf (UKCS) still remains an important global oil and gas province. With high oil prices, operators are currently incentivised to maximise output and pursue new developments. Recent studies estimate that around a third of the oil and gas resource in the UKCS still remains to be extracted⁴ but exploiting these significant reserves is now dependent on developing a large number of small fields using innovative technologies.

A major market is also now developing around decommissioning with an estimated 1.6 million tonnes worth of offshore facilities due to be removed between 2010 and 2025⁵.

Whilst the emerging offshore wind sector presents a great diversification opportunity, competition for resource and the differing economics is a challenge. In particular, the heavy lift vessels and engineering services required for oil and gas decommissioning is also particularly important to the development of the offshore wind industry. This will place a particular strain on capacity for these services.

The oil and gas supply chain will also need to be prepared to adapt to new working practices. One of the major challenges is a move from one-off field developments towards volume production. Project developers in offshore wind also tend to operate different business models and working methods in comparison to oil and gas. Engineering, procurement and construction (EPC) contracts are not necessarily the norm in offshore wind. Moreover different project developers will have unique models, including reliance on in-house resource or issuing multiple contracts and managing the interface risk.

³2010 Economic Report, Oil and Gas UK, 2010

⁴The Long Term Prospects for Activity in the UK Continental Shelf, University of Aberdeen, 2010

⁵The UKCS Offshore Decommissioning Report, 2010-2040, Douglas-Westwood, 2010

Incentives for Development

Within the UK power generation sector the key piece of legislation is the Renewables Obligation (RO), which is designed to incentivise the generation of electricity from renewable sources. Under the RO, all licensed electricity suppliers are obliged to produce an increasing percentage of electricity from renewable sources.

The Department of Energy and Climate Change (DECC) reports that, since its introduction in 2002, the RO has succeeded in more than tripling the level of renewable electricity in the UK from 1.8% to 6.64% and is currently worth around £1.42 billion a year in support to the renewable electricity industry⁶. At the present time, the UK Coalition Government is moving forwards with the Electricity Market Reform (EMR) process. As part of the EMR, feed-in tariffs (FITs) have been recommended as the most efficient means to stimulate development of renewable energy. FITs are likely to be phased in around 2017, with the RO scheme maintained in the interim.

However, the legislation also states that Ministers may review the bands on a four yearly basis, with the first review due to take effect from April 2013. Both the UK and Scottish Government will undertake a consultation during September 2011 to give generators and investors as much advance notice as possible regarding potential changes.

Development to Date and Prospects

The global wind industry represents a massive opportunity for companies that are willing to enter at what still remains an early stage of development. Currently there is almost 3GW of offshore wind capacity online worldwide with in excess of 2GW under construction. Almost 11GW of new global capacity is forecast to be added between 2011 and 2015 and the total planned capacity worldwide exceeds 100GW.

The UK, Germany and China are the three largest markets, which together will install almost 9.3GW or 83% of total global capacity over the next four years. Growth jumps in 2015 as the UK completes Round 2.5 and the first of the Round 3 sites complete their initial phases.

The UK is the leading country in terms of installed offshore wind capacity with over 1.1GW online and the same amount under construction, with the North Sea a centre of activity.

Until recently, there had been relatively few installations outside Europe. This changed in 2010 with China completing the Shanghai East Sea Bridge project - a 102MW wind farm. Several prototype turbines have also been installed and ambitious targets suggest rapid growth in the future.

In North America, a growing number of projects are now in the planning phase with the United States taking a significant step forward with the approval of the Cape Wind project, which had been struggling with permitting for eight years. Now with new legislation taking shape, the US is hoping to stimulate growth.

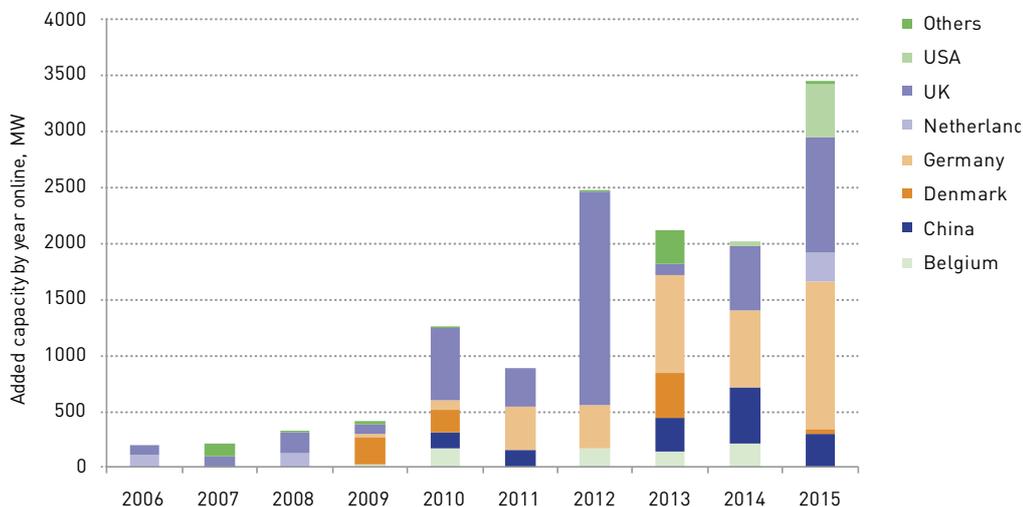
⁶http://www.decc.gov.uk/en/content/cms/meeting_energy/renewable_ener/renew_obs/renew_obs.aspx

Global Overview

UK

- The UK is the largest market for the 2011-2015 period with 4.4GW of new capacity coming online.
- Installation rates around 2013 and 2014 are slightly lower ahead of the first Round 3 and Scottish Territorial Waters (STW) projects.
- The UK is the only country in the world to have installed offshore wind farms each year since the first completed projects in 2003.
- The UK's structured licensing rounds and incentive scheme have helped build its position as the premier offshore wind market.
- The programme of extensions to existing Round 1 and 2 projects has been designed in part to avoid a dip in activity up to 2015.
- In 2015, activity in the UK is likely to accelerate with Round 3 and STW projects moving into the construction phase. These projects are on a larger scale to those built to date and represent a significant commercial opportunity.
- Nine Round 3 zones have been awarded to various project consortia, representing over 30GW of new installed capacity and a potential capital expenditure of around £100 billion. These projects are so large that the majority have been split into multiple phases.
- Whilst the majority of Round 3 projects will not commence construction in the five year forecast period, site survey contracts are already being awarded in many cases.
- In addition to the Round 3 sites exclusive rights were issued for STW in 2009, combined these add up to 10GW.
- Strong growth is expected until 2020 in the longer term forecast (see Figure 2). In this scenario, a level of delay has been applied to project dates provided by the developers. This factor has been implemented to account for potential delays to projects through consents, contracting and potentially, construction. The precedent for this can be seen in the UK's Round 1 and 2 projects
- A period of rapid industry activity is expected between 2016 and 2018 when the first Round 3 phases and a large proportion of STW (Scottish Territorial Waters) projects come online.
- The introduction of a Round 4 will be required to maintain activity levels (particularly within the growing UK supply chain), once Round 3 projects are completed.

Figure 1 | Installed Offshore Wind Capacity by Country 2006–15



Source: Douglas-Westwood

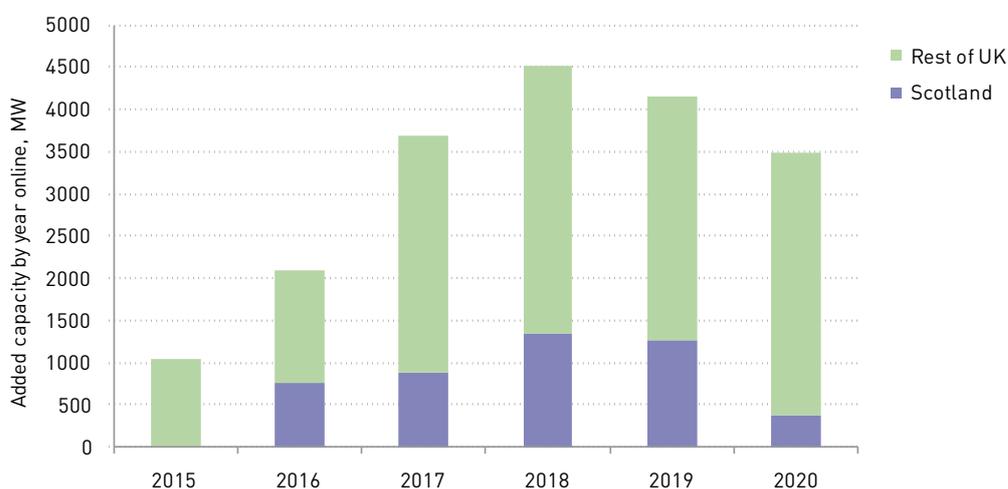
Germany

- With a long standing target of 25GW wind capacity by 2030, Germany is now starting to begin construction on its first commercial projects.
- An updated market mechanism and mandated grid connections are now providing confidence on project delivery out to 2015, with most projects at an advanced stage of contracting.
- The focal point for the German offshore wind industry is Bremerhaven. In 2002 the state government spent £20m reshaping Bremerhaven into a manufacturing and transport hub for the wind industry. It is now home to two offshore wind turbine manufacturers, blade and support structure fabricators plus a growing list of other supply chain companies.
- Due to a reliance on independent project developers, further involvement of utility companies and banks is required to ensure less advanced projects can be taken from approval through to construction.

Rest of Europe

- The recent licensing of Dutch projects has given a boost to the market after a lack of commitment and uncertainty in the past few years. Contracting can now get underway and some activity will take place in the period to 2015, but many projects won't be completed until after this.
- In Denmark, projects are now being built under competitive tender where developers bid for the level of support required as part of their application. This encourages cost reduction but growth has slowed.
- The Belgian government has targeted offshore wind capacity of up to 2.3GW by 2020 and 3.8GW by 2030 and has also identified suitable locations for exploitation but several project applications have recently been turned down.
- Sweden is curtailed by lack of commitment to the sector. Projects here are effectively stalled until policy and market mechanisms are introduced.
- France has set a target of 6GW installed capacity by 2020. In June 2010 the Environmental and Energy Ministry announced plans for the first of three new 3GW offshore wind tender rounds which should allow France to meet its target.

Figure 2 | New UK Offshore Wind Capacity 2015-2020



Source: Douglas-Westwood

The Scottish Opportunity

The development of a sustainable domestic supply chain is highly dependent on having a strong home market, a trend seen in Denmark, Germany and Spain. Local demand is especially important in the early years as local businesses grow and start to export products and services. There is also potential for building centres of excellence around local demand centres, recognised in the National Renewables Infrastructure Plan (NRIP).

There are currently two operational offshore wind farms in Scottish Waters at the Beatrice demonstrator and Robin Rigg. In addition to these operational sites, exclusivity rights were issued for Scottish Territorial Waters (STW) in 2009. These STW sites are located within a 12 nautical mile boundary. Two Round 3 sites are also located in Scotland. Combined, these sites could add

close to 10GW of new capacity, with requirements for more than 2000 offshore wind turbines.

Products, skills and services developed for Scottish offshore wind sites will be well placed for export opportunities over time. These sites are considered challenging in terms of water depth, environmental conditions and general seabed conditions and therefore tend to require alternative support structures and solutions. Deep-water sites with challenging environmental conditions are likely to become the norm in other geographic markets as shallow sites are filled. There are parallels here with the way the Scottish offshore oil and gas supply chain has excelled in exporting their services to global markets.

The following projects are included in the most recent Scottish Government's sectoral marine plan:

Table 2 Scottish Offshore Wind Projects

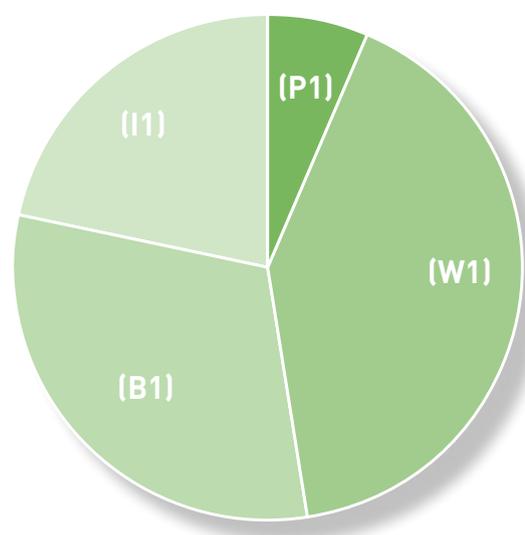
Project	Licensing Round	Developers	Construction Year*	Water depths (estimated)	Potential Capacity(MW)
Islay	STW	SSE Renewables	2019	25–51m	680
Argyll Array	STW	Scottish Power Renewables	2019	0–45m	up to 1,800
Beatrice	STW	SSE Renewables / Repsol Nuevas Energias SA	2014–15	35–50m	c.1,000
Inch Cape	STW	Repsol Nuevas Energias SA	2015	36–54m	up to 1,000
Neart na Gaoithe	STW	Mainstream Renewable Power	2014	44–56m	up to 450
Subtotal Up to 4,930					
Moray Firth Eastern Development Area, Moray Firth	Round 3	Moray Offshore Renewables Limited: EDP Renovaveis / Repsol Nuevas Energias SA	2015	35–60m	up to 1,140
Firth of Forth Phase 1	Round 3	SeaGreen Wind Energy Limited (SSE Renewables/Fluor)	2015	31–71m	1,075
Firth of Forth Phase 2 and Phase 3	Round 3	SeaGreen Wind Energy Limited (SSE Renewables/Fluor)	Phase 2: 2016, Phase 3: 2018	31–64m	up to 2,600
Total					Up to 9,745 MW

Source: Douglas-Westwood
*Quoted

In the Scottish Government's Blue Sea, Green Energy – A Sectoral Marine Plan for Offshore Wind Energy in Scottish Territorial Waters⁷, potential for an additional 25 sites for development have been proposed beyond 2020. Assuming that these sites are on the same scale as the proposed STW sites, an estimated 15GW or more new capacity could be added.

Looking further into the future, the Offshore Valuation Study⁸ published in May 2010 assessed the UK's offshore renewable energy resource potential to 2050. It was estimated as part of this study that Scotland has over 200GW of offshore wind, wave and tidal resources or almost 40% of the UK's total resource. Harnessing only a third of this resource would be equivalent to 68GW of installed capacity or enough to supply Scotland's current electricity requirements seven times over.

Figure 3: CAPEX Breakdown



Project phase

(I1) Installation	21.4%
(P1) Planning & Development	6.5%
(W1) Wind Turbine	41.0%
(B1) Balance of Plant	31.1%

Source: Douglas-Westwood

Offshore Wind Costs

Capital Costs

Rising capital expenditure (CAPEX) has been a particular cause of concern in the offshore wind sector. Inexperience, lack of competition and major technical issues all contributed to significant cost escalation in the five years prior to 2008. At the same time, returns for many projects were insufficiently attractive to offset risk levels. This cost escalation has encouraged European governments to strengthen their market and incentive mechanisms.

In the UK, the RO system has been adjusted several times and in Germany a highly attractive feed-in tariff has been introduced. Analysis of more recent projects indicates that capital costs have now started to level off and currently lie between £2.8 and £3.3 million per megawatt (MW) installed⁹. With projects now tendering for construction in 2014 and 2015 and many contracts being announced, it is clear that these relatively high levels of costs will be maintained for some time to come.

The move into deeper waters will also place pressure on cost. The Beatrice Wind Farm Demonstrator represents the first deepwater project in Scottish waters. Located in 45m of water and using two 5MW turbines, it was the first project to utilise jacket style support structures, coming online in 2007 and reportedly costing ca. £41m to construct¹⁰.

Despite these pressures, cost reduction is necessary in the longer term to bring the cost of offshore wind more into line with other types of electricity generation. Reductions in costs will be expected through increased competition, new manufacturing technologies and installation methods. The experience of the oil and gas supply chain can be a significant driver in the move towards cost reductions.

⁷<http://www.scotland.gov.uk/Publications/2010/05/14155221/0>

⁸<http://www.offshorevaluation.org/>

⁹Global Offshore Wind Project Database, Douglas-Westwood, 2011

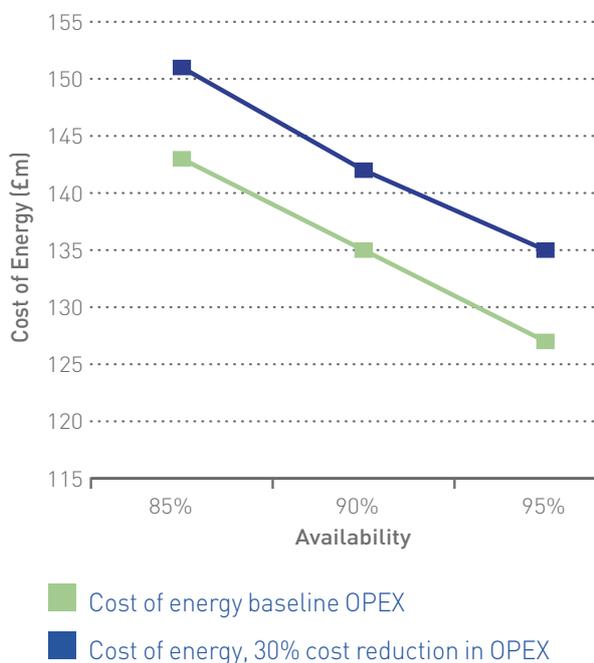
¹⁰<http://www.beatricewind.co.uk/home/default.asp>

Project Lifetime Costs

The Cost of Energy is a key metric for offshore wind project developers and operators, which takes into account the following factors:

- CAPEX: capital investment required from planning through to installation and commissioning
- Availability: the percentage of the year that the wind farm is available to generate electricity
- Cost of Capital: dependant on how the company chooses to finance its assets, i.e. debt or equity or combinations thereof
- Operational Expenditure (OPEX): the main cost component is operations and maintenance (O&M)

Figure 4 | Cost of Energy Reduction



Source: Douglas-Westwood

Using current figures for CAPEX, availability and OPEX, the economic model developed for this guide gives a baseline cost of energy for an offshore wind farm of £145.7 per megawatt hour (MWh). In comparison, the cost of energy for onshore wind was estimated to be £91 per MWh for a utility-scale development in a recent report¹¹. This demonstrates the clear need for cost reduction in the offshore wind sector for it to be fully competitive in the longer term.

Whilst CAPEX will continue to be an area of focus in the offshore wind industry, increasing availability and reducing recurring O&M costs can also lead to significant reductions in the baseline cost of energy as shown in the figure below.

The cost of O&M offshore varies considerably between projects but as a guide it is approximately 2-3% of the capital costs per year. OPEX spend for the Beatrice Wind Farm Demonstrator Project was estimated to be £0.6m per year¹². The high degree of uncertainty around O&M costs are due to the fact that very few, very large offshore wind farms of the type expected in the future have been operating for any significant period of time.

The costs of renewing major components such as gearboxes or generators are high onshore but are even higher in the offshore environment. Studies carried out by the Energy Centre of the Netherlands (ECN) estimate that major lifting operations in an offshore environment cost between five and 10 times more than the equivalent onshore operation.

In addition to equipment replacement and O&M costs there is the compound effect of lost energy production. Maximising wind turbine availability is absolutely fundamental to the economics of offshore wind. In the onshore environment, turbine availability can be 97% or even higher compared to 85% to 95% offshore.

Consequently those supply chain companies that can demonstrate that their products and services reduce the cost of energy will have a particularly attractive value proposition.

¹¹Review of the generation costs and deployment potential of renewable electricity technologies in the UK, DECC, June 2011

¹²Scottish Offshore Wind: Creating an Industry, IPA and Scottish Renewables, 2010

¹³Global Offshore Wind Project Database, Douglas-Westwood, 2011

Generic Offshore Wind Project

In order to quantify the benefits of transferring skills from the oil and gas sector, a generic offshore wind project, based on a 500MW project, has been used as a baseline to analyse and quantify the possible savings that the oil and gas supply chain could bring to offshore wind. In order to calculate the baseline cost of energy, a number of variables including CAPEX and OPEX have been used, which are representative of projects to be constructed over the next 10 years^[13].

For the purposes of this guide the generic offshore wind project lifecycle has been mapped along three major phases:

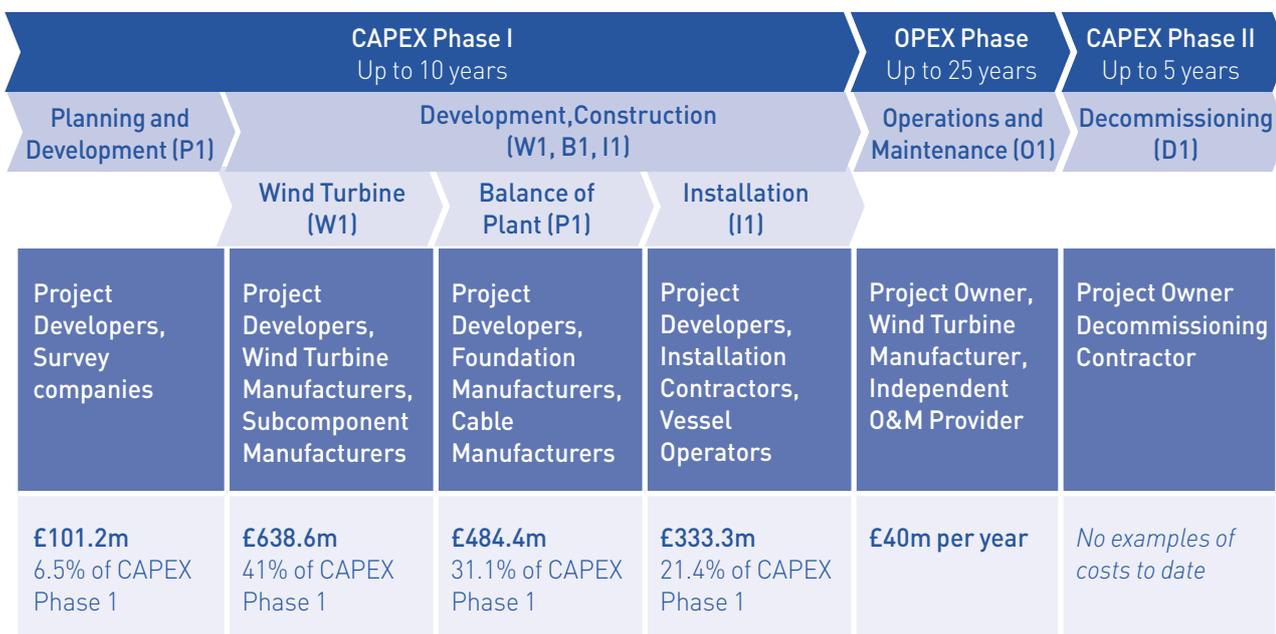
- CAPEX Phase 1: initial capital investment encompassing planning and development, wind turbine procurement, balance of plant procurement and installation.
- OPEX Phase: operations and maintenance throughout the design life of the offshore wind farm. There are also recurring costs in relation to grid maintenance and lease.
- CAPEX Phase 2: decommissioning activities.

In the following figure, the major phases are illustrated. Key components for each phase from project developers to vessel operators have been highlighted. Baseline costs for each phase of a generic 500 MW offshore wind project are also given.

The total CAPEX Phase 1 costs for a generic 500MW offshore wind project would amount to around £1.58 billion with the highest levels of expenditure experienced during the construction sub-phase. In advance of this period of high capital intensity, there is steady spending on planning and development tasks including chartering survey vessels and carrying out conceptual design. In the four to five year long construction sub-phase, wind turbines and balance of plant are being manufactured prior to installation. Expenditure on installation vessels is also high in the final two to three years of the construction sub-phase.

After CAPEX Phase 1 has been completed, a steady OPEX is experienced over the design life of the wind farm, which is typically 20 years or more. OPEX consists of items including replacement equipment and skilled technicians (see Operational section). Equipment degradation and escalation in OPEX over time have also been included in the economic model developed for this guide.

Figure 5 | Generic Offshore Wind Project



Source: Douglas-Westwood

Capability Mapping

This section maps the offshore wind project life cycle to existing oil and gas supply chain capabilities.

A multitude of opportunities exist for oil and gas supply chain companies to either directly transfer or adapt their expertise, products and services for the offshore wind market.

The elements of an offshore wind project have been broken down into more detailed stages and have been assigned an identifier for ease of reference (e.g. P1.1 for development services) and a three tier colour coded ranking system (red, amber, green) to indicate the scale of opportunity for the oil and gas supply chain (see ranking system below).

The criteria, which have been used to assess the colour coding for each segment of the project lifecycle, are as follows:

- **Market value:** based upon the proportion of the project expenditure that the opportunity area represents, whether it is capital or operational. The stated figures are absolute values and it is recognised that relatively small markets may still represent a large opportunity for some companies. Therefore it is recommended that each market player apply their own judgement in assessing the relative market value of areas that fit with their competencies.
- **Oil and gas sector expertise:** an assessment of the degree of overlap between the requirement in the Offshore Wind opportunity area and capabilities within the oil and gas sector.
- **Potential to reduce cost of energy:** in each individual case, the potential benefits in terms of CAPEX and OPEX reduction through utilisation of oil and gas experience and/or increased Offshore Wind farm availability have been quantified, allowing an assessment to be made for the potential for cost of energy reduction.
- **Barriers to entry:** a combined assessment of the level of competition, investment requirements and time to market in the specific area.

Opportunity ranking system

A three-tier, colour-coded ranking system (red, amber, green) indicates the scale of opportunity for the oil and gas supply chain.

Red	Relatively low potential
Amber	Medium potential
Green	High potential

Table 3 | Opportunity Screening Criteria

Market value	→ Accounts for either less than 1% (£16m) of total CAPEX or less than 2% (£16m) of total OPEX over the 20 year life ¹ of the generic 500MW offshore wind project.	→ Accounts for between 1% (£16m) and 5% (£79m) of total CAPEX or between 2% (£16m) and 10% (£79m) of total OPEX over the 20 year life of the generic 500MW offshore wind project.	→ Accounts for more than 5% (£79m) of total CAPEX or more than 10% (£79m) of total OPEX over the 20 year life of the generic 500MW offshore wind project.
Oil and gas sector expertise	→ Relatively low potential for oil and gas experience transfer to offshore wind. New entrants to the offshore wind sector from oil and gas would provide limited additional supply chain capacity.	→ Medium potential for oil and gas experience transfer to offshore wind. New entrants to the offshore wind sector from oil and gas would provide some additional supply chain capacity.	→ High potential for oil and gas experience transfer to offshore wind. New entrants to the offshore wind sector from oil and gas would provide essential additional supply chain capacity.
Potential to reduce cost of energy	→ Transfer of products and services from oil and gas to offshore wind shows potential to reduce CAPEX and/or OPEX and/or increase availability, leading to a cost of energy reduction of up to 0.5% (£0.73/MWh).	→ Transfer of products and services from oil and gas to offshore wind shows potential to reduce CAPEX and/or OPEX and/or increase availability, leading to a cost of energy reduction of between 0.5% (£0.73/MWh) and 1% (£1.45/MWh).	→ Transfer of products and services from oil and gas to offshore wind shows potential to reduce CAPEX and/or OPEX and/or increase availability, leading to a cost of energy reduction of more than 1% (£1.45/MWh).
Barriers to entry	→ There are five or more major players active in this area and investment requirements are extremely high. Long lead times would make it difficult to bring products and services to market before 2015.	→ There are five or more major players active in this area and/or investment requirements are relatively high. Shorter lead times would make it possible to bring products and services to market before 2015.	→ There are low levels of competition in this area and/or investment requirements are relatively low. Short lead times would make it highly possible to bring products and services to market before 2015.
Result: potential to add value	→ There is limited potential for transfer of products and services from the oil and gas sector in this area.	→ There is good potential for transfer of products and services from the oil and gas sector in this area.	→ There is excellent potential for transfer of products and services from the oil and gas sector in this area.

Source: Douglas-Westwood

The table below presents the entire offshore wind project lifecycle broken into components with each area being given a colour ranking highlighting its areas of crossover potential with the oil and gas supply chain. Costings for a generic 500MW project have also been indicated on the table to show the size of the market.

Table 5 on page 18 analyses the most relevant areas for cross over from the perspective of the oil and gas supply chain with a commonly used classification structure. For example, firms operating in the foundations and piling sub-sector of oil and gas activity under the field development and construction will be particularly interested in Support Structure Installation (I1.1) and Offshore Substructure Installation (I1.15) segments of the Offshore Wind project lifecycle.

Table 4 | Offshore Oil and Gas Mapping

CAPEX Phase I Up to 10 years		
Planning and Development (P1)	Development, Construction (W1, B1, I1)	
	Wind Turbine (W1)	Balance of Plant (P1)
Project Developers, Survey Companies	Project Developers, Wind Turbine Manufacturers, Subcomponent Manufacturers	Project Developers, Foundation Manufacturers, Cable Manufacturers
Development services (P1.1)	Nacelle bedplate and yaw systems (W1.1)	Transition piece (B1.1)
Environmental surveys (P1.2)	Drive-train (W1.2)	Support structures (B1.2)
Met station (P1.3)	Rotor system (W1.3)	Array cables (B1.3)
Geophysical surveys (P1.4)	Power conversion (W1.4)	Export cable (B1.4)
Geotechnical surveys (P1.5)	Tower (W1.5)	Offshore substations (B1.5)
FEED (P1.6)	Additional components (W1.6)	Onshore substations (B1.6)
6.5% of CAPEX Phase 1 or £101.2m for generic 500 MW project	41% of CAPEX Phase 1 or £638.6m for generic 500 MW project	31.1% of CAPEX Phase 1 or £484.4m for generic 500 MW project

Source: Douglas-Westwood

Installation (I1)	OPEX Phase Up to 25 years Operations and Maintenance (O1)	CAPEX Phase II Up to 5 years Decommissioning (D1)
Project Developers, Installation Contractors, Vessel Operators	Project Owner, Wind Turbine Manufacturer, Independent O&M Provider	Project Owner, Decommissioning Contractor
Support structure installation (I1.1)	Replacement equipment (O1.1)	Design / engineering analysis (D1.1)
Turbine Installation (I1.2)	Personnel transfer (O1.2)	Marine lifting / crane vessels (D1.2)
Array cable-lay (I1.3)	Skilled technicians (O1.3)	Support vessels (D1.3)
Export cable-lay (I1.4)	Installation / repair vessels (O1.4)	Ports (D1.4)
Offshore substation installation (I1.5)	O&M ports (O1.5)	Diving and underwater services (D1.5)
Construction ports (I1.6)	Recurring costs (lease, grid, etc.) (O1.6)	Geological surveys (D1.6)
Onshore substation installation (I1.7)		Environmental assessment monitoring (D1.7)
21.4% of CAPEX Phase 1 or £333.3m for generic 500 MW project	£80,000 per MW per year or £40m per year	No examples of costs to date

Table 5 | Offshore Oil and Gas Mapping

Reservoirs		Wells		Field Development and Construction		Operation		Decommissioning	
Oil Company Survey Company		Oil Company Project Manager Drilling Contractor Oilfield Services Contractor		Oil Company Engineering Contractor Fabrication Contractor Installation Contractor Pipe-lay Contractors Heavy Lift Contractors Subsea Contractor		Oil Company Duty Holder Platform Drilling Contractor IMR Contractor		Operators Decommissioning contractors (topsides) Decommissioning contractors (subsea) Heavy-lift Contractor	
O&G sub-sector	Relevant areas	O&G sub-sector	Relevant areas	O&G sub-sector	Relevant areas	O&G sub-sector	Relevant areas	O&G sub-sector	Relevant areas
Geological survey	P1.5, D1.6	Drilling Equipment		FEED	P1.6, D1.1	Reservoir management		Design/ engineering analysis	D1.1
Data recording	P1.2, P1.4, P1.5	Drilling Services		Substructure Fabrication	P1.3, W1.5, B1.1, B1.2	Well Services		Well Abandonment	
Survey Vessels	P1.4, P1.5	Completions	I1.1	Foundations and Piling	I1.1, I1.5	Inspection Services (Topsides)	O1.3	Marine lifting/ crane vessels	D1.2, I1.5
Data acquisition	P1.4, P1.5	Well Intervention		Topsides Equipment	B1.5	Maintenance and Repair Services (Topsides)	O1.3	Support vessels	I1.5, O1.4, O1.3
Support Services	P1.1	Ports	I1.6, O1.5, D1.4	Accommodation Modules	B1.5	Inspection Services (Subsea)	I1.3, I1.4	Ports	I1.6, O1.5, D1.4
Environmental assessment	P1.1, P1.2	Offshore Logistics (including vessels)	I1. O1.2	Subsea equipment	B1.3, B1.4	Maintenance and Repair Services (Subsea)	O1.3, O1.4	Pipeline abandonment	
				Subsea Installation	I1.1, I1.3, I1.4	Ports	I1.6, O1.5, D1.4	Diving and underwater services	I1.1, I1.3, I1.4, I1.5, D1.5
				Certification	W1, B1	Offshore Logistics (including vessels)	I1. O1.2	Onshore Disposal	I1.6, O1.5
				Ports	I1.6, O1.5, D1.4			Post-abandonment Surveys	P1.2
				Offshore Logistics (including vessels)	I1. O1.2				

Source: Douglas-Westwood

P1 Green Light Opportunities

The following section summarises the offshore wind project lifecycle⁽¹⁴⁾ phases relevant to the oil and gas sector supply chain. Where a 'green light' opportunity has been identified in the project lifecycle map in table 4 it is analysed in more detail. Each 'green light' opportunity is given a 'scorecard' assessment of its market value, ability to transfer oil and gas expertise, potential to reduce the cost of energy and potential barriers to market entry.

Please note that all offshore wind opportunities, including those classified as 'amber and red' are discussed in full in the longer, supplementary version of this guide.

Planning & Development (P1)

Summary

- The planning and development phase accounts for around 6.5% of CAPEX.
- It describes the process of moving from inception to financial close.
- At the completion of this phase, a project may be sold on to another company.
- Larger surveying companies, often from the oil and gas sector are capable of offering a full service covering environmental, geophysical, geotechnical surveying and even offshore installation.

Table 6: CAPEX Breakdown – Planning and Development

Area	Proportion of total CAPEX	CAPEX for a generic 500MW project	Potential
Development services (P1.1)	3.5%	£54.5m	Green
Environmental surveys (P1.2)	0.6%	£9.3m	Orange
Met station (P1.3)	0.4%	£6.2m	Orange
Geophysical Surveys (P1.4)	0.4%	£6.2m	Orange
Geotechnical Surveys (P1.5)	1.4%	£21.8m	Orange
FEED (P1.6)	0.2%	£3.1m	Orange
TOTAL	6.5%	£101.2m	

¹⁴ Excludes opportunities considered green under decommissioning (D1) due to data not being available at this time

Source: Douglas-Westwood

For the purposes of this report, planning and development refers to equipment and services, which are required prior to the point of 'financial close' or placing orders to proceed with wind farm construction. With more than 19GW of new capacity expected in UK waters from 2015 to 2020 (see Global Overview section), the pipeline of new developments is significant.

This phase involves the project developer identifying a suitable site which meets all the criteria required to generate electricity. This includes design and consenting activities such as geological surveys and environmental impact analysis which must be completed prior to any installation work being performed. Connection to the grid can be applied for before the

planning application is submitted and contracts can be arranged before a final investment decision is made.

Planning and development depends on a wide range of long-term surveys, which are often highly specialist in nature. This data feeds into the consenting process and also into technical choices such as support structure concept.

The larger surveying companies, often from the oil and gas sector are capable of offering a full service covering environmental, geophysical, geotechnical surveying and even offshore installation. The cost breakdown for the planning and development phase is shown below. Please note that all opportunities are discussed in full in the long-form version of this guide.

Case Study | PETROFAC



Petrofac is a major player in both the oil and gas and renewables industry, providing facilities solutions around the globe including the design and build of energy infrastructure; operation, maintenance and management of facilities; training of personnel, and where they can leverage their service capability, they develop and co-invest in upstream and energy infrastructure projects.

The huge potential of the offshore wind sector and the close synergy between market opportunities and company capability has been the catalyst for Petrofac's growth in renewables. Their early success in the offshore wind sector is largely based on their ability to consider the market differences and transform their operations to suit. This has involved multiple specialist acquisitions, investment in capability and an associated shift in culture.

Their already extensive portfolio of offshore wind experience includes:

- Offshore construction and commissioning supervision on behalf of Tennet for the world's first offshore HVDC substation – BorWin Alpha (400MW), Germany.

- Design verification, construction management and installation/commissioning supervision on behalf of Tennet for the DolWin 1 (800MW) offshore transmission hub, Germany.
- Design verification and concept design of offshore transmission grid connections for Moray Firth (Round 3); InchCape (STW) and numerous Round 1, Round 2 and Round 2 extension developments. Scope includes, defining inputs to Rochdale Envelopes, technology selection (AC versus HVDC) and front-end engineering design, cost estimation and risk management for all offshore electrical infrastructure.
- Driving industry cost reduction and strategic thinking through key technological, commercial and regulatory assessments of integrated offshore transmission infrastructure for Ofgem, DECC, Carbon Trust OWA program and ISLES EU funded projects.
- Renewable UK accredited training provider and developing training curriculum and standards for key offshore wind industry associations.

www.petrofac.com

Development Services (P1.1)

Requirements

Each offshore wind project has unique requirements leading to the need for specialist advice at almost every stage of the development process. Securing this specialist advice represents a significant expense for any project developer. In general, the following support services would be required:

- Management of the project development process: the majority of UK offshore wind projects have been developed by utilities but independent project developers can also manage the process.
- Legal services: advice on the planning process, relevant legislation and procurement contracts. Some full-service law firms may be able to cover all areas but it is more likely that work with specialists in each field will be utilised.
- Financial diligence: development of commercial contracts, analysis of project economics and advice on fund raising and investment. When analysing the project economics, finance experts will work closely with wind resource specialists.
- Stakeholder engagement: consultations are required throughout the planning and development process with particular attention to local communities that may be affected.
- Specialist advice: technical consultancy may also be required throughout the planning and development phase to cover areas including but not limited to radar issues (for both civilian and military sectors), environmental considerations and human impact studies.

scorecard	
Market Value	Development services represent 3.5% (£54.5m) of the CAPEX for a typical 500MW offshore wind project.
Oil and gas sector expertise	The O&G supply chain has a multitude of capabilities covering all of the support services required in offshore wind. These skills and the related track record are highly applicable.
Potential to reduce cost of energy	Cost of energy reduction would be greater than 0.5% assuming a 20% reduction in CAPEX could be achieved by streamlining the development process.
Barriers to entry	Investment costs are relatively low in this area and there are few companies offering a full range of services.
Result: potential to add value	There is excellent potential for transfer of skills and services into this segment. Offshore oil and gas project development skills and track record will be highly valued.

The project management costs to the developer, whether they are an independent or a global utility, in terms of both personnel and facilities have also been included in this segment. The size of the full-time project development team will clearly be highly dependent on the in-house capabilities of the developer.

Oil and Gas Skills Transfer

There is significant experience of managing major offshore construction projects from concept through to production in the North Sea region. The skills previously highlighted can be found in both the major turnkey contractors and in specialist engineering and niche consultancies. All of the major areas of expertise appear to be covered by the existing knowledge base within oil and gas.

Case Study | XODUS GROUP



Xodus Group is an Aberdeen-based energy consultancy with its roots in oil and gas, which has grasped the renewables opportunity and set up a low carbon division of its business, exporting its services worldwide. They report that the renewables market now accounts for over £2 million of their turnover and they predict this to rise to £10 million by 2015.

The company provides an integrated package of consultancy solutions for energy production from conceptual definition, through design and construction and into operation. This covers areas such as subsea, wells and subsurface, integration technology, environment, technical safety and risk and process and facilities.

Xodus had more than 25 live renewable projects at the time this report was put together including:

- Offshore engineering and field development concept integration on Round 3 offshore wind projects.

- Operations strategy development for a North American offshore wind pilot project.
- Environmental and consenting support to Statoil for Hywind's Scottish pilot project – the world's first commercial full-scale floating wind turbine project.
- Delivering the Environmental Impact Assessment (EIA) for MeyGEN's tidal project in the Pentland Firth, consisting of up to 400 1MW turbines – enough to power 400,000 homes.
- Providing the conceptual engineering of a novel tidal stream turbine for a major multi-national manufacture and system integrator.

Xodus are expanding their services in offshore wind and looking to develop relationships with academia to push the boundaries of state of the art projects and to work with developers and the finance sector to look for ways to bring down the cost of energy.

www.xodusgroup.com

Balance of Plant (B1)

Summary

- Balance of plant⁽¹⁵⁾ represents a major proportion of the CAPEX.
- Balance of plant costs are highly dependent on the site parameters including water depth and distance from shore.
- There is significant scope for cost reduction in this area as designers and manufacturers gain more experience.
- The crossover potential between oil and gas and offshore wind is considerable in some cases.

Balance of plant refers to all major equipment required for the completion of an offshore wind farm out with the wind turbine and tower.

Balance of plant for offshore wind is a major expense and is highly sensitive to various site parameters including power output, water depth and distance from shore. For example, early offshore wind developments built in the UK did not have a requirement for offshore substations but future developments including Round 3 and STW sites will require one or more offshore substations due to their scale.

Water depth is another key consideration with many of the Scottish offshore wind projects located in relatively high water depths greater than 35 metres necessitating the use of 'deep-water' support structures including lightweight jackets. Design and production of jackets is a particular area of expertise in the offshore sector.

Cabling requirements are significant with major demand for array cable, which interconnect wind turbines and higher capacity export cabling. To date, the majority of export systems have been rated between 33KV and 132KV using HVAC technology

with cable-runs of between 20 and 50km from offshore substations to landfall. With larger projects, further from shore, it is expected that HVDC technology will become increasingly important.

The cost breakdown for the balance of plant components is outlined below. This breakdown represents a mean of offshore wind projects completed to date⁽¹⁶⁾. Deepwater projects introduce different requirements, for example some integrated designs may not require a transition piece.

Table 7: CAPEX Breakdown – Balance of Plant

Area	Proportion of total CAPEX	CAPEX for a generic 500MW project	Potential
Transition Pieces (B1.1)	3.2%	£49.8m	Orange
Support structures (B1.2)	13.7%	£213.4m	Green
Array cables (include cable protection) (B1.3)	1.9%	£29.6m	Orange
Export Cables (B1.4)	4.8%	£74.8m	Orange
Offshore Substation (B1.5)	5.0%	£77.9m	Green
Onshore Substation (B1.6)	2.5%	£38.9m	Orange
TOTAL	31.1%	£484.4m	

Source: Douglas-Westwood

¹⁵Global Offshore Wind Project Database, Douglas-Westwood, 2011

¹⁶For the purposes of this report, balance of plant refers to all major equipment required for the completion of an offshore wind farm, out-with the wind turbine and tower

Support Structures (B1.2)

Requirements

Supply of support structures represents a major component of a project's capital cost. With larger wind turbines expected in the future, support structures will increase in size and weight. The choice of structure depends on site-specific parameters including water depth and seabed conditions as well as the size and weight of the turbines being used. There are several main classes of support structure at present:

- **Gravity-base structures (GBS)** – a concrete (or steel) structure, which secures the turbine to the seabed through its mass, typically between 500 and 1,000 tonnes. GBS units can be assembled onshore and installed without drilling or piling. Installation requires seabed preparation and a specially modified transportation vessel. GBS support structures are suitable for most types of seabed soil conditions except those where there is heavy erosion.
- **Monopiles** – A standard monopile foundation is typically between 3.5m and 5m in diameter and is driven (drilled if there is rock) up to 35m into the seabed. The majority of the larger fabricators produce monopiles as their primary output with rolled steel sourced from a single supplier. However, additional steel rolling facilities are expected in the future.
- **Tripods** – This type of structure is designed to be used in deep waters of 30m or more. They can be used at sites as long as there is at least 7m of water, any less and service vessel access would be problematic. A tripod support structure would normally be anchored to the seabed by three small piles, one in each corner of the structure. These steel piles which would be up to 1m in diameter would typically be driven between 10m and 20m into the seabed.
- **Jackets** – Jacket style support structures have been extensively used offshore in oil and gas applications. Being large structures, jackets are best suited to deepwater or high-load applications. The cost of producing a small number of jackets is high but it is likely that savings can be achieved through economies of scale. The Beatrice Wind Farm Demonstrator project off Scotland was the first to utilise jacket style support structures. Located in 45m of water and using 5 MW turbines, support structure design was critical. The jackets designed by OWEC Tower AS of Norway, are secured to the seabed with four piles. The jackets are transported offshore and installed in one piece.

Oil and Gas Skills Transfer

Fabrication facilities across Scotland have been servicing the oil and gas sector for forty years with capabilities spanning pipelines, subsea structures, process modules, ancillary equipment and components. This capacity appears highly relevant to the production of structures for deepwater such as jackets and tripods. There may also be scope to develop facilities for production of towers in particular. There are also companies with capability to manufacture ancillary components such as flange rings, bolting systems and boat landings.

scorecard	
Market Value	The support structure represents 13.7% (£213.4m) of the CAPEX for a typical 500MW offshore wind project. This represents one of the highest value segments.
Oil and gas sector expertise	Crossover is high in this area with a leading supplier established in the area of deep-water support structures.
Potential to reduce cost of energy	Cost of energy reduction would be more than 1% assuming a 20% reduction in the CAPEX could be achieved through a combination of mass manufacturing and new technology.
Barriers to entry	Investment costs for new production facilities are high in this area with a cluster of existing suppliers based in Northern Europe.
Result: potential to add value	This is an excellent area for skills transfer with offshore expertise in designing and manufacturing support structures, especially in more challenging deep water sites.

Offshore Substations (B1.5)

Requirements

Offshore transformer substations are used to reduce electrical losses by increasing the voltage prior to exporting the power to shore. Generally an offshore substation does not need to be installed if:

- The project is small – 100MW or less
- It is close to shore – 15km or less or
- The connection to the grid is at collection voltage – e.g. 33 kV.

Many early offshore wind projects met some or all of these criteria, so were built without an offshore substation. However, the majority of future offshore wind farms will require one or more offshore transformer substations because they will exceed all of the above criteria.

The power produced from each turbine is fed to an offshore substation via the inter-array cables, where the voltage from the site distribution voltage, 30 to 36 kV, is stepped up to a higher voltage of between 132 to 170 kV. This step-up reduces the number of export cables required between the offshore substation and the shore. Typically, each export circuit may be rated in the range 150 to 200MW. Currently, there is no set standard for offshore substations, apart from its core function of stepping up the voltage and feeding it onshore.

Substation contracts have been typically awarded on a turnkey or multi-contract basis to companies from the energy transmission sector and/or a company from the offshore engineering sector. Depending on the company selected, the appropriate sub-contractor(s) will be used to supply the following components:

- Transformer and associated electronics (e.g. ABB, Areva, EDF, Siemens)
- Topside structure (e.g. Bladt, HSM, Heerema, SLP, McNulty, IMS)
- Foundation (e.g. Bladt, HSM, Heerema, SLP, McNulty, IMS)
- Substation internal fabrication and systems (e.g. Bladt, Semco)

In the future, oil and gas solutions are likely to be adopted by combining accommodation facilities with offshore substation facilities. Offshore accommodation can bring a number of advantages to the operator in that they would have the ability to house personnel, spare parts and equipment in one place which could result in quicker maintenance responses and year-round maintenance programmes.

The first example of a dedicated accommodation platform being introduced was at Horns Rev II off Denmark, installed in 2009. The three-level accommodation platform can accommodate 24 persons, with direct access to the transformer platform via an outer gangway.

Oil and Gas Skills Transfer

There are over 600 offshore structures of various types in the UK sector of the North Sea, including over 200 steel construction platforms. Many of the challenges associated with designing and fabricating offshore production facilities are shared with offshore substations.

Oil and gas sector skills will become especially valuable as projects move further offshore and incorporate accommodation, helipads and maintenance facilities. Several large offshore wind farms include offshore accommodation facilities in their design. Oil and gas sector expertise in producing modular accommodation would be highly beneficial in this area.

scorecard	
Market Value	The offshore substation represents 5.0% (£77.9 m) of the CAPEX for a typical 500MW offshore wind project.
Oil and gas sector expertise	The offshore oil and gas sector has fabricated over 200 platforms in the North Sea. Potential fabrication sites also have the necessary support facilities in place.
Potential to reduce cost of energy	Cost of energy reduction would be more than 1% assuming a 20% reduction in the CAPEX could be achieved through application of oil and gas expertise in design and fabrication of offshore structures.
Barriers to entry	Fabrication sites around Scotland have the necessary scale for final assembly of offshore substations.
Result: potential to add value	This is an excellent area for skills transfer with particular expertise in the areas of detailed design, fabrication and project management.

Installation (I1)

Summary

- Supply and demand of installation vessels has become a key issue in this emerging industry.
- New-builds are coming to market but future large-scale developments such as Round 3 and STW require an accelerated build programme.
- Future concepts for installation exist but there appears to be scope for further transfer of offshore oil and gas experience.

The supply and demand of installation vessels is a key issue. At the present time, constraints on offshore installation vessel availability mainly apply to turbine installation but installation of support structures is an important future issue. This has not yet been crucial due to a wider range of vessels being suitable for this type of work.

Until 2008, only a handful of projects were being installed at any one time, so demand for vessels could be met. As demand has steadily risen, the leading installation contractors have found themselves in high demand due to their proven track record and the efficiency of their specialist vessels. This lack of competition led to rising day rates, especially in the area of wind turbine installation.

As project developer's plans became clearer in the period between 2008 and 2010, several companies including incumbents and new entrants, placed orders for new vessels, well aware that supply would be constrained otherwise.

Whilst new-builds are now starting to come to market there will be a requirement for an accelerated build programme to satisfy the requirements of the STW and Round 3 opportunities in particular. This looks to largely be met with many new vessels under construction from established contractors such as MPI and new entrants such as Beluga-Hochtief. Investment decisions are long-term; vessels being 'green-lit' today will be coming to market in 2016-2017 in the expectation of major capacity build-out.

Future concepts for installation include the use of so called 'feeder vessel' strategies whereby installation vessels or barges remain at the offshore wind site and further vessels bring the turbines or support structures from the construction or load-out port. This allows the more costly installation vessels to remain on location. It is a process which may start occurring when larger projects are built. At present larger vessels can carry as many as nine complete turbines at a time, which allow small projects to be built with relatively few load-outs.

The cost breakdown for the installation services required for an offshore wind project is outlined below.

Table 8: CAPEX Breakdown – Installation

Area	Proportion of total CAPEX	CAPEX for a generic 500MW project	Potential
Support structure installation (I1.1)	6.2%	£96.6m	Green
Turbine installation (I1.2)	4.0%	£62.3m	Orange
Array cable laying (I1.3)	3.7%	£57.6m	Green
Export Cable laying (I1.4)	4.9%	£76.3m	Green
Offshore substation installation (I1.5)	0.9%	£14.0m	Orange
Construction ports (I1.6)	1.1%	£17.1m	Orange
Onshore substation installation (I1.7)	0.6%	£9.3m	Orange
TOTAL	21.4%	£333.3m	

Source: Douglas-Westwood

Support Structure Installation (I1.1)

Requirements

Whilst there are a growing number of contractors able to carry out foundation installation using vessels also built for turbine installation (A2Sea and MPI for example), foundation installation work has been performed using less specialised vessels such as crane barges.

Installation methods vary depending on the type of support structure chosen. Monopiles are driven into the seabed using jack-up vessels or the newer self-propelled turbine installation vessels, whereas GBS structures are typically installed using a crane barge.

To date, experience from recent offshore wind projects shows that installation rates have averaged one support structure every two days. GBS foundations can be installed at a faster rate provided the supply logistics are efficient, with separate installation and transportation vessels. The piling involved with monopiles requires longer installation times per support structure. Installation rates have typically been very efficient with only minor problems reported. Faster installations are, however, possible through the use of multiple vessels which will be seen as projects increase in size.

Installation also includes the installation of the transition piece which is a tubular structure that either fits over or under the foundation structure and has a flange built into the top allowing the tower to be bolted in place. The installation process for the transition piece allows the tower to be positioned accurately to the vertical and is designed to incorporate important ancillary equipment. During installation, the transition piece initially rests on the support structure with temporary brackets and is then manipulated to the vertical before structural grouting is applied. Transition pieces can be installed at a rate of over one per day but around 1.5 days per transition piece is standard across a project.

The locations of the offshore wind farms installed to date mean that the challenges of more advanced projects have not been fully experienced. Stable sea conditions are required for foundation installation and increased downtime is therefore to be expected with projects further offshore and in deeper waters.

Oil and Gas Skills Transfer

Many of the large offshore construction contractors have bases in Scotland and have major construction assets at their disposal. The offshore construction fleet is highly utilised in the subsea construction and maintenance markets. There is new capacity entering the market however as a consequence of an extensive build programme pre-2009 but securing crews for these assets will also present a challenge.

In addition to planned vessel capacity, there will be a requirement for new designs and installation methodologies in the future. The oil and gas sector can add value here in developing new vessel concepts and applying installation expertise. For example, application of structured risk assessment methodologies in the planning stages can often identify potential cost over-runs and allow mitigations to be put in place.

Specialist expertise in areas such as structural grouting and scour protection around the base of support structures is highly applicable. For example, major cementing contractors from the oil and gas sector have been involved in the early offshore wind projects.

scorecard	
Market Value	Installation of support structures represents 6.2% (£96.6m) of the CAPEX for a typical 500MW offshore wind project.
Oil and gas sector expertise	The offshore sector has installed over 200 platforms in the North Sea. This expertise is highly relevant in this segment.
Potential to reduce cost of energy	Cost of energy reduction would be more than 1% assuming a 20% reduction in the CAPEX could be achieved through offshore oil and gas installation expertise.
Barriers to entry	Investment costs for support structure installation vessels are extremely high.
Result: potential to add value	This is a particularly promising area for skills transfer with contractors in the offshore sector having extensive track record and understanding of offshore construction risks.

Case Study | ROTECH



Established in 1994 to service the needs of the offshore oil and gas market, Rotech have successfully expanded their business into the offshore renewables sector. The company's main focus is the provision of subsea excavation services backed up by engineering and manufacturing, offshore know how and robust R&D to bring new technology to market. Their business is divided into three areas: Rotech Subsea, Rotech Fabrications and Rotech Engineering.

Specific services applicable to the offshore wind market include the company's ability to provide pipeline and cable excavation, trenching and deburial, rock dump removal, seabed preparation, route clearance, inspection and repair and maintenance work with their own, sonar guided equipment. Their services can be used for new installations right through the project lifecycle to decommissioning. Rotech Fabrications complement the company's products and services with the manufacture of pipe and structural steel work,

and the company's engineering division focuses on research and development work for new products and technologies such as their Tidal Turbine device for the offshore renewables market.

The company has undertaken numerous projects in the Irish, German and North Sea renewables sector. Some of these include:

- Post trenching/excavation work for power cables and cable loops in the Alpha Ventus field, German North Sea
- Post trenching of power cables and J-Tube entry around monopoles in the Greater Gabbard field, Southern North Sea
- Post trenching of in situ cable ends and crossings in various water depths at Thanet wind farm, Southern North Sea
- Cable trenching to a depth greater than 3m below seabed at Walney wind farm, Irish Sea

www.rotech.co.uk

Array Cable-lay (I1.3) and Export Cable-lay (I1.4)

Requirements

The cable-lay segment presents a significant market opportunity with over 4,600km of subsea cable required over the next five years. By comparison, 1,400km was installed over the past five years. In three of the next five years, the installation rate will be more 1,000km per year as the number of projects increase and move further from shore¹⁷.

Cables are laid using the reel-lay method. The cable is made up onshore and spooled onto a reel or carousel on the lay vessel. Once the vessel reaches the installation site, the line is progressively unwound, straightened and paid out in a J-curve through the vessel moon pool or over the stern and down to the seabed.

During installation, trenching and burial are some of the most costly and time consuming activities requiring a dedicated marine spread. Depending on the seabed soil type, trenching operations are performed by ploughs, jetting machines or, on hard soils, cutters. Burial may be effected by backfilling the trench with

the excavated soil, although trenching without backfill is usually adequate for on-bottom stability and protection.

A typical third-generation lay-barge has a draft of about 12m and it may only be able to get within 3 to 4km of the shore, depending on the inclination of the seabed. To minimise the length of cable that must be pulled from the ship to shore, the shore approach section of a line is typically perpendicular to the beach. A perpendicular approach also enhances the stability of the line as it minimises the destabilising effect of cross currents caused by wave refraction in shallow water. Even so, the shore approach sections of most cables are buried for protection purposes.

The most common landfall construction technique is to pull the cable ashore using a winch mounted on the beach. To protect the cable, a combination of land equipment and marine dredgers may be used to dig a trench across the beach through the tidal zone (using cofferdams to prevent the tide from filling it in again) and out to the lay barge. The cable is pulled ashore in this trench, usually with temporary buoyancy modules attached to ease its passage.

Once the cable is installed, the trench is filled in, and the lay barge completes its offshore installation operations. Landfall trenches are typically 3m deep to ensure that the cable is adequately protected against future erosion.

¹⁷ Global Offshore Wind Project Database, Douglas-Westwood, 2011

Fixed burial depths (such as the 3m burial depth required in UK waters) are seen as a problem by some contractors. This depth significantly increases time and costs as it requires ploughing. To date, some contractors have been unwilling (or are unable) to enter the market under these circumstances. A 1.5m depth means that high power air jets can be used to do this process, which is then quicker and cheaper.

In terms of installation rates it is possible to surface lay one array cable per day (12 hours) whilst simultaneous burial can take 1.5 days. Vessels with dynamic positioning (DP) have been demonstrated to offer significant efficiency savings. For example, array cable installation times at the Thanet wind farm were reduced by 50% using the specially adapted cable installation vessel, the Polar Prince. Traditional barge methods can take longer despite the reduced day rates. For export cable installation, while 12km a day (500m/hr, ploughing) is possible a more typical rate is 5km per day (200m/hr, ploughing) and is used for planning.

Oil and Gas Skills Transfer

The offshore oil and gas sector has developed leading capabilities to lay and bury both cables and umbilicals but there is likely to be competition for the limited skills and installation assets between the two sectors.

Offshore expertise may be particularly attractive in this area as cable-lay is perceived by developers, insurers and financiers as one of the greatest areas of risk in the installation phase. Clients will be looking for services, which mitigate risk particularly in the following areas:

- Cable route engineering: ensuring that the proposed routes avoid anchoring and all other dangerous zones.
- Seabed surveying: ensuring that a thorough surveying campaign is carried out. The relatively low expense incurred in surveying can be extremely beneficial.
- Burial specifications: these must strike a balance between assessments of risk and cost implications.
- Contractor capabilities: selection of contractors must take into account track record, experience of personnel and financial position.
- Installation spread: this must be fit-for-purpose in terms of vessel dimensions, storage, handling and burial equipment.

- Link between client and contractor: there must be an effective link between the installation contractors and the main client whether that is a developer or main contractor. This point extends to early engagement in the planning stages where cost savings and efficiencies can often be identified.

Remote Operated Vehicle (ROV) support is also particularly important in this area with application in a number of offshore operations including pre-lay and post-lay cable route surveys, cable installation, cable burial, inter-array cable pull-ins, support structure installation and Inspection, Repair and Maintenance (IRM).

scorecard	
Market Value	Installation of array and export cabling represents 8.6% (£133.9m) of the CAPEX for a typical 500MW offshore wind project.
Oil and gas sector expertise	As well as subsea cable installation expertise, the oil and gas sector covers all of the essential support services including ROV support, trenching and burial.
Potential to reduce cost of energy	Cost of energy reduction would be more than 1% assuming a 20% reduction in the CAPEX could be achieved through application of recognised oil and gas installation expertise.
Barriers to entry	Whilst investment costs and charter rates for high specification cable installation vessels are extremely high, there is a need for additional installation capacity in the marketplace.
Result: potential to add value	This is an excellent area for skills transfer with risk reduction needed. The offshore sector is able to demonstrate risk reduction in several key areas throughout the cable-lay process.

Operational (01)

Summary

- Offshore wind turbines have a 20 year design life and as a consequence, the value of O&M services is both high and sustained.
- Personnel access is an area of concern with a major requirement to increase availabilities.
- Over time, as turbine manufacturers offload their warranty liabilities, a significant market for independent O&M provision will develop.
- Cross-over potential is significant, with many oil and gas supplies, product, service and competences already in this market.

The operational phase for a renewable energy site offshore is a process of ensuring that the development is inspected and maintained regularly and that suitable spare components are available to allow for speedy repairs when necessary. Operational lifetimes vary depending on the renewable energy source.

Modern wind turbines typically have a 20 year design life. Onshore turbines are designed to have one or two planned maintenance checks per year and whilst this was also the target offshore, it is some way off realisation. Project owners have come to realise that continued maintenance and inspection is crucial to avoid more costly remedial works. The cost of operations and maintenance offshore varies considerably between projects but as a guide it is approximately 2-3% of the capital cost per year or around £40m per year for the generic 500 MW project.

Typically, unplanned stoppages occur every 1-3 months on turbines in serial production, most frequently due to sensor, wiring and control system faults, though gearboxes, generators and blades are the source of highest unplanned maintenance cost. Availabilities (the percentage of time that turbines are without fault, hence available to run) are generally warranted to 97% onshore, but lower offshore. During the warranty period, planned and unplanned maintenance activities are generally carried out directly by the wind turbine manufacturer.

The rapid transfer of maintenance personnel to offshore wind turbines is also particularly important. Based

on existing projects, one personnel transfer vessel is required for approximately every 25 turbines. For major repairs to large wind farms, operators will aim to charter vessels for the necessary period to perform any major repair/overhaul work. The ability to plan this type of work will help operators control these costs, although the current and foreseen future demand for these vessels will not reduce the rates these vessels command.

Over time, it is likely that independent O&M providers will begin to participate in this market as has been seen in the onshore marketplace. However, barriers to entry for independent O&M providers seeking to enter the offshore market are far higher in terms of capital requirements. Another possibility is that project owners with large offshore wind portfolios will take on this responsibility as has been the case with DONG Energy, which is investing in vessels directly, although DONG's position on this issue is fairly unique amongst project owners.

Table 9: OPEX Breakdown

Area	Proportion of total CAPEX	CAPEX for a generic 500MW project	Potential
Replacement equipment (01.1)	51%	£20.4m / year	
Personal transfer (01.2)	9.0%	£3.6m / year	
Skilled technicians (01.3)	8.0%	£3.2m / year	
Installation / repair vessels (01.4)	6.0%	£2.4m / year	
O&M ports (01.5)	5.0%	£2.0m / year	
Grid maintenance, lease and other recurring costs (01.6)	21.0%	£8.4m / year	N/A
TOTAL	100%	£40m / year	

Source: Douglas-Westwood

Replacement Equipment (01.1)

Requirements

The cost of repair and replacement of equipment on the turbine and support structure represents the largest proportional cost of offshore wind O&M. These costs can generally fluctuate depending on failure rates of items, when overhauls take place and the frequency of interim maintenance works. The cost attributed to this segment is representative of the average cost that is spent within a given year on a typical offshore wind project.

As cumulative offshore wind capacity increases over time, there will be a requirement for larger logistics bases, which store replacement equipment. These facilities will be most efficient where they serve more than one offshore wind farm. As well as the requirements for storage, there is a need to develop robust logistics chains to ensure components can be delivered quickly to where they are needed.

Oil and Gas Skills Transfer

Maintaining asset integrity is an essential requirement for all North Sea duty holders, especially for older infrastructure, and extending the life of assets can also be a consideration. Integrity records must be completed for all defects and repairs. Duty holders are often responsible for power generation and distribution facilities offshore and these skills appear relevant to wind turbines. With almost half of the oil and gas assets on the North Sea being unmanned, there is leading expertise here in remote monitoring of equipment.

There is also a comprehensive logistics chain in place servicing North Sea oil and gas installations. While this capacity is fully utilised, the skills and expertise appear to be highly relevant to the offshore wind opportunity.

scorecard	
Market Value	Replacement equipment represents 51% (£20.4m) of the annual OPEX for a typical 500MW offshore wind project.
Oil and gas sector expertise	The offshore oil and gas sector is supported from local logistics bases, which hold replacement equipment and carry out repairs.
Potential to reduce cost of energy	Cost of energy reduction would be more than 1% assuming that a reduction in the OPEX and increased availability could be achieved through local sourcing and more efficient logistics.
Barriers to entry	Barriers to entry are low with Scottish projects expected to be serviced out of local logistics hubs.
Result: potential to add value	This is an excellent area for skills transfer. The offshore sector already operates a large service and logistics operation.

Personnel Transfer (01.2)

Requirements

Personnel transfer vessels (PTVs) and alternative transport methods such as helicopters are essential tools in the O&M phase of an offshore wind project. The market for these services is rapidly growing and some of the key facts are highlighted below:

- Typically one PTV is required for every 25 wind turbines in the operational phase.
- Current vessels are typically based on a 15-20 metre hull with capacity for between 10 and 15 passengers and have ranges of between 50 and 70 miles.
- In the future vessels are likely to be based around 25 to 30 metre hulls and have capacity for between 25 and 30 passengers. These vessel designs are being marketed as a solution for Round 3 with longer range and wider operating windows.
- Vessels are generally contracted on long term leases with five year operational support contracts possible.
- The majority of the market is made up of small operators with a fleet of three or less vessels.
- To date, there has been little in the way of consolidation among the PTV operators.
- Growth in this market is expected to be rapid with a need to more than treble the number of vessels over the next five years.
- In order to further widen operating windows, several personnel access solutions are being marketed including the Ampelmann and Offshore Access System.

Oil and Gas Skills Transfer

As well as existing conventional vessels being used for personnel transfer, a wide range of solutions for safe access and egress to both fixed and floating rigs have been developed to service the North Sea sector. Helicopter access for example has demonstrated

extremely high availability levels and Aberdeen’s heliport transports over 400,000 passengers per year.

Helicopter transit has shown potential to increase personnel access levels to 90% or more and this will become increasingly relevant as offshore O&M accommodation modules are built for the larger Round 3 projects. These facilities will be on a similar scale to current offshore platforms.

There are also many custom-built access solutions in the North Sea including motion-compensated gangways between flotels and production platforms.

scorecard	
Market Value	Personnel transfer represents 9% (£3.6m) of the annual OPEX for a typical 500MW offshore wind project.
Oil and gas sector expertise	Safe access and egress to offshore installation is a fundamental skill-set in the oil and gas sector. Helicopter transits can offer particularly high access availabilities.
Potential to reduce cost of energy	Cost of energy reduction is more than 1% assuming that a reduction in OPEX and a 1% improvement in availability could be achieved through application of oil and gas personnel transfer solutions.
Barriers to entry	Barriers to entry are low with local vessel operators and other transport providers contracted to carry out this work.
Result: potential to add value	This is an excellent area for skills transfer with the offshore sector able to demonstrate track record and the highest possible safety standards.

Skilled Technicians (O1.3)

Requirements

Labour costs cover the cost of operation and maintenance staff which will typically be stationed on the project full time. Transfer to the turbines is typically performed by workboats for routine inspection and maintenance operations. A typical operations and maintenance crew will consist of two people for every 20 to 30 wind turbines in a wind farm. For smaller wind farms there may not be a dedicated O&M crew but arrangements will be made for regular visits from a regional team. Typical routine maintenance time for a modern wind turbine is 40 hours per year. Non-routine maintenance may be of a similar order.

Oil and Gas Skills Transfer

While the oil and gas workforce is highly utilised in its core market, the training infrastructure can certainly be leveraged. A wide range of training providers offer accredited training, which needs to be renewed on a regular basis. Areas which are covered include fire equipment training, emergency re-breather and underwater escape training. Specialist courses are also provided for aspects such as climbing, working at height and specialist equipment.

Inspection and repair activity is high within the North Sea sector with a high number of skilled and experienced technicians. In the operational phase, there will be specialist requirements to maintain turbines and for removal and replacement of major subcomponents. The skills required to carry out underwater inspection, maintenance and repair are already well developed.

scorecard	
Market Value	Skilled technicians represent 8% (£3.2m) of the annual OPEX for a typical 500MW offshore wind project.
Oil and gas sector expertise	The offshore oil and gas workforce is highly trained and offshore training and certification is regularly updated.
Potential to reduce cost of energy	Cost of energy reduction would be more than 1% assuming that a 20% reduction in OPEX and a 1% improvement in availability could be achieved by leveraging existing skills.
Barriers to entry	Barriers to entry are low in this area with local skilled technicians expected to be used. However, competition for the services of skilled technicians would need to be managed.
Result: potential to add value	This is an excellent area for skills transfer with a highly skilled workforce and a comprehensive training infrastructure.

O&M Ports (01.5)

Requirements

Support to operational wind farms is typically provided from a local port. These ports must be able to support the maintenance crews, vessels and replacement parts necessary for efficient operations and maintenance.

As offshore wind farms increase in scale, the use of offshore accommodation platforms will be necessary. These offshore platforms may be accessed by helicopters, as well as personnel transfer vessels, likely to create a further requirement for aviation facilities onshore as per the oil and gas model.

In addition to local ports, specialised O&M hubs may develop over time with the capability to carry out major repairs and store large components.

Oil and Gas Skills Transfer

Ports around Scotland have been playing an important role in the development and upkeep of the North Sea oil and gas assets, supporting areas such as inspection, repair and maintenance (IRM), surveying, diving support, offshore logistics and subsea services. The experience gained in servicing these requirements means that there are a number of locations with suitable facilities. These tend to be located on the East coast of Scotland but there will be a need for further bases on the West Coast.

The development of service hubs for offshore wind would mirror the role of Aberdeen as the centre of activities for maintenance in the North Sea. Peterhead is also a major servicing base, including ASCO's logistics hub for the North Sea. This infrastructure is highly relevant to the scale and requirements of the offshore wind sector.

scorecard	
Market Value	The O&M ports represent 5% (£2m) of the annual OPEX for a typical 500MW offshore wind project.
Oil and gas sector expertise	The offshore oil and gas sector is supported from local O&M bases and major service hubs such as Aberdeen.
Potential to reduce cost of energy	Cost of energy reduction would be less than 0.5% as it is unlikely that OPEX could be significantly reduced in this area.
Barriers to entry	Offshore wind projects in Scottish waters will be serviced from local O&M ports.
Result: potential to add value	There is scope for skills transfer in this area with infrastructure and support services in place in strategic locations.

Conclusions

Assessment of Benefits

To quantify the benefits of skills transfer from the oil and gas sector to offshore wind, the cost of energy metric has been used based on a generic 500 MW offshore wind project. The baseline cost of energy has been calculated in order to provide a reference point. All baseline values are based upon research into global offshore wind projects.

In order to reduce the baseline cost of energy, any product or service must demonstrate potential to reduce the initial capital expenditure or operational expenditure, or increase the availability of offshore wind farms.

In the capability mapping section, a number of areas have been highlighted as showing the greatest potential for cross-sector skills transfer. Some of these areas show potential to reduce more than one cost of energy component (see overleaf for reference).

High potential opportunities include fabrication of support structures, cable-lay and provision of skilled personnel throughout the operational phase.

By achieving cross sector transfer of skills in all of the high potential areas, significant reductions in the cost of offshore wind operations could be achieved.

As well as the clear opportunities in high potential areas, there is also scope for skills transfer in the medium potential areas. For example, whilst there is less overlap of skills in the supply of wind turbine components, these areas are of such high value that they are worthy of consideration.

Cost Reduction Potential

Based on the assessment in this guide, the table below shows the possible contribution that the green and amber categories identified could make to the development and operational cost of an offshore wind farm.

Transfer of skills from the oil and gas sector in the high priority areas identified in this guide could reduce the cost of energy for offshore wind from current levels by 12.6%. In a more ambitious scenario whereby cross-sector transfer of skills in both the high and medium potential areas is achieved, there is potential for a reduction of 20.1%.

This cross-sector transfer could benefit the offshore wind sector greatly through cost reduction, application of expertise and access to new supply chain capacity. This could lead to long term reductions in project expenditure, project risk and downtime. At the same time, the offshore wind sector presents an exciting new commercial opportunity for the oil and gas sector.

Table 10: Cost Reduction Potential

Area	Project Baseline	Project with improvements 	Project with improvements  + 
CAPEX	£1,558m	£1,442m	£1,347m
OPEX	£40m/year	£34.2m/year	£33.9m/year
Availability	88%	92%	95%
Cost of Energy	£145.7/MWh	£127.3/MWh (-12.6)	£116.4/MWh (-20.1)

Source: Douglas-Westwood



Table 11 | High Potential Areas

Area	Potential to add value	Increased Competition	OPEX Reduction	Increased Availability	OPEX Reduction	Opportunity
Development services (P1.1)	There is excellent potential for transfer of skills and services into this segment. Offshore oil and gas project development skills and track record will be highly valued.	✓	✓			
Support structures (B1.2)	This is an excellent area for skills transfer with offshore expertise in designing and manufacturing support structures, especially in more challenging deep-water sites.	✓	✓			
Offshore substations (B1.5)	This is an excellent area for skills transfer with particular expertise in the areas of detailed design, fabrication and project management.	✓	✓			
Support structure installation (I1.1)	This is a particularly promising area for skills transfer with contractors in the offshore sector having an extensive track record and understanding of offshore construction risks.	✓	✓			
Array cable-lay (I1.3)	This is an excellent area for skills transfer with risk reduction needed. The offshore sector is able to demonstrate risk reduction in several key areas throughout the array cable-lay process.	✓	✓			
Export cable-lay (I1.4)	This is an excellent area for skills transfer with risk reduction needed. The offshore sector is able to demonstrate risk reduction in several key areas throughout the export cable-lay process.	✓	✓			
Replacement Equipment (O1.1)	This is an excellent area for skills transfer. The oil and gas sector already operates a large service and logistics operation covering the North Sea region.			✓		
Personnel transfer (O1.2)	This is an excellent area for skills transfer with the offshore sector able to demonstrate their track record and the highest possible safety standards.			✓	✓	
Skilled technicians (O1.3)	This is an excellent area for skills transfer with a highly skilled workforce and a comprehensive training infrastructure.			✓	✓	
O&M ports (O1.5)	There is scope for skills transfer in this area with infrastructure and support services in place in strategic locations.			✓	✓	
Total			7.5% reduction	14.5% reduction	4% increase	

Source: Douglas-Westwood

Table 12| Medium Potential Areas

Area	Potential to add value	Increased Competition	OPEX Reduction	Increased Availability	OPEX Reduction	Opportunity
Environmental Surveys (P1.2)	Environmental surveying represents an excellent opportunity for survey companies to diversify. Highly specialised contractors will be particularly well-placed.	✓				
Met station (P1.3)	There is scope for transfer of skills and services into this segment. Companies with experience of developing and operating remote unmanned assets will be well placed in this area.	✓	✓			
Geophysical surveys (P1.4)	There is further potential to leverage surveying and analytical skills from the oil and gas sector into this segment.	✓				
Geotechnical Surveys (P1.5)	There is potential for transfer of offshore oil and gas sector expertise and supply chain capacity into this segment.	✓	✓			
FEED (P1.6)	There is potential for transfer of design skills and services into this segment. Offshore oil and gas track record will be highly valued in this area.	✓				
Drive-train (W1.2)	Oil and gas sector expertise could add value through development of more reliable solutions tailored to the offshore environment. Given the high value of the drive-train, this is an area worth investigating.	✓	✓		✓	
Rotor System (W1.3)	The high value of the rotor systems and the relatively moderate costs of setting up production facilities make this an attractive area. Current expertise would need to be expanded to cover mass manufacturing.	✓	✓			
Power Conversion (W1.4)	The high value of power conversion equipment makes this an attractive area for new entrants. Choice of suppliers in this area is also currently limited.	✓	✓			
Tower (W1.5)	The high value of the tower makes this an attractive area with reduced barriers to entry in comparison to other high value components.	✓	✓			
Additional Components (W1.6)	There is some scope for transfer of oil and gas supply chain capacity given that design and manufacture is less specialised in this area.	✓	✓			
Transition Piece (B1.1)	The relatively high value of transition pieces for offshore wind makes this an attractive area.	✓	✓			
Array Cables (B1.3)	There is scope for skills transfer in this area, especially by leveraging skills honed in the production of umbilical systems.	✓	✓			
Export Cables (B1.4)	This is a high value component where growth in production capacity is required as a priority.	✓	✓			
Onshore Substations (B1.6)	There is limited scope for skills transfer in this area.	✓	✓			
Turbine Installation (I1.2)	This appears to be a good area for skills transfer with additional installation capacity required over the next 10 years.	✓	✓			
Offshore Substation installation (I1.5)	There is scope for skills transfer in this area with expertise developed in the North Sea offshore installations and decommissioning markets.	✓	✓			
Construction Ports (I1.6)	There is scope to exploit the construction sites around Scotland as integrated assembly and manufacturing hubs.	✓				
Onshore Substation Installation (I1.7)	There is scope for skills transfer in this area but the value of these services is low in relation to the total project expenditure.	✓				
Installation / Repair Vessels (O1.4)	There is scope to transfer offshore sector expertise in this area with specialist IRM and diving services showing particular promise.	✓		✓	✓	
Total						

Source: Douglas-Westwood

How Scottish Enterprise supports innovation in Offshore Wind

Scottish Enterprise (SE) has a number of R&D and innovation support mechanisms that can assist companies from the early stages of investigating market and technical feasibility; through product, process or service development; to market launch. This is a summary of the innovative support services we offer:

Innovation Support Service

The Innovation Support Service is an impartial advisory service available, free, to all companies that require advice and guidance on innovation projects. The Support Service is focused on helping with the front-end planning process and developing robust business cases for your innovation project. As well as providing advice and guidance, our experienced innovation advisers will help identify and link your business to relevant partner organisations and point you to relevant sources of further support.

SMART: SCOTLAND

The SMART: SCOTLAND programme is a single company R&D support scheme that aims to stimulate the creation of new innovative businesses and to help existing small businesses improve their competitiveness by developing new products and processes.

The R&D Grant

The R&D Grant is a discretionary grant that can support the eligible costs of all sizes of companies that wish to grow through the development of new products, process or services in Scotland. The grant is for projects with activities that fit within the European Union definitions of 'industrial research' and 'experimental development' (essentially activities up to the point of creating a prototype). Projects must represent a significant innovation, with significant risks, for the company concerned.

Scottish Manufacturing Advisory Service

SMAS provides expert advice, one-to-one support, training and events for manufacturing companies of all sizes throughout Scotland. The practitioner team consists entirely of hands-on experts in process improvement and lean manufacturing, and allied disciplines.

Proof Of Concept

Researchers from Scotland's universities and research institutes can receive funding and support to turn their ideas into a business. Proof of Concept funding will cover 100% of salaries, consumables, market assessment, patent costs, subcontracting, travel, and essential equipment. Applications should be early stage ideas that have typically reached patent level and could lead to the establishment of new, high growth businesses in Scotland and must have been approved and endorsed by the Principal/Director of the Institution and its commercialisation office.

Offshore Wind Expert Support

Expert Support is designed to help companies consider and build diversification strategies to enable them to win business in the offshore wind sector. The focus of the support is on identifying and exploring potentially profitable revenue streams and culminates in the production of a company specific action plan. Companies receive 2-days of fully funded support delivered by specialists who have knowledge and experience of the Offshore Wind sector.

The National Renewables Infrastructure Fund

The National Renewables Infrastructure Fund (N-RIF) has been established to support the development of port and near-port manufacturing locations for offshore wind turbines and related developments including test and demonstration activity, with the overall aim of stimulating an offshore wind supply chain in Scotland.

Offshore Wind Portal

The Offshore Wind Portal is a web based information portal designed to act as a 'one-stop shop' for anyone interested in the burgeoning offshore wind industry in Scotland. It contains key information about the sector, links to sites of other key stakeholders, an interactive map detailing sites, ports and harbours etc.

Further Information contact our Enquiry & Research Service via offshorewind@scotent.co.uk

If you require this publication in an alternative format and/or language please contact the Scottish Enterprise Helpline on 0845 607 8787 to discuss your needs.

Scottish Enterprise

Atrium Court
50 Waterloo Street
Glasgow
G2 6HQ

Helpline: 0845 607 8787
E-mail: enquiries@scotent.co.uk

www.scottish-enterprise.com

SE/3432/Sep11

