Final Report

Scottish Offshore Wind: Creating an Industry

to

Scottish Renewables

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IPA Energy + Water Economics **Scottish Renewables**

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VISION FOR OFFSHORE WIND IN SCOTLAND

IPA Energy + Water Economics (IPA) was commissioned by Scottish Renewables and partners to undertake the study *Scottish Offshore Wind: Creating an Industry*. The goal of this study was to understand the potential scale of the offshore wind sector and the economic effects related to offshore wind capacity and industry development in Scotland. To this end, IPA modelled a range of scenarios for Scottish offshore wind industry development out to 2020.

The scenarios provide four alternative futures for the Scottish offshore wind industry. Scenario A gives a vision of the benefits that Scotland can achieve if it takes decisive steps now. This can be contrasted with our other scenarios. Scenario B demonstrates the effects of more moderate offshore wind development. In Scenario C, Scotland fails to capture the economic benefits of offshore wind development, in much the same way as the onshore wind industry today. The lowest case, Scenario D, shows the consequences if Scotland does not act on the opportunities presented by offshore wind and has few successful projects developed and limited supply chain. The industry can be seen to be at a crossroads in its development, and it will require significant effort to ensure that the full potential is achieved.

Scenario A gives a theoretical target for the Scottish offshore wind industry, with a high level of offshore wind project development and strong supply chain growth:

> Under **Scenario A**, Scotland's high wind regimes encourage developers to complete the full 10.6GW of offshore wind sites currently available for commissioning by 2020, with Scottish Territorial Water sites developed first (earliest sites commissioned in 2014), and the larger Round 3 sites following.
>
> This requires significant grid reinforcement and results in over 2,000 additional 5MW offshore wind turbines installed by 2020. Beyond 2020, the capacity development will continue at a rate of 2 to 3GW/year. Simultaneously, Scotland develops a full supply chain for all phases of the project lifecycle. This exploits all opportunities that Scotland offers: a turbine manufacturer sets up a manufacturing base in Scotland; significant skills and expertise transfer takes place from the oil and gas sector; port infrastructure is developed, upgraded and adapted to the needs of the offshore wind industry; Scottish-based companies with relevant manufacturing and service skills move into the offshore wind sector and existing suppliers scale up significantly to meet domestic (and growing UK and international) demand for equipment and services. The overall sector activity develops over the decade to its full potential, resembling the automotive industry in its level of coordination and density. By 2020, an industry of the scale of the oil & gas sector has developed.
>
> Sufficient supply chain capacity is developed to export equipment and services to supply a share of the rest of the UK market with some export to the wider European market and internationally. Major export areas include machinery and equipment, offshore engineering and construction skills, R&D and technical consultancy.
>
> This adds significant value to the Scottish economy: IPA calculated that the value retained in Scotland directly from the offshore wind industry is £1.3bn in the year 2020 and £7.1bn over the decade. Indirect and induced effects could generate an additional

£6bn of added value. In 2020, this creates more than 28,000 full-time equivalent jobs directly in the offshore wind sector. Indirect and induced effects could create another 20,000 jobs in 2020. This compares to the current Scottish energy sector with a total value of £5.5bn in 2007[1] and 41,900 direct jobs[2] in 2008.

Scenario B assumes that the supply chain still develops significantly but that offshore wind projects are developed over a longer period than in Scenario A:

Scenario B sees more moderate but still strong offshore wind project development. Reasons for this may include developers focusing on shallow water sites in the rest of Britain first and then transferring lessons learnt to the deeper water sites around Scotland. Grid capacity and port infrastructure begin to become available at the right time, but may be a constraining factor on large-scale offshore wind developments in the short-term. By 2020, around half of currently available offshore wind sites are operational and more than 1,000 new 5MW offshore wind turbines are installed. All Scottish Territorial Waters and Round 3 sites are developed and commissioned by 2025.

While supply chain development captures a similar share of the market as Scenario A, there is less development for the industry to supply and little export to Europe or international markets. A turbine manufacturer locates in Scotland and triggers overall supply chain development by strengthening local offshore wind businesses.

Despite slower delivery of Scottish offshore wind projects, IPA found that Scenario B still generates significant benefits for the economy. In 2020, more than 19,000 people can be employed directly in the offshore wind sector in Scotland. An additional 13,000 jobs could be created through indirect and induced effects. The industry is worth a cumulative value of £4.5bn over the coming decade. Indirect and induced effects could create an additional £3.8bn over the period.

To achieve Scenario A or B, concerted government and industry effort is required to put essential infrastructure, skills and capability in place. Action will need to be taken to streamline and shorten the consenting and development period for offshore wind projects; to enable access to financial resources; to boost the supply chain and infrastructure development; to establish sufficient grid capacity; and to facilitate and provide resources for innovation as well as skills and expertise for the industry.

The next few years to 2014 are critical to the success or failure of the Scottish offshore wind industry. If Scotland fails to pick up this opportunity, the offshore wind industry could resemble **Scenario C** or **Scenario D** in 2020:

[1] Government figure which includes mining of coal; manufacture of coke, refined petroleum and nuclear fuel; electricity, gas, steam, and hot water supply; collection and purification and distribution of water; service activities incidental to oil and gas extraction http://www.scotland.gov.uk/Publications/2010/03/22115357/2

[2] Figure includes all of the above (see footnote 1) plus extraction of crude petroleum and natural gas http://www.scotland.gov.uk/Publications/2010/03/22115357/2

Scenario C demonstrates the consequences of lack of investment in the Scottish supply chain. The result is similar to the onshore wind supply chain in Scotland now. Developers bring offshore wind generation online at the same rate as under Scenario A but the wider industrial base does not develop. The majority of equipment and services is imported.

Local content of most projects is comparatively low and the economic benefits for Scotland remain largely unrealised. Most equipment and the majority of services are imported from elsewhere in the UK or Europe. Domestic benefits are realised from short-term construction and commissioning support in the early years and operations & maintenance services in the long-term.

Consequently, Scotland does not see much of the economic benefits. Only around 6,000 full-time equivalent jobs exist in the offshore wind sector in 2020. Indirect and induced employment would generate an additional 5,000 jobs. A total cumulative value added of £1.6bn between 2011 and 2020 is the result, with a further £1.4bn of indirect and induced benefits.

Under **Scenario D**, Scotland fails to capitalise on its vast offshore wind resource, as developers find it too capital-intensive to develop sites in deeper waters and equipment is not suited to rougher conditions off the Scottish coast. This is reinforced by the economic recovery being slow and Government support mechanisms not being extended and expanded sufficiently to match any potential additional costs that may arise in Scottish waters. Long consenting processes and lack of grid development may delay projects.

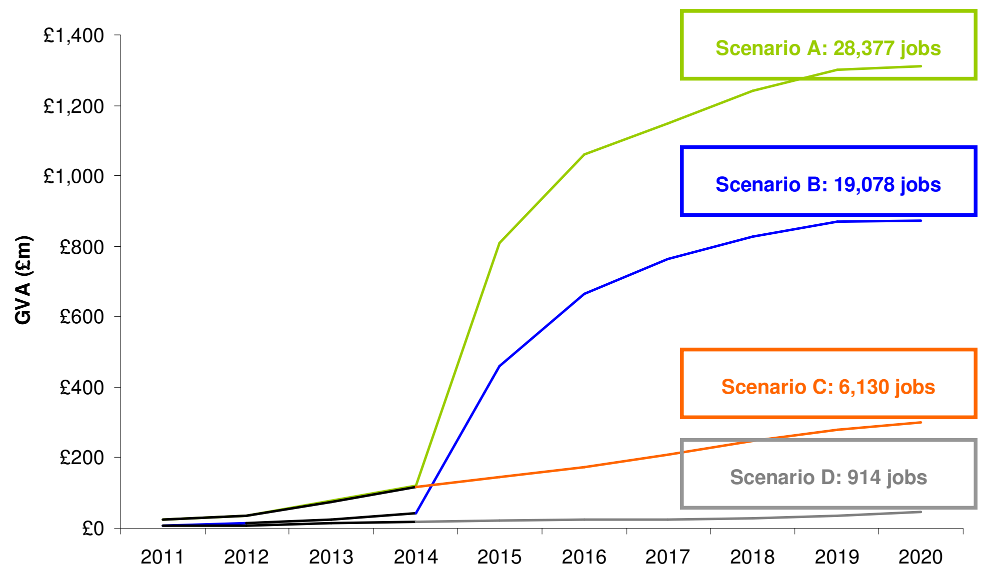
Developers look elsewhere for projects (the rest of UK, Europe and international waters progress with offshore wind development) and the manufacturing and service industry will locate close to where the bulk of offshore wind capacity is being developed. Skills and capacity transfer in Scotland is low, with companies uncertain about the long-term prospects of the sector. As a consequence, the majority of equipment and services will be imported by Scotland if and when required.

Only a few average sized sites will be developed slowly to 2020, bringing online an additional 1.2GW at a rate of 200MW/year. This results in 230 new 5MW offshore wind turbines installed by 2020. The remaining Scottish Territorial Water sites will be commissioned gradually post-2020, but build rates would only move up to 500MW/year.

The benefits are limited: IPA calculated that the offshore wind industry generates a cumulative value of £224m is generated in Scotland over the decade, with indirect and induced effects worth around £200m. This creates around 900 full-time equivalent jobs directly in the industry in 2020 with indirect and induced effects accounting for around 730 jobs.

Figure 1 summarises the modelling results and gives a brief summary of all four scenarios.

Figure 1: Aggregated results for direct GVA and FTEs in Scotland by 2020



Source: IPA

Scenario D

Little Scottish offshore wind industry and low capacity development – around 1.3GW by 2020. Projects are largely supplied by imported services and equipment.

Scenario C

Little Scottish offshore wind industry materialises despite high capacity development of 10.6GW by 2020. Projects are largely supplied by imported services and equipment.

Scenario B

Structural changes and industrial base development take place to 2014.

Construction of about half of currently available offshore wind sites by 2020, with full 10.6GW operational by 2025.

Market activity gradually picks up.

Export of equipment and services to the rest of the British offshore wind market.

Scenario A

Structural changes and industrial base development take place to 2014.

Construction of 10.6GW offshore wind capacity in Scotland by 2020, and strong continued growth beyond 2020.

Market activity gradually picks up.

Export of equipment and services to rest of the British market, Europe and internationally

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1. INTRODUCTION

This report is the final deliverable of the project *Scottish Offshore Wind: Creating an Industry* undertaken by IPA Energy + Water Economics (IPA) for Scottish Renewables.

1.1. Project Objectives

IPA was commissioned by Scottish Renewables and partners to carry out a study into the potential benefits for Scotland from the offshore wind sector.

The goal of this project was to understand the potential scale of the offshore wind sector and the related economic effects of capacity and industry development in Scotland. We carried out a quantitative assessment of the overall offshore wind sector potential and identified the level of opportunity for the Scottish economy. The quantitative analysis considered four scenarios, assuming high, medium or low offshore wind project development and varying levels of industrial development in Scotland. We also carried out qualitative analysis to describe the opportunities and economic effects in more detail.

Another purpose of this study is to provide input to the planned Offshore Wind Industry Group (OWIG) Route Map for the Scottish offshore wind sector. The roles and objectives of the Route Map and OWIG are:[3]

> The *"**Route Map** assesses the current position of the offshore wind sector in Scotland and highlights the opportunities for further development of the sector in the form of scenarios for growth. It identifies the following key issues – infrastructure, supply chain, innovation, grid, offshore planning/consents, skills, finance and the international dimension – which will be vital in terms of realising the highest growth scenarios."* The Route Map will inform Scottish Government and ministers of possible economic outcomes of different levels of support offered to the offshore wind sector in Scotland.
>
> *"The role of the **Offshore Wind Industry Group** is to: provide a forum for the public sector (Scottish Government, Scottish Enterprise, Highlands and Islands Enterprise and Scottish Development International), offshore wind developers active in Scotland and other relevant parties to support the emergence of this new industry into Scotland, The role of the Group is to identify and take forward the actions necessary to support this industry in realising the fullest economic and environmental benefits for Scotland."*

1.2. Report Structure

This report presents the full findings of this study as follows:

- **Section 2** describes the status quo of the offshore wind industry in Scotland. We present current installed and planned capacity; a brief overview of the current status of the Scottish offshore wind supply chain; and an assessment of the

[3] Provided by Scottish Renewables

estimated spend to date in Scotland on offshore wind projects that are completed or in the pipeline;

- **Section 3** summarises the inputs and methodology for the quantitative analysis of offshore wind industry development in Scotland; and
- **Section 4** presents our results for GVA and employment effects for each of the scenarios and provides the qualitative analysis around these findings. We put the results for GVA and employment effects into the context of the Scottish economy. We further describe supply chain needs in the Scottish offshore wind industry in more detail and discuss the export market potential.

In addition,

- **Annex A** presents our methodology for the economic model used and more detailed descriptions of the input data;
- **Annex B** includes results tables for each scenario;
- **Annex C** presents the results of a back-casting session hosted by Scottish Renewables and the Scottish Government together with industry representatives to define key requirements in the Scottish offshore wind sector; and
- **Annex D** covers a number of good practice case studies in the Scottish offshore wind industry;
- **Annex E** summarises our consultation with project developers, turbine and tier 1 manufacturers. We describe potential barriers and suggest mitigation measures to achieving the full market potential for the Scottish offshore wind industry.

2. SCOTLAND'S OFFSHORE WIND INDUSTRY

This section introduces the Scottish offshore wind sector by outlining the overall capacity potential in Scotland, summarising the current status of the Scottish offshore wind supply chain and estimating how much investment has been made to date.

2.1. Offshore Wind Capacity

Scotland presently has two operational offshore wind sites, the Beatrice demonstrator project with two 5MW turbines and Robin Rigg with a total capacity of 180MW.

In addition to these sites, exclusivity rights were issued for ten sites with a total development capacity of 6.5GW in 2009. They are located within the 12 mile limit of Scottish Territorial Waters (STW). While developers carry out initial surveys under these exclusivity rights, Scottish Government is conducting a Strategic Environmental Assessment (SEA). The draft SEA was issued for consultation in May 2010. Developers are now awaiting the results of the appropriate assessment by the Government under the Habitats Regulations, which will determine which sites can be awarded leases.

Two further offshore wind sites were awarded under The Crown Estate's Round 3, with a total of 4.8GW development capacity. These sites will also be subject to the appropriate assessment.

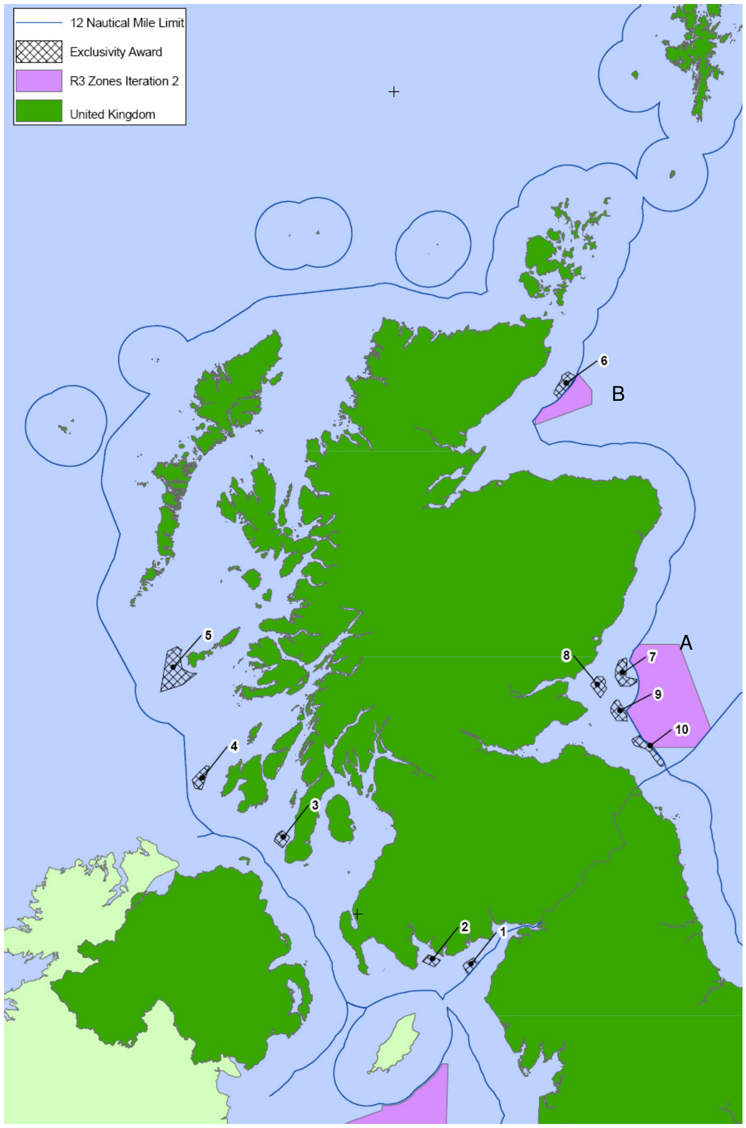
All sites around Scotland are listed in Table 1 and shown in Figure 2. They are at various early stages of development.

Table 1: Scottish Territorial Waters offshore wind farms exclusivity agreements awarded & Round 3 sites

Wind Farm	Estimated MW	Developer	Map reference
Solway Firth	300	E.ON	1
Wigtown Bay	280	DONG Energy	2
Kintyre	378	SSE Renewables	3
Islay	690	SSE Renewables	4
Argyll Array	1500	Scottish Power Renewables	5
Beatrice	920	SSE Renewables & SeaEnergy	6
Inch Cape	905	Npower & SeaEnergy	7
(Bell Rock)[4]	(700)	(SSE Renewables & Fluor)	(8)
Neart na Gaoithe	420	Mainstream	9
Forth Array	415	Fred Olsen	10
Firth of Forth	3,500	SSE Renewables and Fluor	A
Moray Firth	1,300	EDP Renováveis & SeaEnergy	B

[4] It was announced on 19th May 2010 that SSE Renewables and Fluor have made a decision not to take development of the Bell Rock offshore wind farm any further due to radar activity in the area. The future of the site was unclear at finalisation of this report.

Figure 2: Exclusivity agreements in Scottish Territorial Waters & Round 3 sites



In the Draft Plan for Offshore Wind Energy in Scottish Territorial Waters,[5] the Scottish Government proposes an additional 25 sites for development of offshore wind beyond 2020. Assuming that these sites will be around the average size of the current STW sites (approximately 650MW), a total of 16.3GW could be added.

[5] http://www.scotland.gov.uk/Publications/2010/05/14155221/0

2.2. Supply Chain Strengths and Opportunities

There is some existing capacity and capabilities in the Scottish supply chain for offshore wind. Furthermore, a lot of untapped potential exists for existing companies who are not yet active in offshore wind to move into the sector.

The main strengths of the Scottish supply chain include:

- Offshore engineering with expertise in construction, O&M, project management and training through Scotland's offshore oil & gas sector;
- Design and development services including consultancy, engineering and project development services;
- R&D expertise in the private sector, academia and public sector-funded programmes;
- Existing port facilities with North Sea access and the surrounding offshore service networks; and
- Some fabrication and manufacturing of components at various scales (in particular foundations).

Specific capabilities are further elaborated in Section 4.2 and export markets are covered in Section 4.3.

The gaps in the Scottish supply chain are also its main opportunities:

- ***Wind Turbine Manufacturers***

  Attracting a major wind turbine manufacturer to Scotland would represent a major achievement and opportunity for the Scottish supply chain. Various levels of manufacturing could be achieved, including the production of specific components, R&D and assembly, each with associated supply chains.

  Although it has proven difficult so far to attract major European wind turbine manufacturers to the UK, some recent announcements (such as Clipper Wind) provide evidence that the proposed offshore wind developments make the UK market attractive to major turbine and tier 1 manufacturers. Although there is a real possibility of attracting a major or emerging wind turbine manufacturer to Scotland, the opportunity may be time-sensitive and depend on developments and investment in Scotland and elsewhere in the UK.

- ***Large Engineering and Manufacturing Groups***

  A small but significant number of large international engineering groups are headquartered or located in Scotland where they also have retained design and manufacturing capabilities. They include companies such as Rolls Royce Marine, Doosan Babcock, Howden, the Wood Group and the Weir Group. These companies have the expertise and resources to play a significant role the offshore wind market. Several have already started developing capabilities in the sector.

- ***Offshore wind supply chain clusters***

  The existing concentration of offshore industries in and around Aberdeen means that this region already provides a hub of expertise for the offshore industry, with the potential to expand services to the offshore wind sector. Due to its established oil and gas industry, the area can particularly demonstrate a concentration of offshore construction capabilities, vessels and related services industries.

  Initiatives are ongoing in order to promote the creation or development of additional clusters, especially at Fife Energy Park. The National Renewable Infrastructure Plan (NRIP) specifies a number of port sites suited to serve the offshore wind sector.

We have produced a high-level description of a number of good practice case studies of key projects and companies which have played a significant role in the Scottish offshore wind sector to date. The full case studies are provided in Annex D to this report:

- Beatrice, Moray Firth;
- Robin Rigg, Solway Firth;
- Burntisland Fabrications (BiFab), Fife;
- Skykon Tower Ltd., Machrihanish;
- Subocean, Aberdeen; and
- SgurrEnergy, Glasgow.

Most of these companies may have a first mover advantage in the Scottish offshore wind industry as they are taking the risk to venture into a new but potentially highly rewarding market. From these key players and other UK experience, lessons can be learnt for the future development of the Scottish offshore wind sector.

2.3. Investment to Date

As part of the assessment, IPA was asked to provide an estimate of the investment to date in the Scottish offshore wind sector. Whilst it is possible to obtain some estimates of project Capex and Opex costs, estimating the value retained by the Scottish economy is not as straightforward.

Capex and Opex for Scotland's two operational offshore wind projects are as follows.

- The **Beatrice Demonstrator** project was estimated to cost £45m[6] and it is estimated that the Scottish economy retained around £16.2m in Capex.[7] The Opex spent between 2006 and 2010 was estimated to be £603,000/year.[8]

[6] Phone conversation with Scottish Development International on 11th May 2010

[7] IPA analysis: Snedden Economics (2005) forecasted Capex of £28.3m and retention of £10.2m in Scotland. The actual capital cost was £45m, so we have scaled the retained value accordingly.

- Original Capex estimates for the **Robin Rigg** project were quoted as £325m.[9] Overall retention of the capital spend in Scotland has been estimated by E.ON to be around 11%.[10] This would imply a value of around £36m spent in the Scottish economy throughout the development and construction. As Robin Rigg only became operational in spring 2010, no Opex figures have been released to date. The operational base for the project is in Cumbria rather than Scotland.

We therefore estimate that at least £52m in Capex has been retained in Scotland to date from the two existing projects.

In addition to investment on operational projects, it can be assumed that some investment has been made on the proposed STW and Round 3 sites. However, most project developers are only engaging in limited pre-scoping work while awaiting the outcome of the SEA. Some Scottish companies have also been engaged to work on projects elsewhere in the UK and Europe, bringing export value to Scotland.

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[8] Sneddon Economics, 2005. Economic impact of proposed Talisman offshore wind farm in the Beatrice oilfield.

[9] E.ON press release: http://pressreleases.eon-uk.com/blogs/eonukpressreleases/archive/2007/12/18/1159.aspx

[10] Indicative estimates provided by E.ON.

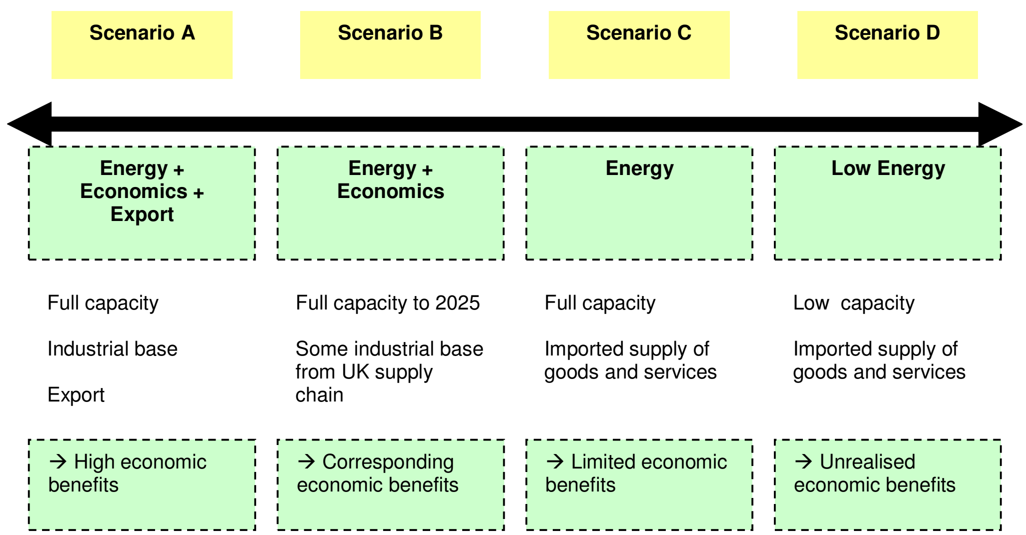
3. METHODOLOGY

This section presents the quantitative assessment of offshore wind industry development in Scotland. We define the scenarios and summarise our economic modelling approach. A more detailed description of the assumptions and results are presented in Annex A.

3.1. Scenarios

IPA was asked to assess four potential future scenarios for the Scottish offshore wind industry to 2020. Figure 3 below presents definitions of the four scenarios modelled.

Figure 3: Scenario definitions



Scenario A:	Scotland rapidly develops most of the proposed Scottish offshore wind sites by 2020. It builds global companies of scale that can capture a proportion of the investment in Scottish, UK and international waters.
Scenario B:	Scotland develops most of the proposed Scottish offshore wind sites by 2025. At the same time, it develops strong capabilities to supply the rest of the UK market. Corresponding economic benefits ensue as manufacture and installation resource is developed in Scotland.
Scenario C:	The proposed Scottish offshore wind sites are developed to 2020. However, much of the equipment and installation comes from outside Scotland, bringing limited economic benefits.
Scenario D:	Supply chain resources are drawn to near-shore sites in the rest of the UK and Europe first, leaving the bulk of Scottish sites undeveloped by 2020. Much of the equipment and installation resource is brought in from outside of Scotland and economic benefits are largely unrealised.

We have calculated Gross Value Added (GVA) and employment effects to 2020 for Scotland. GVA measures the difference between the value of goods and services produced (in this case the investment in offshore wind) and the cost of the materials and other inputs used in production, giving an understanding of the value of the offshore wind industry to the economy.

We have considered a number of potential export markets: Britain, Europe and the rest of the world. We have assumed different retention factors for each of these markets based on the current status of the Scottish offshore wind supply chain the potential for existing companies to move into the sector and new players relocating to Scotland.

3.2. Modelling Approach

We used a number of key inputs for the model. The constant inputs that do not change for the different scenarios are:

- Capacity forecast for Britain, Europe and the rest of the world to 2025 (excluding Scotland);
- Initial Capex and Opex;
- Learning rates; and
- Multipliers for GVA and employment.

The variables between each scenario are:

- Capacity forecast for Scotland; and
- Retention factors.

Each input is described in more detail below.

3.2.1. Capacity Forecast

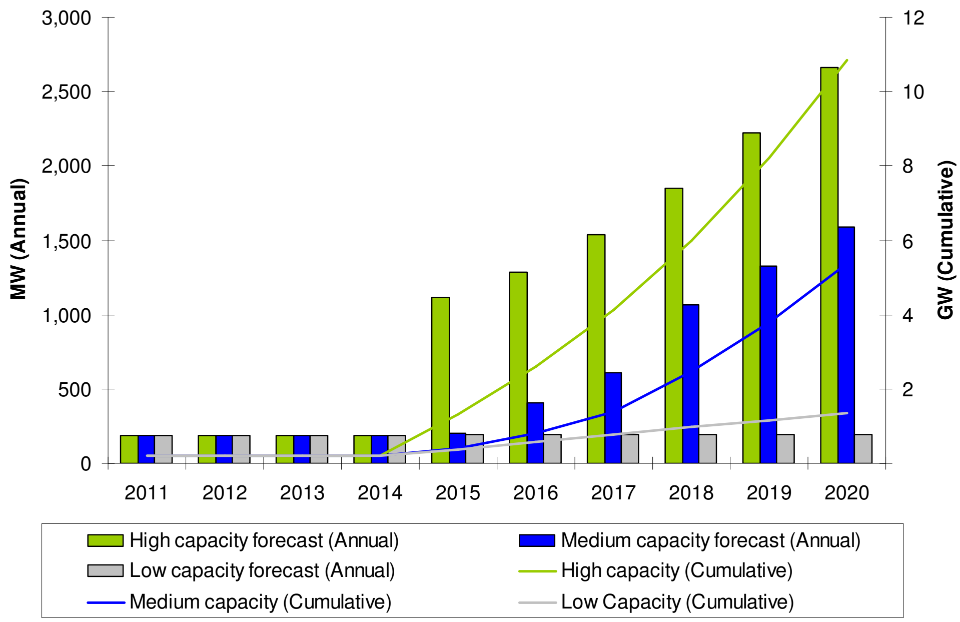
Our forecast for the amount of offshore wind developed by 2020 for each region is summarised in Table 2 below. We developed a high, medium and low case capacity forecast for Scotland. We used a single forecast for capacity for the rest of Britain, Europe and the world.

The three Scottish capacity forecasts are presented in Figure 4. The detailed forecasts are provided in Annex A.

- **High capacity forecast**: In Scenario A and Scenario C, all STW and Round 3 sites are developed by 2020. To maintain industry activity in construction and development, we have assumed that capacity will continue to grow beyond 2020. STW Round 2 sites are currently under discussion, and we have assumed that 25 sites would be tendered at an average size of the current STW sites and could be developed over 5 years to 2025, maintaining an annual installation rate of 2 to 3GW to 2025.
- **Medium capacity forecast**: In Scenario B, all STW and Round 3 sites are developed to 2025, with around half the capacity (5.4GW) operational in 2020.
- **Low capacity forecast**: In Scenario D, only around two sites would be installed by 2020, at an average size of all STW sites. The capacity forecast for 2025 is based on the assumption that the remaining STW Round 1 sites

would be developed post 2020 over a period of 10 years, with Round 3 sites not being developed.

Figure 4: High, medium and low annual and cumulative capacity forecasts for Scotland



Source: IPA

Table 2: Capacity forecast: Total installed capacity by 2020 (2025)

	Scenario A	Scenario B	Scenario C	Scenario D
Scotland	10.8GW (25.4GW)	5.4GW (10.8GW)	10.8GW (25.4GW)	1.4GW (3.7GW)
Rest of Britain	17.8GW (31.4GW)			
Rest of Europe	28.2GW (36.2GW)			
Rest of World	8.1GW (23.1GW)			

In the rest of the British market, we assumed that all Round 1, 2 and 3 sites would be developed by 2025. Projects that are currently under construction, have been approved or submitted planning application are assumed to be operational by 2015. All remaining sites will become operational between 2016 and 2025.

The 2020 forecast for the rest of Europe is based on the low case projected by the European Wind Energy Association (EWEA).[11] We assumed that EWEA's high case for 2020 of 35GW can be achieved a little later, by 2025.

[11] EWEA, The European offshore wind industry - key trends and statistics 2009, January 2010

The 2020 forecast for the rest of the world is based on the Carbon Trust's 2020 forecast[12] of 8GW. We recognise that China in particular has vast potential for offshore wind development because of its extremely shallow coastal waters. We have assumed that global activity will pick up speed post-2020, resulting in a total capacity forecast of 23GW in 2025.

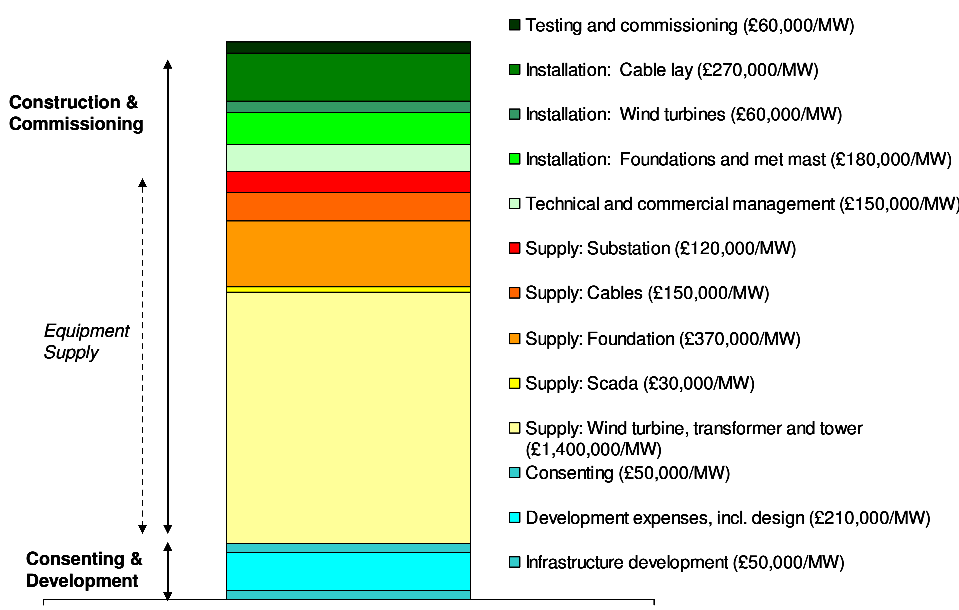
3.2.2. Capex and Opex

Capex and Opex do not change by scenario.

- An Opex of £80,000/MW/yr over the lifetime of an offshore wind farm has been assumed. Opex includes operations & maintenance and other costs (such as insurance premiums and decommissioning costs).
- The total Capex is assumed to be £3,100,000/MW. The supply chain components that make up this figure are presented in Figure 5.

Figures are in 2010 real terms and do not include assumptions on exchange rates. We applied learning rates to demonstrate how costs will reduce as more capacity is installed. The full learning rates have been applied with every doubling of installed capacity. On average, we have assumed a learning rate of 9%.

Figure 5: Capex (£/MW)



Source: IPA

[12] Carbon Trust, Offshore wind power: big challenge, big opportunity, October 2008

3.2.3. Multipliers

Factors were used to calculate employment and GVA effects of offshore wind industry development. These factors allow us to assess how much employment and GVA is created in an economy by investing a certain amount in one sector. We applied multipliers for employment creation and GVA in the component supply and development, installation and commissioning of an offshore wind farm. These factors are based on a CogentSI report for Scottish Enterprise[13] and are set out in detail in Annex A.

3.2.4. Retention Factors

Table 3: Average market retention

	Scenario A	Scenario B	Scenario C & Scenario D
Scotland	33%	33%	9%
Rest of Britain	18%	18%	0%
Rest of Europe	4%	0%	0%
Rest of World	1%	0%	0%

Retention factors have been applied for each component of the supply chain, showing how much of the Scottish, British, European and international markets can be accessed by a Scotland's industrial base. These are detailed in Annex A. The factors presented in Table 3 are the weighted averages of retention factors for each supply chain component.

To reflect the limited existing industrial base, we have assumed a base level of retention between 2011 and 2014 at the lower level of Scenario C and D for all scenarios. For Scenarios A and B, the retention increases in 2015, reaching the maximum level (as in Table 3) in 2016. This is designed to reflect the build up of capability in the coming years, as manufacturing and assembly facilities may take two to three years to construct.

[13] CogentSI, Scottish Energy Ready Reckoner, April 2010

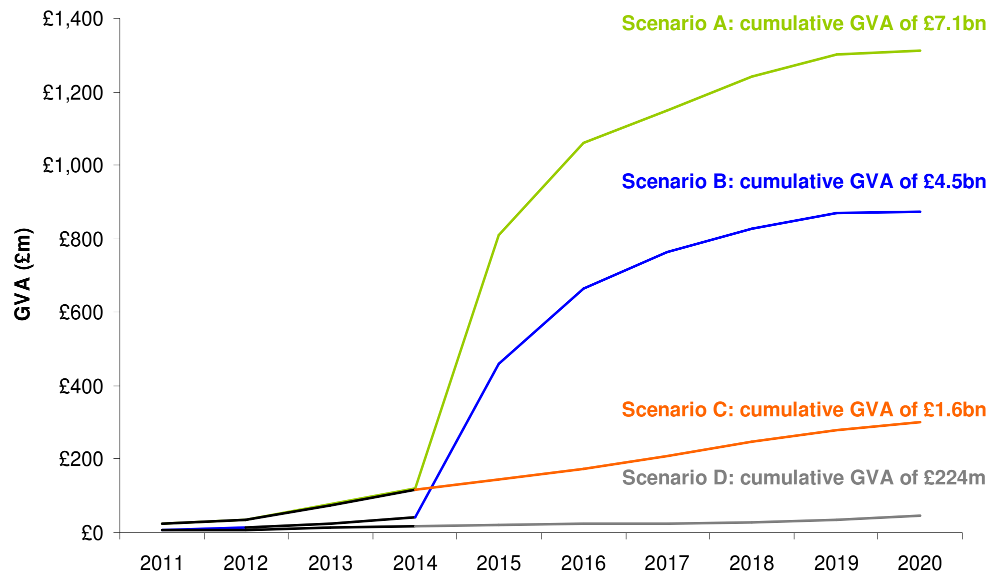
4. SCENARIO RESULTS AND ANALYSIS

This section presents the modelling results and puts them into context of the Scottish economy.

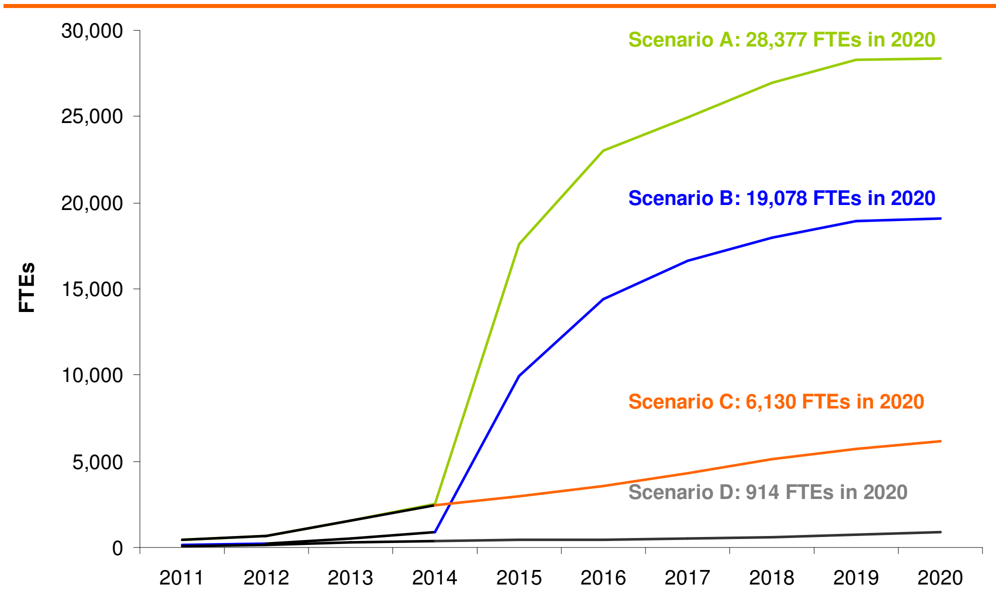
4.1. Value and Employment by Scenario

Figure 6 shows the number of full-time equivalent (FTE) jobs and GVA that will be created directly by the Scottish offshore wind industry under each of the four scenarios.

Figure 6: Direct GVA and FTEs



Source: IPA



Source: IPA

The differences in both GVA and employment between scenarios are determined by

- Total offshore wind capacity built in Scotland and the timing of development;
- Whether the Scottish offshore wind supply chain can supply its own market with the required equipment and services; and
- Whether the Scottish industrial base can compete successfully in the rest of the British, European and international markets.

Scenarios A and B would generate the highest economic benefit as a strong industrial base accompanies the rapid development of Scotland's offshore wind potential:

- **Scenario A** has very high offshore wind development and a highly developed supply chain. Under Scenario A, an additional 20,000 FTEs in 2020 and a cumulative £6bn of GVA could be generated through indirect and induced effects.
- **Scenario B** still provides significant benefit, a result of supplying the Scottish market as well as retaining around 18% of the rest of the British market. The benefit is reduced by slower capacity development. Under this scenario, an additional 13,000 FTEs and a cumulative £3.8bn of GVA could be generated through indirect and induced effects.

Consenting and development lead times for offshore wind capacity suggest that the first projects will become operational in 2014. It will take time to make the necessary structural changes in the Scottish economy (skills transfer, setting up manufacturing capacity, infrastructure development, etc.). A strong Government and industry push is needed now to have the necessary supply chain in place to meet domestic market demand in 2014/2015 and supply export markets.

Scenario C and D provide the lower benefit due to the lack of a Scottish industrial base for offshore wind. Offshore wind capacity development will be largely supplied by imported equipment and services:

- **Scenario C** is based on a high level of offshore wind development, without the development of an equivalent industrial base. Domestic economic impact remains low. An additional 5,000 FTEs and a cumulative £1.4bn of GVA could be generated through indirect and induced effects under this scenario.
- **Scenario D** does not see any relevant capacity uptake and all of the capacity that is built is being supplied by other markets, including the rest of Britain. In terms of indirect and induced effects, Scenario D could see an extra 730 FTEs and a cumulative £200m of GVA being created.

Economic benefits in both scenarios mainly arise from the comparatively low-value supply chain components of the consenting and development stage as well as some support in the construction and commissioning of the Scottish capacity. O&M provides some long-term income to the Scottish economy.

4.1.1. GVA in Context

In the year 2020, Scenario A would generate a direct GVA, i.e. the value added directly from the offshore wind industry, of around £1.3bn. This compares to a total direct GVA of £5.5bn from the Scottish energy sector in 2007.[14]

The supply chain component with the highest value is the turbine, which costs around £1.4m/MW. This is almost half of the total capital cost of 1MW of offshore wind capacity. While a large share of this cost is the raw materials, especially steel, the engineering and complex manufacturing process involved with the turbine generator also adds to the total cost.

The engineering and manufacturing of offshore wind turbines is where the main economic benefit lies. To capture these benefits, it is vital to attract an offshore wind turbine manufacturer to Scotland. Without the presence of a major turbine manufacturer who can supply at least 33% of Scotland's offshore wind capacity development and export to the rest of UK, Europe and internationally, the potential GVA of Scenario A would be reduced by about a third.

4.1.2. Employment in Context

In the year 2020, Scenario A would generate direct employment of around 28,000 FTEs. This compares to 41,900 direct FTEs in the Scottish energy sector in 2008.[15]

Installation and construction of capacity will offer high levels of employment in the short- to medium-term, depending on capacity development in Scottish Waters beyond 2020. In addition, component manufacturing and services will offer large employment opportunities. This potential can be prolonged way beyond commissioning of the last offshore wind turbines in Scottish Waters by developing an export base fit to supply the European and international markets. If there is still a strong European market, manufacturers may retain their bases in Scotland, turning towards increased export of components. A favourable economic climate (in particular exchange rates) will be an advantage.

Once the peak of offshore wind capacity development has passed,[16] employment focus will turn towards O&M of existing capacity. Major benefits for the Scottish economy in terms of long-term employment lie within the O&M sector. With full supply chain capabilities (skilled workforce, infrastructure, equipment and vessels), we assume that up to 100 jobs for each 500MW installed capacity could be available in 2020 in offshore wind O&M.

[14] Government figure which includes mining of coal; manufacture of coke, refined petroleum and nuclear fuel; electricity, gas, steam, and hot water supply; collection and purification and distribution of water; service activities incidental to oil and gas extraction
http://www.scotland.gov.uk/Publications/2010/03/22115357/2

[15] Figure includes all of the above (see footnote 14) plus extraction of crude petroleum and natural gas
http://www.scotland.gov.uk/Publications/2010/03/22115357/2

[16] No point in time has been defined within this report. The actual peak will depend on the level of capacity made available for development beyond 2020.

4.2. Supply Chain Needs

In order to achieve the most beneficial development scenario, Scenario A, and to exploit the full Scottish potential for offshore wind capacity and industry development, the Scottish supply chain requires a significant scale-up. Overall sector activity would need to increase in every stage of the supply chain to meet the full potential by 2020. This would mean a supply chain develops which resembles the automotive industry in its level of coordination and density and achieves economic significance to Scotland that is equivalent to the oil & gas sector.

Since we expect the first sites to become operational in 2014, major developments will need to take place before then to fill the current supply chain gaps and to enable Scotland to meet Scenario A. Table 4 presents a comparison between Scotland's current supply chain and the immediate industry requirements to 2015. The assessment is based on a number of sources and details of each can be found in Annex C, D and E:

- An industry consultation with project developers, turbine and tier 1 manufacturers;
- Details from Scottish good practice case studies; and
- A back-casting session held by Scottish Renewables in partnership with the Scottish Government and industry representatives in June 2010.

Table 4 provides a high-level assessment of the Scottish supply chain. The listed companies provide an indicative high-level overview of the main players that are currently shaping the Scottish offshore wind industry and Scottish-based companies that would have the skills and capabilities to contribute to the supply chain development for offshore wind.

Each assessed supply chain stage in Table 4 has been marked up as follows to visualise the current position of Scotland's offshore wind industry and its prospects:

⊗ indicates a gap or weakness in Scottish capability and capacity that requires significant development to meet the needs of Scenario A; and

⊘ indicates that relevant Scottish resource is available. However, further development may still be necessary and requires further investigation.

Table 4: Supply Chain Gap Analysis

Supply chain stages	High level assessment of Scottish industry resources (not exhaustive)	Immediate requirements to 2015
Infrastructure		
Port facilities with deep sea water access:	– First Phase sites in NRIP are Dundee, Leith, Peterhead, Hunterston, Nigg Yard, Energy Park Fife at Methil, Aberdeen, Arnish, Campbeltown, Ardersier, Kishorn	– Onshore and offshore **testing and demonstration sites** and encouraging coordination and collaboration between academia and private sector for R&D and innovation – Funding and installation of **MetMast** – **Manufacturing clusters:** At least two additional fabrication sites and facilities suitable for manufacture of cables, blades, towers, turbines, etc. with offshore access and access to assembly sites (as outlined in Phase 2 of NRIP) – Dedicated **installation hub** on the East coast – Creation of technology hubs for R&D and innovation (around or near testing and demonstration sites) – **Onshore grid capacity upgrade** – potentially establish guarantee mechanisms for grid access or set up suitable compensation mechanisms – **Offshore grid development** and clarification of the Offshore Transmission Owner (OFTO) regime – Major **offshore node** to be installed for R&D purposes
Grid:	– Insufficient grid capacity at present to support full capacity development – Beauly-Denny is first step for onshore grid reinforcement	

<table>
<tr><th>Supply chain stages</th><th>High level assessment of Scottish industry resources (not exhaustive)</th><th>Immediate requirements to 2015</th></tr>
<tr><td colspan="3">Project consenting and development, incl. design</td></tr>
<tr><td>Scottish utility project developers:</td><td>– SSE Renewables
– Scottish Power Renewables</td><td rowspan="5">– Finalisation of SEA by Government
– Encourage industry collaboration
– Set up public database of site assessments to facilitate data sharing
– 9 month turnaround for consenting
– Local authority buy-in and increasing public awareness of the industry potential and employment opportunities to generate positive public attitude
– Commitment to further projects: Round 4 and STW “Round 2”</td></tr>
<tr><td>Scottish independent project developers:</td><td>– SeaEnergy Renewables
– Mainstream Renewables have a Scottish base</td></tr>
<tr><td>Surveys:</td><td>– Various Scottish-based lead contractors with experience in offshore wind are AECOM, Environmental Resources Management, Natural Power, Noble Denton, Mott Macdonald, PMSS, Royal Haskoning, Metoc, Fraser Nash and RPS
– Other smaller, specialist companies and freelance consultants with key skills in EIA available
– Vessels suppliers for environmental surveys with a presence in Scotland include Fugro and APEM</td></tr>
<tr><td>Engineering services:</td><td>– Scottish front end engineering and design (FEED) services include Noble Denton, ODE, RES and Sgurr Energy</td></tr>
<tr><td>Support services:</td><td>– Diving services through e.g. C. D. Campbell Marine Contracts, Shearwater Marine, North West Marine (including vessel supply)</td></tr>
</table>

Supply chain stages	High level assessment of Scottish industry resources (not exhaustive)	Immediate requirements to 2015
Technical & Commercial management		
Project management:	– Project management for Beatrice and Robin Rigg were both outsourced to AMEC and ODE respectively. Both have a Scottish base.	– Standardisation of **contracts** – Streamlined **procurement** of services and supply contracts – Standardised **health & safety** procedures to be put in place – Training and transfer of **skills** (conversion courses, mid-career transfers)
Logistics:	– Few Scottish-based dedicated offshore wind industry players – Oil & gas sector capability is transferrable.	
Component supply		
Foundations:	– BiFab	– Funding for companies intending to **develop or expand manufacturing capacities** to the offshore wind sector, including expansion of manufacturing capacity of **oil and gas** sector focused companies to include offshore wind – Major **turbine manufacturer** – **Blade manufacturer** – **Cable manufacturer** – **Certification schemes** with minimum industry standards to be put in place – Channel capacity of tier 2 and 3 companies into offshore wind market – **Supply chain coordinator** in place for Scotland – **Major contracts** are signed that encourage confidence in the supply chain – **Standard contracts**
Towers:	– Skykon tower manufacturing	
Turbines:	– REPower have sales offices	
Cables:	– JDR Cable Systems have sales offices – Global Marine Systems have offices in Scotland	
Power converters:	– Converteam have some production capacity and testing facilities	
Gearboxes:	– Converteam have some production capacity and testing facilities	

Supply chain stages	High level assessment of Scottish industry resources (not exhaustive)	Immediate requirements to 2015
Transformers:	– SDC Industries	–
Steel structures:	– No Scottish-based dedicated offshore wind players, except BiFab's fabrication facilities, but oil & gas sector capability could be made available – Wide range of smaller tier 2 and 3 manufacturers for steel forging and fabrication of smaller components – Some remaining ship building infrastructure	
Offshore installation, testing & commissioning		
Vessels:	– Most Scottish services are rather small scale, able to provide support services requiring tugs, barges, anchor handling, personnel transport, diver support etc, e.g. Argyll work boats and Inverlussa	– Adaptation of existing **vessels** or construction of new vessels for offshore wind industry needs – **Expansion of installation services** of various oil and gas sector focused companies to include offshore wind – Training and transfer of **skills** (conversion courses, mid-career transfers) and resources from the oil & gas and other relevant sectors
Construction, installation and assembly	– Dawson Energy (installation and cabling, worked on offshore wind in UK and Denmark) – CTC Marine Projects – Isleburn (worked on Beatrice project)	
Shipbuilding:	– StormCats is Scotland's largest GRP (glass-reinforced plastic) boat building company	
Cable laying:	– Subocean Group – Global Marine Systems	
Other support services:	– Various marine support services around port sites	

Supply chain stages	High level assessment of Scottish industry resources (not exhaustive)	Immediate requirements to 2015
Operation & Maintenance		
Service providers for maintenance and inspection:	– Various existing marine support services as outlined above who can also move into O&M by contracting with turbine manufacturers (during warranty period) or project developers (after warranty period)	– Specialist **O&M hub** – Training and transfer of **skills** (conversion courses, mid-career transfers) – Expansion of **O&M services** of various oil and gas sector focused companies to include offshore wind – Most action needed post 2015, facilitate local company **development for the long-term** – Introduce opportunities for local service suppliers to **contract with turbine manufacturers**
Vessels:	– Most Scottish services are rather small scale, incl. surveying and diving support services – O&M tends to require catamarans of between 15-20 metres with capacity for up to twelve technicians. There are boat builders that can produce this scale of boat in Scotland, e.g. StormCats	

Coordination of the various players is an important factor across the whole supply chain. Without a central coordinator who can bring together turbine and tier 1 manufacturers and other component suppliers, project developers may struggle to access the Scottish industry. They may instead turn to the rest of the UK, European or international offshore wind industry to source equipment and services. While some coordination is already taking place through the initiative of various public sector bodies, there could be scope for formalising existing activities by setting up a dedicated offshore wind supply chain coordinator.

To sustain the benefits of supply chain development, Scottish companies will need to develop the necessary in-house skills and capabilities to meet the demands of the offshore wind industry. However, this investment will depend on the extent to which long-term orders can be secured. Supply chain coordination, standardisation of procurement processes and facilitation of business contacts across the supply chain, backed up by a strong political message and long-term Government agenda for offshore wind, can help improve confidence in the industry.

A number of key external factors will further determine the success or failure of supply chain development in Scotland:

- the general economic climate and speed of economic recovery in Scotland, the rest of UK and globally;
- the investment climate in Scotland including domestic funding from both the private and public sectors and inward investment including joint ventures and investment by overseas companies;[17]
- changes in the legal and regulatory environment for offshore wind energy;
- the price and outlook for Renewable Obligation Certificates (ROCs) or the development of a feed in tariff for large-scale renewable energy; and
- Scottish and UK government commitment to offshore wind energy, demonstrated through financial and political support.

While some of these aspects are beyond the direct influence of the Scottish industry, much can still be done in terms of lobbying and industry representations to progress most of these points and create a favourable climate for supply chain development.

4.3. Export Potential

The EWEA[18] proposes a target of 40 GW installed capacity from offshore wind power by 2020 for the EU and considers that 12.8% of total electricity demand could be met by EU offshore wind energy production. The EWEA further estimates that 150GW of offshore wind energy could be installed in the EU by 2030.

[17] Investment by overseas companies and joint ventures will also depend on the degree of commitment to investment in Scotland as well as the sharing of intellectual property and technical knowledge which will have medium to long term impacts on GVA and employment retention in the country.

[18] EWEA (2009), Oceans of Opportunity.

The development of the export potential in the Scottish offshore wind power sector will depend on economic growth in current and export markets as well as indigenous and inward investment in the Scottish industry. Within our analysis, the export potential of offshore wind energy development in Scotland ranges from a high export potential (Scenario A) – which sees Scotland's offshore wind industry develop and expand its capacity beyond meeting its own needs – to virtually no exports (Scenario D) – where Scotland imports the vast majority of equipment and services to supply a low level of capacity development.

Under Scenario A, Scotland could cover the following exports to the rest of UK, Europe and international offshore wind markets:

- **Machinery and equipment**: This would be the export area with the highest value to Scotland's economy. Scotland already has a strong capability in foundations and manufactures some offshore wind components (towers and subsea cables). However, expanding the export potential for machinery and equipment will depend on whether a turbine manufacturer can be attracted to Scotland and build a local supply chain.
- **Offshore engineering skills**: Scotland's four decades of experience in the offshore oil & gas sector leaves it with extensive expertise in offshore engineering skills, including installation at sea and O&M, which can be transferred into the offshore wind sector and also be exported to serve other markets. This may initially be confined to the North Sea but other markets may also want to draw upon Scotland's expertise. O&M in particular can provide a long-term market opportunity.
- **Offshore construction skills in marine waters**: Similarly, Scotland's offshore hubs are experienced in the management and logistics of offshore construction, all of which can be applied to the offshore wind sector with some adaptation. Export beyond the North Sea market can focus on knowledge and skills which are not physically and logistically tied to a location.
- **R&D expertise**: there is an existing R&D base and widespread activity across Scotland's private sector, universities and public sector research organisations in the area of offshore wind. These skills and knowledge can be applied in other markets through cooperative R&D initiatives. Potential testing and other R&D facilities could attract companies from abroad to Scotland to research new prototypes.
- **Technical consultancy**: Skills developed in Scotland through the experience of developing the Scottish offshore wind sector could be in high demand in other offshore wind markets.

The successful exports of Scottish equipment and services is obviously determined by the uptake of offshore wind capacity in other markets, in particular in the rest of UK and Europe – the two main potential target markets for Scotland. Development in these markets will depend on:

- the targets for and policy towards offshore wind energy;
- the costs of alternative energy sources;
- pricing policy for renewable energy, and market barriers where renewable energy competes with conventional sources;

- the legal and regulatory environment;
- the development of grid integration within the European power market as well as grid capacity development to account for intermittent renewable generation; and
- environmental requirements, public perception and planning practice.

In addition, Scenario A would further depend on a number of general factors, such as:

- foreign exchange rates between sterling and other currencies, notably the Euro and US Dollar;
- the price and quality competitiveness of Scottish machinery, equipment and services, including management, financial, legal, insurance and other services; and
- competition from existing and emerging international suppliers of goods, services and technology for the offshore wind sector.

ANNEX A – ASSUMPTIONS

This annex provides the detailed inputs that are described in Section 3. The variable inputs are:

- High, medium and low capacity forecasts to 2025 (plus installed capacity in 2010 and the expected delivery timescales); and
- Retention factors for all scenarios.

Constant inputs (i.e. inputs that do not vary across the scenarios) are:

- Capex and Opex (these have been set out in Section 3);
- Learning rates; and
- Employment and GVA multipliers.

Capacity Forecast

Assumed installed capacity to date is based on the status of commissioned offshore wind farms in all four areas: Scotland and rest of GB, Europe and the world. They are summarised in Table 5 below.

Table 5: Installed capacity in May 2010

Scotland	Rest of GB	Rest of Europe	Rest of World
190	851	1,173	102

To allow economic benefits throughout the project lifecycle to be analysed, we have assumed timescales for consenting and construction. Table 6 presents the delivery timescales we have assumed across all regions. These are based on Carbon Trust figures[19] and consultation with key industry participants. Wider discussions with developers suggest that these timescales are optimistic but achievable.

Table 6: Delivery timescales in years

Consenting & Development	3
Construction & Commissioning	2

IPA's capacity forecasts for all four regions are summarised in Table 7 for Scenarios A and C, Table 8 for Scenario B and Table 9 for Scenario D.

The forecast is for total installed capacity and includes existing capacity.

[19] Carbon Trust, Offshore Wind Power: Big Challenge, Big Opportunity

Table 7: Capacity forecast for Scenarios A and C

Capacity (GW)	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Scotland	0.2	0.2	0.2	0.2	1.3	2.6	4.1	6.0	8.2	10.8	13.8	16.7	19.6	22.5	25.4
Rest of GB	1.6	2.3	3.7	6.2	7.4	9.1	11.0	13.1	15.4	17.8	20.3	22.9	25.6	28.4	31.4
Rest of Europe	3.9	6.6	9.3	12.0	14.7	17.4	20.1	22.8	25.5	28.2	29.8	31.4	33.0	34.6	36.2
Rest of World	0.1	0.1	1.1	2.1	3.1	4.1	5.1	6.1	7.1	8.1	11.1	14.1	17.1	20.1	23.1

Table 8: Capacity forecast for Scenario B

Capacity (GW)	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Scotland	0.2	0.2	0.2	0.2	0.4	0.8	1.4	2.5	3.8	5.4	7.3	9.2	10.5	10.8	10.8
Rest of GB	1.6	2.3	3.7	6.2	7.4	9.1	11.0	13.1	15.4	17.8	20.3	22.9	25.6	28.4	31.4
Rest of Europe	3.9	6.6	9.3	12.0	14.7	17.4	20.1	22.8	25.5	28.2	29.8	31.4	33.0	34.6	36.2
Rest of World	0.1	0.1	1.1	2.1	3.1	4.1	5.1	6.1	7.1	8.1	11.1	14.1	17.1	20.1	23.1

Table 9: Capacity forecast for Scenario D

Capacity (GW)	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Scotland	0.2	0.2	0.2	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.8	2.3	2.7	3.2	3.7
Rest of GB	1.6	2.3	3.7	6.2	7.4	9.1	11.0	13.1	15.4	17.8	20.3	22.9	25.6	28.4	31.4
Rest of Europe	3.9	6.6	9.3	12.0	14.7	17.4	20.1	22.8	25.5	28.2	29.8	31.4	33.0	34.6	36.2
Rest of World	0.1	0.1	1.1	2.1	3.1	4.1	5.1	6.1	7.1	8.1	11.1	14.1	17.1	20.1	23.1

Retention Factors

Retention factors can be thought of as Scotland's market share. They demonstrate how much of each supply chain component in the Scottish offshore wind market and export markets[20] is retained in the Scottish economy. We have used different levels of retention for each scenario based on the assumed level of supply chain development.

Retention under Scenario A

Table 10 presents the retention factors for Scenario A.

Table 10: Retention factors for Scenario A

	Scotland	RoGB	RoEur	RoW
Infrastructure development	50%	20%	2.5%	1%
Development expenses, incl. design	50%	20%	2.5%	0.5%
Consenting	50%	20%	5%	0.5%
Technical & Commercial management	30%	10%	2.5%	0.5%
Supply: Turbines, transformers & towers	30%	15%	2.5%	0.3%
Supply: Scada	5%	2.5%	1.5%	0.3%
Supply: Foundations	50%	40%	10%	5%
Supply: Cables	30%	10%	1.5%	0.3%
Supply: Substations	20%	5%	1.5%	0.3%
Installation: Foundations & MetMast	40%	30%	10%	5%
Installation: Wind turbines	30%	15%	2.5%	0.3%
Installation: Cable lay	15%	10%	1.5%	0.3%
Testing & Commissioning	20%	10%	2.5%	0.3%
Operation & Maintenance	60%	20%	2.5%	0.5%
Other costs	25%	0%	0%	0%
Weighted average retention				
Consenting & Development	50.0%	20.0%	2.9%	0.6%
Construction & Commissioning	30.9%	17.6%	3.8%	1.2%
Operational	44.7%	11.3%	1.4%	0.3%

Retention under Scenario B

Table 11 presents the retention factors for Scenario B.

Table 11: Retention factors for Scenario B

	Scotland	RoGB	RoEur	RoW
Infrastructure development	50%	20%	0%	0%
Development expenses, incl. design	50%	20%	0%	0%
Consenting	50%	20%	0%	0%
Technical & Commercial management	30%	10%	0%	0%
Supply: Turbines, transformers & towers	30%	15%	0%	0%

[20] Export markets are Rest of Great Britain (RoGB), Rest of Europe (RoEur), and Rest of World (RoW).

Table 11: Retention factors for Scenario B

	Scotland	RoGB	RoEur	RoW
Supply: Scada	5%	2.5%	0%	0%
Supply: Foundations	50%	40%	0%	0%
Supply: Cables	30%	10%	0%	0%
Supply: Substations	20%	5%	0%	0%
Installation: Foundations & MetMast	40%	30%	0%	0%
Installation: Wind turbines	30%	15%	0%	0%
Installation: Cable lay	15%	10%	0%	0%
Testing & Commissioning	20%	10%	0%	0%
Operation & Maintenance	60%	20%	0%	0%
Other costs	25%	0%	0%	0%
Weighted average retention				
Consenting & Development	50.0%	20.0%	0%	0%
Construction & Commissioning	30.9%	17.6%	0%	0%
Operational	44.7%	11.3%	0%	0%

Retention under Scenario C and D

Table 12 presents the retention factors for Scenarios C and D.

Table 12: Retention factors for Scenarios C and D

	Scotland	RoGB	RoEur	RoW
Infrastructure development	20%	0%	0%	0%
Development expenses, incl. design	20%	0%	0%	0%
Consenting	20%	0%	0%	0%
Technical & Commercial management	20%	0%	0%	0%
Supply: Turbines, transformers & towers	0%	0%	0%	0%
Supply: Scada	5%	0%	0%	0%
Supply: Foundations	20%	0%	0%	0%
Supply: Cables	0%	0%	0%	0%
Supply: Substations	10%	0%	0%	0%
Installation: Foundations & MetMast	20%	0%	0%	0%
Installation: Wind turbines	10%	0%	0%	0%
Installation: Cable lay	5%	0%	0%	0%
Testing & Commissioning	20%	0%	0%	0%
Operation & Maintenance	20%	0%	0%	0%
Other costs	50%	0%	0%	0%
Weighted average retention				
Consenting & Development	20.0%	0%	0%	0%
Construction & Commissioning	6.6%	0%	0%	0%
Operational	33.1%	0%	0%	0%

Learning Rates

Full learning rates apply with every doubling of capacity to demonstrate a reduction in costs through learning overtime and potential economies of scale. Table 13 presents the learning rates applied to Capex and Opex across all regions. These figures were based on work published by the Carbon Trust,[21] industry consultation and IPA assessment.

Table 13: Learning rates

Infrastructure development	2%
Development expenses, incl. design	10%
Consenting	10%
Technical & Commercial management	5%
Supply: Turbines, transformers & towers	10%
Supply: Scada	5%
Supply: Foundations	5%
Supply: Cables	5%
Supply: Substations	5%
Installation: Foundations & MetMast	10%
Installation: Wind turbines	10%
Installation: Cable lay	10%
Testing & Commissioning	10%
Operation & Maintenance	10%
Weighted average learning rate	9%

GVA and Employment Calculations

Multipliers for GVA and employment are applied to the total value created by an offshore wind industry to demonstrate how much GVA and employment is actually created by activity in one region. The multipliers and factors used in our analysis are based on a report by CogentSI[22].

CogentSI have taken their multipliers from the DREAM Detailed Regional Economic Accounting Model. These differ from the multipliers calculated for the Scottish Government Input-Output Tables (2004) as they are updated to 2007 and take into account self-employment.

Multipliers for GVA and employment include both indirect and induced benefits. We have assumed the same multipliers across all regions. All factors for direct, indirect and induced employment and direct, indirect and induced GVA are presented in Table 14.

Note that CogentSI bases its calculation of direct GVA on factor relating Capex and GVA. Similarly, direct employment is calculated based on a factor relating GVA to employment (the average cost of one full-time employee).

[21] Carbon Trust, Offshore Wind Power: Big Challenge, Big Opportunity, p.34

[22] CogentSI, Energy Ready Reckoner, Draft Report

Table 14: Multipliers and factors

Direct GVA factor (Capex/GVA)	**All regions**
Infrastructure development	2.27
Development expenses, incl. design	2.27
Consenting	2.27
Technical & Commercial management	2.27
Supply: Turbines, transformers & towers	2.54
Supply: Scada	2.54
Supply: Foundations	2.54
Supply: Cables	2.54
Supply: Substations	2.54
Installation: Foundations & MetMast	2.54
Installation: Wind turbines	2.54
Installation: Cable lay	2.54
Testing & Commissioning	2.27
Operation & Maintenance	2.27
Other costs	2.27
Indirect & induced GVA multiplier	
Infrastructure development	1.95
Development expenses, incl. design	1.95
Consenting	1.95
Technical & Commercial management	1.95
Supply: Turbines, transformers & towers	1.80
Supply: Scada	1.80
Supply: Foundations	1.80
Supply: Cables	1.80
Supply: Substations	1.80
Installation: Foundations & MetMast	1.80
Installation: Wind turbines	1.80
Installation: Cable lay	1.80
Testing & Commissioning	1.95
Operation & Maintenance	1.95
Other costs	1.95
Direct employment factor (GVA/employment)	
Infrastructure development	£52,000
Development expenses, incl. design	£52,000
Consenting	£52,000
Technical & Commercial management	£52,000
Supply: Turbines, transformers & towers	£44,000
Supply: Scada	£44,000
Supply: Foundations	£44,000
Supply: Cables	£44,000
Supply: Substations	£44,000
Installation: Foundations & MetMast	£44,000
Installation: Wind turbines	£44,000
Installation: Cable lay	£44,000
Testing & Commissioning	£52,000
Operation & Maintenance	£52,000
Other costs	£52,000
Indirect & induced employment multiplier	
Infrastructure development	1.93
Development expenses, incl. design	1.93
Consenting	1.93
Technical & Commercial management	1.93
Supply: Turbines, transformers & towers	1.63
Supply: Scada	1.63
Supply: Foundations	1.63
Supply: Cables	1.63
Supply: Substations	1.63
Installation: Foundations & MetMast	1.63
Installation: Wind turbines	1.63
Installation: Cable lay	1.63
Testing & Commissioning	1.93
Operation & Maintenance	1.93
Other costs	1.93

ANNEX B – RESULTS TABLES

Table 15: Results for GVA and employment under Scenario A

		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Operational capacity in Scotland 2011-2020	GW	0.2	0.2	0.2	0.2	1.3	2.6	4.1	6.0	8.2	10.8
Gross Value Added (GVA)											
Direct GVA retained for Scotland	£m	£24	£36	£76	£120	£439	£591	£672	£758	£822	£838
Direct GVA retained for rest of GB	£m	£0	£0	£0	£0	£279	£361	£372	£384	£390	£391
Direct GVA retained for rest of Europe	£m	£0	£0	£0	£0	£82	£97	£93	£88	£70	£53
Direct GVA retained for rest of world	£m	£0	£0	£0	£0	£09	£12	£12	£11	£20	£28
Total direct GVA retained in Scotland	**£m**	**£24**	**£36**	**£76**	**£120**	**£810**	**£1,060**	**£1,149**	**£1,242**	**£1,302**	**£1,310**
Total indirect & induced GVA retained in Scotland	**£m**	**£23**	**£34**	**£68**	**£106**	**£682**	**£893**	**£969**	**£1,047**	**£1,098**	**£1,108**
Total GVA retained in Scotland	**£m**	**£47**	**£69**	**£145**	**£226**	**£1,492**	**£1,954**	**£2,117**	**£2,288**	**£2,401**	**£2,418**
Employment											
Direct employment retained for Scotland	FTEs	463	684	1,569	2,513	9,464	12,745	14,509	16,385	17,767	18,056
Direct employment retained for rest of GB	FTEs	0	0	0	0	6,121	7,893	8,141	8,392	8,522	8,533
Direct employment retained for rest of Europe	FTEs	0	0	0	0	1,812	2,151	2,047	1,950	1,538	1,159
Direct employment retained for rest of world	FTEs	0	0	0	0	207	257	255	252	449	629
Total direct FTEs retained in Scotland	**FTEs**	**463**	**684**	**1,569**	**2,513**	**17,604**	**23,045**	**24,950**	**26,978**	**28,276**	**28,377**
Total indirect & induced FTEs retained in Scotland	**FTEs**	**431**	**636**	**1,267**	**1,946**	**12,416**	**16,256**	**17,625**	**19,046**	**19,991**	**20,177**
Total FTEs retained in Scotland	**FTEs**	**894**	**1,320**	**2,836**	**4,459**	**30,020**	**39,301**	**42,576**	**46,024**	**48,266**	**48,554**

Table 16: Results for GVA and employment under Scenario B

		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Operational capacity in Scotland 2011-2020	GW	0.2	0.2	0.2	0.2	0.4	0.8	1.4	2.5	3.8	5.4
Gross Value Added (GVA)											
Direct GVA retained for Scotland	£m	£08	£12	£25	£44	£181	£302	£391	£442	£476	£479
Direct GVA retained for rest of GB	£m	£0	£0	£0	£0	£280	£362	£374	£385	£392	£393
Direct GVA retained for rest of Europe	£m	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0
Direct GVA retained for rest of world	£m	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0
Total direct GVA retained in Scotland	**£m**	**£08**	**£12**	**£25**	**£44**	**£461**	**£664**	**£765**	**£827**	**£868**	**£872**
Total indirect & induced GVA retained in Scotland	**£m**	**£07**	**£12**	**£23**	**£39**	**£390**	**£560**	**£644**	**£696**	**£728**	**£730**
Total GVA retained in Scotland	**£m**	**£15**	**£24**	**£48**	**£83**	**£851**	**£1,224**	**£1,409**	**£1,523**	**£1,595**	**£1,602**
Employment											
Direct employment retained for Scotland	FTEs	149	239	503	889	3,839	6,493	8,448	9,575	10,395	10,506
Direct employment retained for rest of GB	FTEs	0	0	0	0	6,133	7,916	8,171	8,425	8,558	8,572
Direct employment retained for rest of Europe	FTEs	0	0	0	0	0	0	0	0	0	0
Direct employment retained for rest of world	FTEs	0	0	0	0	0	0	0	0	0	0
Total direct FTEs retained in Scotland	**FTEs**	**149**	**239**	**503**	**889**	**9,972**	**14,409**	**16,619**	**18,000**	**18,954**	**19,078**
Total indirect & induced FTEs retained in Scotland	**FTEs**	**138**	**222**	**433**	**728**	**7,105**	**10,198**	**11,719**	**12,652**	**13,216**	**13,248**
Total FTEs retained in Scotland	**FTEs**	**287**	**461**	**936**	**1,617**	**17,076**	**24,607**	**28,338**	**30,652**	**32,169**	**32,327**

Table 17: Results for GVA and employment under Scenario C

		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Operational capacity in Scotland 2011-2020	GW	0.2	0.2	0.2	0.2	1.3	2.5	4.0	5.8	8.0	10.8
Gross Value Added (GVA)											
Direct GVA retained for Scotland	£m	£24	£35	£75	£117	£144	£174	£207	£247	£279	£299
Direct GVA retained for rest of GB	£m	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0
Direct GVA retained for rest of Europe	£m	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0
Direct GVA retained for rest of world	£m	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0
Total direct GVA retained in Scotland	**£m**	**£24**	**£35**	**£75**	**£117**	**£144**	**£174**	**£207**	**£247**	**£279**	**£299**
Total indirect & induced GVA retained in Scotland	**£m**	**£22**	**£33**	**£67**	**£103**	**£128**	**£155**	**£184**	**£219**	**£248**	**£268**
Total GVA retained in Scotland	**£m**	**£46**	**£67**	**£142**	**£220**	**£272**	**£329**	**£391**	**£466**	**£527**	**£567**
Employment											
Direct employment retained for Scotland	FTEs	453	664	1,538	2,450	2,988	3,597	4,273	5,104	5,750	6,130
Direct employment retained for rest of GB	FTEs	0	0	0	0	0	0	0	0	0	0
Direct employment retained for rest of Europe	FTEs	0	0	0	0	0	0	0	0	0	0
Direct employment retained for rest of world	FTEs	0	0	0	0	0	0	0	0	0	0
Total direct FTEs retained in Scotland	**FTEs**	**453**	**664**	**1,538**	**2,450**	**2,988**	**3,597**	**4,273**	**5,104**	**5,750**	**6,130**
Total indirect & induced FTEs retained in Scotland	**FTEs**	**422**	**617**	**1,239**	**1,896**	**2,357**	**2,861**	**3,406**	**4,052**	**4,586**	**4,962**
Total FTEs retained in Scotland	**FTEs**	**875**	**1,281**	**2,777**	**4,345**	**5,346**	**6,458**	**7,680**	**9,156**	**10,336**	**11,092**

Table 18: Results for GVA and Employment under Scenario D

		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Operational capacity in Scotland 2011-2020	GW	0.2	0.2	0.2	0.2	0.4	0.6	0.8	1.0	1.2	1.4
Gross Value Added (GVA)											
Direct GVA retained for Scotland	£m	£06	£07	£13	£19	£20	£23	£26	£29	£37	£44
Direct GVA retained for Rest of GB	£m	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0
Direct GVA retained for Rest of Europe	£m	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0
Direct GVA retained for Rest of World	£m	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0
Total Direct GVA retained in Scotland	**£m**	**£06**	**£07**	**£13**	**£19**	**£20**	**£23**	**£26**	**£29**	**£37**	**£44**
Total Indirect & Induced GVA retained in Scotland	**£m**	**£05**	**£07**	**£12**	**£16**	**£18**	**£21**	**£23**	**£26**	**£33**	**£40**
Total GVA retained in Scotland	**£m**	**£11**	**£14**	**£25**	**£35**	**£38**	**£44**	**£49**	**£55**	**£70**	**£84**
Employment											
Direct employment retained for Scotland	FTEs	110	136	270	392	416	473	528	579	752	914
Direct employment retained for Rest of GB	FTEs	0	0	0	0	0	0	0	0	0	0
Direct employment retained for Rest of Europe	FTEs	0	0	0	0	0	0	0	0	0	0
Direct employment retained for Rest of World	FTEs	0	0	0	0	0	0	0	0	0	0
Total Direct FTEs retained in Scotland	**FTEs**	**110**	**136**	**270**	**392**	**416**	**473**	**528**	**579**	**752**	**914**
Total Indirect & Induced FTEs retained in Scotland	**FTEs**	**103**	**127**	**218**	**302**	**326**	**382**	**435**	**485**	**612**	**731**
Total FTEs retained in Scotland	**FTEs**	**213**	**263**	**489**	**694**	**741**	**856**	**963**	**1,064**	**1,364**	**1,644**

ANNEX C – SCOTTISH GOOD PRACTICE

This annex presents an overview of the two completed Scottish offshore wind projects and a number of case studies to give an indication of existing "good practice" in the Scottish offshore wind sector.

Beatrice, Moray Firth

Background

The Beatrice Wind Farm Demonstrator Project installed two 5MW wind turbines adjacent to the Beatrice oil field, 25 km off the east coast of Scotland, at a cost of £45m. At a water depths of up to 45m, the project became the first deep-water offshore wind installation.

The Beatrice demonstrator was part of the DOWNVInD (Distant Offshore Windfarms with No Visual Impact in Deepwater) Project, a consortium of 17 organisations. The consortium included some key European players in the global offshore wind sector and was led by Talisman Energy partnered with Scottish and Southern Energy (SSE).

Supply Chain

AMEC (UK) was contracted by Talisman and SSE as project managers.

The following manufacturing contracts were awarded:

- REpower (Germany) – turbines
- Burntisland Fabrications (Scotland) – foundation manufacture
- JDR Cable Systems Ltd (USA) – cable manufacture
- Global Marine Systems (UK) – cable installation and tie-in
- Scaldis Salvage & Marine Contractors NV (Belgium) – installation
- Isleburn Ltd (Scotland) – assembly

Development Timeline

The DOWNVInD Project began in 2004 and was completed in mid September 2009. Installation of the turbines took place over the summers of 2006 and 2007.

Robin Rigg, Solway Firth

Background

Robin Rigg is Scotland's first offshore wind farm, located in the Solway Firth. Consisting of 60 Vestas V90-3MW wind turbines on monopile foundations, it has a nameplate capacity of 180MW and is currently the second largest operational offshore wind farm in the UK.

Developed by E.ON UK with a total Capex of £300m, the windfarm first generated power on 9 September 2009, and was fully online on 15 April 2010.

Supply Chain

Offshore Design Engineering Ltd was contracted by E.ON as project managers.

The following manufacturing contracts were awarded:
- Vestas Offshore AS (Denmark) – turbines
- MT Hojgaard A/S (Denmark) – foundations
- Parker Scanrope (Norway) – array cabling
- Prysmian S.p.A.(Italy) – export cabling
- Bladt Industries A/S (Denmark) – fabrication of offshore substation
- Harland and Wolff Heavy Industries Ltd (Northern Ireland) – other manufacture

Other roles which were awarded included:
- CTC Marine Projects (UK) – installation and burial of cables
- Subocean Group Limited (Scotland) – installation of export cable
- Areva T&D (France) – design, procurement, construction and commissioning of all the equipment of the two offshore substations and the onshore substation

Development Timeline

Following planning consent in December 2006, a two and a half year period was envisaged for construction and Robin Rigg was expected to become operational from mid 2009. However, there were various setbacks, including a three month delay due to damage to the jack-up barge from a gale in late 2007. In April 2010 Robin Rigg was commissioned, with a delay of 12 months.

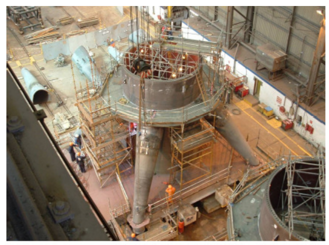
Burntisland Fabrications, Fife

Background

Burntisland Fabrications Ltd. (BiFab) was formed in 2001 following a management buyout from the former owners, Consafe Burntisland. BiFab has grown its turnover from £20m to £90m in the past four years and expanded its workforce to over 950.

Capability

The company has leading expertise in the construction of jackets (support structures) for offshore wind farms. BiFab completed the development and construction of two jackets for the Beatrice project. BiFab made about 60 jackets last year, including for Alpha Ventus (Germany) and Greater Gabbard (England).[23] They also have a contract to supply 30 jackets to Vattenfall's Ormonde project (England)



Scottish Capacity

BiFab has two fabrication yards in Fife – Burntisland and Methil. In 2009 they took over operation of a construction yard previously used for the oil industry at Arnish Point on the Isle of Lewis. This facility has a steel rolling plant and will contribute some components to the offshore wind industry.[24] The long term plan is for the site to supply the marine renewables (wave and tidal stream) industry.[25]

BiFab has an apprenticeship scheme, with 56 apprentices now and 30 more planned in the next two years.

Recent Developments

In April 2010, SSE bought a 15% share of BiFab for £11m and placed an order for at least 50 jackets a year for offshore wind turbines.

That same month, BiFab secured a £2m grant from the Regional Selective Assistance fund run by the Scottish Executive Government and a commercial loan worth a further £4m from Scottish Enterprise. This will be used to construct a new plant at the Fife Energy Park. The new facility is expected to open in late 2011 and will take production to about 130 jackets a year, employing 400 people.

In May 2010, Atkins and BiFab announced a partnership to launch an innovative design of a transition piece and jacket substructure for offshore wind turbines. This aims for 30-40% reductions in manufacturing costs, based on large scale orders.

[23] http://www.s1jobs.com/newsandguides/bifabs-14m-expansion-plan-sets-platform-to-create-200-jobs-in-fife.html

[24] http://www.newenergyfocus.com/do/ecco/view_item?listid=1&listcatid=32&listitemid=2485

[25] http://www.scotsman.com/business/Boost-for-renewables-as-SSE.6221077.jp

Skykon Campbeltown Ltd, Machrihanish

Background

Skykon Campbeltown Ltd. is located in Machrihanish, near Campbeltown. It designs, builds, manufactures and applies surface treatments to towers, foundations, internals and other steel constructions for the wind turbine industry.

The manufacturing site was originally established by Vestas, the Danish wind turbine manufacturer, in 2002 with a view to supplying towers for Vestas' wind turbines in the English, Irish and Scottish markets. In March 2009, the site was taken over by another Danish company, Skykon A/S.

Capability

Skykon has cutting, rolling, welding and surface treatment capabilities for the manufacture of complete towers for the wind industry. Located close to a functioning deep-water harbour in Campbeltown, Skykon is able to ship towers to wind turbine sites in the UK market and beyond.

Scottish Capacity

Skykon was initially focussed on the onshore market. They have been contracted by Siemens to supply all 152 turbine towers for the proposed 548MW Clyde Wind Farm, near Abington in South Lanarkshire, Scotland.

Recent Developments

Skykon are undergoing expansion in order to begin production of offshore turbine towers. They have recently received fast-track planning approval to build an extension to the Machrihanish plant with a new purpose-built factory. £14m of investment coming from Skykon A/S, with a further £5m from Highlands & Islands Enterprise (including £2m of European funding though the European Regional Development Fund) for land remediation and site preparation work.

This extension should result in an increase in staff numbers from 100 to 300 and triple the number of towers produced by 2012.

Subocean, Aberdeen

Background

Subocean is an Aberdeen-based cable-laying company, founded in 2005. It provides services to the oil and gas and telecommunications sector, and more recently, the offshore renewables industry.

Capability

In addition to core activities of cable laying and trenching, Subocean provides turnkey project design and implementation, including engineering, procurement, installation and commissioning of subsea facilities. It also supplies offshore management personnel, divers, life support technicians, Remotely Operated underwater Vehicles (ROV), subsea equipment operators and offshore administrators.

Scottish Capacity

The company has a number of vessels and barges tailored for the installation of offshore cables, and have proven capability of burying power cables for offshore wind farms to a depth of three metres.

Subocean has worked on several offshore wind farms, including Burbo Offshore Windfarm, Lynn and Inner Dowsing, Sheringham Shoal, Thanet and Robin Rigg.

Recent Developments

Subocean was named the best Renewable Energy company at the Aberdeen and Grampian Chamber of Commerce's Northern Star awards. (Sept 2009).

As part of a £42m fundraising private equity deal at the end of 2009, Subocean received £17m from LDC, the private equity arm of the Lloyds Banking Group, with an extra £25m from HSBC. They plan to use this investment to double the business in two years and achieve £300m turnover by 2014 by targeting the European market.

SgurrEnergy, Glasgow

Background

SgurrEnergy is a technical advisory engineering consultancy specialising in renewable energy. Established in 2002 with headquarters in Glasgow, they have offices in Ireland, France, Canada, the USA, India and China.

Employing over 100 sustainable energy consultants, SgurrEnergy has extensive UK and international experience. They have assessed over 40,000 MW of renewable energy developments.

Capability

SgurrEnergy provides a wide range of services, including wind monitoring, feasibility studies, technical advice, due diligence and operation and maintenance consultancy.

SgurrEnergy are one of only two consultancies recognised for the role of offshore wind lenders engineer.

Scottish Capacity

SgurrEnergy has supported a number of high profile offshore wind energy projects, either in direct support of the developers and owners, or on behalf of lenders and investors:

- Princess Amalia Wind Park - The world's first project financed offshore wind farm, Netherlands;
- Lenders Engineer, Borkum West II (400MW), Dexia, KfW, HVB Unicredit, Rabobank, HSH Nordbank, Germany;
- Thornton Bank offshore wind farm, Belgium;
- Ormonde offshore wind farm, (150MW), Dexia, Bank of Scotland, Unicredit and Societe Generale, UK;
- China wind energy development offshore 1000MW;
- Fujian, China offshore wind energy resource exploitation, (multi MW), CRESP, China;
- Inner Dowsing & Lynn offshore wind farms (180MW), Scottish & Southern Energy, UK;
- London Array Windfarm (1GW), Masdar;
- Offshore Wind Resource Map of the Atlantic and Channel coasts of France, wind resource mapping for the north and west coasts of France.

ANNEX D – BACK-CASTING OF SCENARIO A

Scenario A has the highest long-term benefits for the Scottish economy. Scottish Renewables and Scottish Government hosted an industry session to discuss what actions need to be taken to realise Scenario A. The results of this back-casting exercise are presented in Table 19. It shows success indicators that would need to be achieved by 2020, 2015 and 2012 if the full benefits of Scenario A (10.8GW installed offshore wind capacity, over 28,000 jobs, and a cumulative GVA of over £7.1bn) are to be realised by 2020. Major risk factors have also been considered.

It is important to note that many of the success indicators reinforce each other, with a potential to create a "virtuous cycle" of self-sustaining development. The risks can also reinforce each other, creating a lack of faith in the industry. Setting out on the right path early will be critical to success.

The table is set out as follows:

Back-casting from 2020, what milestones and key indicators need to be achieved in each stage of the supply chain beforehand to realise Scenario A.

Green sections present indicators that sector development is on track for Scenario A

Orange sections outline risk factors that may prevent Scotland realising the full potential of Scenario A.

Table 19: Back-casting Scenario A

	Before 2012	Before 2015	By 2020
Consenting & Development	– Finalised Strategic Environmental Assessment (SEA) – Appropriate assessments for SEA completed by Government – Industry collaboration to share data – 9 month turnaround for consenting – Funding of MetMast – Local authority buy-in for consenting process – Issues with marine protected areas. – Constrained resources for consenting processes – Objections to projects – Debate over community benefits	– 9 month turnaround for site specific assessments – Commitment to Round 4 and STW "Round 2"	– Crown Estate Round 4 sites and STW "Round 2" sites are licensed and partially consented – Public database of site assessments facilitates data sharing – Adequate marine spatial planning framework is in place – Public acceptance of offshore wind industry and engagement with key stakeholders – Offshore wind industry is a key industry and becomes a powerful and influential lobby group with the Scottish, UK and European governments – Competition prevents data sharing
Finance	– Public sector match fund necessary private investments – Support mechanism stability – Capital availability – Focus on shallow water projects – Relevant levels of public funds unavailable due to economic crisis – Failure to capture private investment commitment to develop infrastructure	– Projects are attractive to major players – Project Fidelity Funds (managed collective investment schemes) develop – Incentive programmes are clarified for coming 5 years	– 30% cost reduction for Capex – Projects make investment sense at financial close – Developments are seen as an attractive investment proposition: relatively low risk, attractive to pension and infrastructure investors – Projects deliver consistent returns – Investments come from variety of organisations – Time for project delivery is reduced by 30% – Opex costs exceed budget

Table 19: Back-casting Scenario A

	Before 2012	Before 2015	By 2020
Supply Chain & Infrastructure	– Supply chain coordinator in place for Scotland – Discussions on standardised contracts take place – Major contracts are signed that encourage confidence in the supply chain – Active engineering support services are available for project construction – Cable manufacturer sets up manufacturing facility in Scotland – Cost reductions through standard contracts for example based on former CRINE (Cost Reduction Initiative for the New Era) model – Development of industry standards and certification schemes with minimum industry standards – Procurement of services and supply contracts streamlined, for example based on F.PAL (First Point Assessment)	– Cost reductions through standardised contracts continue – Blade and tower manufacturers set up in Scotland – Turbine supplier commits and builds major turbine manufacturing facility – East coast installation hub becomes operational – Second fabrication site is set up for turbine and/or tier 1 manufacturer – Discussions for third fabrication site underway – First projects become operational – Standardised health & safety procedures in place – New offshore services sector develops through merging of oil & gas and marine renewables services	– Scottish firms secure UK and European contracts – West coast installation hub set up – Offshore platforms are set up – Major scaled-up construction since 2015 – Contracts are put in place prior to consents due to confidence in supply chain: “Faith in Delivery Process” – Third turbine and/or tier 1 fabrication site is set up – Specialist O&M hub operational – Mature and well established Scottish supply chain is involved in Scottish and international waters – Significant export turnover
	– Contracts can not be placed due to missing consents – Boards do not approve early contracts	– Boards still do not approve early contracts – Installation hub is not in Scotland. Alternative location with access to Scottish sites is promoted	– Poor production delivery
Grid	– National Grid investment – Grid planning applications processed and decided – Acceptable pricing of grid access in place	– Major offshore node is constructed	– Bootstrap installed (grid reinforcements due to the East-West interconnector between Wales and Ireland) – Interconnection with Europe – Cost of grid access is reasonable
	– National Grid rights issue fails (i.e. they fail to raise sufficient investment for network upgrade) – Grid Regulation Framework is disadvantageous to offshore wind projects – The FSL required is too high (Final Sums Liability, amount payable by a generator to National Grid if they cancel a signed Transmission Entry Capacity agreement after reinforcement works have started on the grid)	– Insufficient capacity of onshore grid – OFTO regime remains unclear	

Table 19: Back-casting Scenario A

	Before 2012	Before 2015	By 2020
Technology	– Commitment to an offshore test/demonstration site – Onshore demonstration site set up – Offshore demonstration site follows	– Innovation & R&D keep market and industry moving	– 5MW jacket technology leap – Standardisation of jackets, foundations and electrical installation reduces costs and creates strong export niche for Scotland as first mover – First generation productivity improvements reduce costs – New and improved installation aids deployed – Next generation vessels specified and under construction to meet future demand – 2nd generation offshore wind technologies commercialised – Development cost reduces by 30% – Equipment fails
Skills	– Complete skills audit shows intervention opportunities – Perception of the offshore wind sector as a viable and long-term career prospect changes	– “Up-skilling/ Re-skilling” of construction, installation and engineering skills – Transfer of construction skills from offshore oil & gas sector – Increased demand for conversion courses for mid-career transfers – Engineering and project management services become more available – O&M skills develop – High oil prices cause shift of work force to oil and gas industry – Offshore wind salaries can not match those paid in oil & gas sector	– Transfer of O&M skills from offshore oil & gas sector – Sufficient workforce available to supply domestic and export market with services – Competitive salaries and long-term career prospects

ANNEX E – INDUSTRY MESSAGES

This annex summarises the main industry messages and proposed mitigation measures that were suggested to us during our consultation with project developers, turbine and tier 1 manufacturers. The summary also takes into account findings from the case studies and the back-casting exercise.

Summary of Main Messages

The main areas addressed by project developers and component suppliers during our consultation included some key areas of concern that should be considered for the development of the Scottish offshore wind industry:

- the role of the Scottish and UK Government and the public sector bodies;
- timescales for planning and consenting and related issues;
- manufacturing, component supply and supply chain coordination;
- infrastructure development, most notably ports and grid; and
- sufficient and adequately skilled human resources.

It is important to note that these points are those of immediate relevance and interest to the industry – issues will continue to evolve as the sector develops. It is therefore important to track industry opinion and feed messages back within the industry. To this end, one major developer suggested the creation of an annual reference document based on the oil & gas industry's 'Brown Book'[26] which contained key industry data useful to track developments (economic data, health and safety issues, production volumes, etc.). A similar system could be useful for the offshore wind sector, given the rapid industry development.

Government and Wider Public Sector Role

Political, financial and strategic support from both the Scottish and UK Government is seen as paramount by all players across the industry. Similarly, support from public sector bodies such as Scottish and Highlands & Islands Enterprise provides significant incentives for companies to move into the Scottish offshore wind market. It reassures companies that their investment is made with long-term prospects and reduces the political risk.

Skykon is an example of how public sector support can promote the development of a supply chain for the offshore wind industry. Public sector support in purchasing the Campbeltown facility for onshore tower manufacturing was crucial for Skykon. With the support came the commitment that Skykon would expand its manufacturing capacity to include tower manufacturing for offshore wind. Around

[26] The last Brown Book was published by DTI in 2001. http://www.dbd-data.co.uk/brownbook/index.htm Since then, oil & gas sector data has been incorporated in the UK Energy Statistics. Further information can be found here: https://www.og.decc.gov.uk/information/brown_book.htm

£19m has been invested so far by Skykon and Highlands & Islands Enterprise in the development of the additional manufacturing facilities. Skykon expects staff numbers to rise from 100 to 300 by 2012 and allow numbers of towers produced to triple.

Conversely, another Scottish company recently pulled out of the wind sector by selling all of their fabrication capability for this area. The company felt that the return on offshore wind was not worth the investment, and Government support was insufficient (with the limited public funds available going to other companies).

These two examples illustrate the importance of public sector support as a key decision-making factor for the manufacturing industry to move into the sector. Having said this, Government support needs to be matched by equal commitment from industry to ensure success.

Further points made with regard to UK Government support included the financial support mechanisms: the risk of fluctuating ROC prices, level of ROC support and uncertainty over what happens post 2014 were the main concerns for project developers. It was stated by some consultees that a long-term feed-in tariff may be more suitable to reduce project risks.

Based on the consultation, the following measures could be instrumental in breaking down some industry barriers:

- Funding for companies intending to move into the offshore wind sector (e.g. through dedicating part of the funds under the fossil-fuel levy to the offshore wind sector, or match-funding investments). Targeted distribution of funding to maximise returns;
- Investigate possibilities for funding under the Green Investment Bank announced under the 2010 Budget;
- Clarifying position of offshore wind in the RO beyond 2014; and
- Reviewing adequacy of ROCs for offshore wind and consider feed-in tariffs for large scale renewables.

Planning, Consenting and Construction

The planning and consenting stage for an offshore wind farm is a crucial time for whether the project goes ahead and how quickly capacity will be developed. Any significant delays in consenting new capacity will adversely affect the successful achievement of 2020 targets. This is therefore a crucial factor where the Scottish Government can influence the sector.

One major developer stated that the Scottish Government is already good at quick decision-making for offshore wind projects. However, consenting times are still fairly within the average of the UK and European timeframes. Shorter consenting times could give an advantage for Scotland over the rest of the UK and Europe where some project developers find the consenting time is longer than 3 years.

A main reason for prolonged planning and consenting periods is the availability of data (in particular, bird surveying). Uncertainty around environmental assessments is also a major issue. At present, some project developers are postponing their projects and only engage in pre-scoping studies until the SEA is completed.

Some developers find that there is an interim period of 2 to 3 years between consent and the start of construction. This may be due to supply chain constraints and sourcing of component suppliers and services. High demand in the onshore wind industry created a market that suffers from severe supply constraints – a similar situation is developing for offshore wind.

The construction of offshore wind projects and capacity delivery also depends on the availability of suitable construction vessels, a constraint that was pointed out by a number of project developers and component manufacturers. Project timescales are reliant on the availability and performance of suitable installation vessels. Incidents affecting them can severely delay the whole project, for example The Robin Rigg project was delayed by a year due to a few setbacks, including damage to the jack-up barge.

Based on the consultation, the following measures could be instrumental in breaking down some industry barriers:

- Shortening the consenting period;
- Completion of the SEA;
- Encouraging cooperation amongst project developers to make environmental data publicly available;
- Facilitating coordination between project developers, turbine manufacturers, tier 1 manufacturers and the rest of the supply chain;
- Encouraging and supporting expansion of oil & gas sector companies supplying vessels into offshore wind sector; and
- Streamlining procurement and standardising contracts to speed up construction start.

Manufacturing and Component Supply

Component supply is a major supply chain constraint in the offshore wind sector and often cited as responsible for some of the delays experienced by projects. It is therefore essential that component suppliers and developers coordinate their activities. Most developers indicate their preference to source equipment and services locally, but this is not the most important factor and developers will procure the best deal internationally. Some developers also have framework contracts with key suppliers, to ensure supply for their developments. It is therefore even more important that some turbine and tier 1 manufacturing capacity is attracted to Scotland.

Not only the Scottish but the UK-wide supply chain for offshore wind is seen as comparatively poor. While some domestic manufacturing capacity is under development, as the largest and highest value components (in particular, cables, turbines and towers), are mostly produced outside of Scotland. Most of the high-tech, small and high voltage components are also manufactured overseas.

Overall, turbine and tier 1 manufacturers see a need for designers and manufacturers to become aligned with fabricators in Scotland to make designs cheaper and easier to fabricate (e.g. jackets). The Scottish offshore wind supply chain is not restricted to the project developer, turbine and the tier 1 manufacturer. Activity is also required at the lower tiers of the supply chain where innovation and design should be coordinated with local industry and manufacturing capacities.

Manufacturing itself, in particular of larger components, needs to be located in areas with suitable deep water access and close to the development sites. One major component manufacturer stated that the availability of large strategically positioned manufacturing sites with deep water access for wide beamed vessels remains a challenge for many areas in the UK.

Based on the consultation, the following measures could be instrumental in breaking down some industry barriers:

- Encouraging and facilitating coordination between R&D and industry (including on- and offshore test and demonstration sites);
- Developing suitable manufacturing sites for tier 1 manufacturers and creating technology hubs; and
- Strengthening the role of a supply chain coordinator.

Infrastructure: Ports and Grid

The need for adequate port infrastructure was mentioned by most project developers and major manufacturers.

Consultees emphasised the difference between ports for installation purposes (which may have a lifetime of around 2 years) and ports for O&M (which will have a lifetime of 25 years or more).

Scotland has the advantage of an existing port infrastructure that is geared towards offshore access. However, alteration and expansion is still needed to accommodate offshore wind fabrication, assembly and installation facilities. The oil & gas sector is still very active and there may be competition for space and access. This can only be avoided by developing new facilities. NRIP is investigating specific opportunities in Scotland.

Another key area for infrastructure development is grid access. All consulted developers were concerned about the current lack of sufficient grid capacity to accommodate new offshore wind development out to 2020. Grid connections are perceived to be more challenging on the west coast than east coast. In addition, there is considerable uncertainty about the OFTO regime.

Based on the consultation, the following measures could be instrumental in breaking down some industry barriers:

- Developing port facilities (as investigated under the NRIP);
- Clarifying the OFTO regime;
- Speed up grid upgrade; and
- Guarantee of grid access or suitable compensation mechanisms.

Skills

A short term lack of suitably skilled staff (surveying experts, engineers, offshore operations etc.) could become a bottleneck in project development. If developers or manufacturers are not able to attract key staff in Scotland, then industry and employment may locate elsewhere.. In the longer term, concerns have been expressed over the availability of sufficiently trained O&M staff.

Developers tend to use large contractors for their projects to reduce project risk. Scottish companies may not have the skills available to meet the scale of capacity development off the Scottish coast. Training and cross-sector skills transfer would need to scale up significantly to supply sufficient skilled personnel to allow the industry to scale up to the level required.

Scotland has a strong skills base in the wider energy sector. There are a few key offshore wind project developers based in Scotland. In addition, skills from the existing oil & gas sector could benefit the offshore wind sector. The scope for cross-sector skills transfer will be limited until the offshore wind sector can offer the same stability, employment framework and incentives as the oil & gas sector.

Based on the consultation, the following measures could be instrumental in breaking down some industry barriers:

- Supporting the provision of mid-career development programmes;
- Setting up training courses for offshore wind technicians and O&M together with higher education institutes and academia; and
- Increasing public awareness of industry potential and employment opportunities: highlight opportunities for career development, graduates and school-leavers.