5 THE NEED FOR THE DEVELOPMENT

5.1 INTRODUCTION

5.1.1 The need for new manufacturing facilities and construction ports in the UK to enable growth of the renewable marine energy sector arises from a number of international, national and regional imperatives, viz.

- **World production of energy needs to be decarbonised** in order to avoid the potential adverse impacts of climate change. Climate change is the first global environmental challenge that mankind has knowingly faced; it is regarded as one of the most serious threats facing the world's environment, economy and society (DEFRA, 2006). Accordingly, international treaties, European and national legislation compel the UK Government to make an urgent transition to a low carbon economy.

- **The UK must ensure security of its energy supplies** whilst managing its own transition from fossil fuels to renewable forms of energy over the next few decades. In this context, a secure energy supply is characterised by: a diverse energy mix of different sources and fuels; limited reliance on imported supplies; reliable and well managed infrastructure and stable prices. Wind energy is part of such a diverse mix of energy generation. The transition is to be market-led.

- **Europe must develop large capacity offshore wind turbines** to make the delivery of sufficient offshore wind turbine capacity feasible and to reduce the environmental impacts associated with manufacturing, deployment and maintenance. Such turbines will need to be manufactured at portside locations. Other marine energy components are also likely to need manufacturing facilities at UK ports but development of those products is much less advanced and the current investment focus is on offshore wind.

- **The UK needs to increase its manufacturing base** and, where practicable to do so, target investment in areas of relative deprivation to reduce social imbalance between regions. The transition from a fossil fuel economy to a low carbon one, offers substantial new employment opportunities in the manufacturing sector and the potential for significant socio-economic benefit to the UK.

The Need to Decarbonise Energy Production

5.1.2 The earth's climate has been changing constantly over millions of years. Indeed, it is only ten thousand years since the majority of the UK land mass was covered by a series of thick ice sheets. In the current era we can understand the climate and the factors that influence it.

5.1.3 The climate is mainly influenced by the amount of energy coming from the sun, but also by factors such as the amounts of greenhouse gases and aerosol propellant in the atmosphere. Recent human activity is changing the composition of the atmosphere and its properties. Since pre-industrial times (around 1750), carbon dioxide concentrations have increased by just over a third from 280 parts per million (ppm) to 380 ppm today, predominantly as a result of burning fossil fuels, deforestation and changes in land use. The concentration of other greenhouse gases such as methane and nitrous oxide are also rising.

5.1.4 There is compelling scientific evidence that the rising levels of greenhouse gases will have a warming effect on the earth's climate through increasing the amount of infrared radiation (heat energy) trapped in the atmosphere, "the greenhouse effect". In total the warming effect due to all greenhouse gases[1] emitted by human activities is now equivalent to around 430 ppm of carbon dioxide and is rising at around 2.3 ppm per year. Current levels of greenhouse gases are higher now than at any time in at least the past 650 000 years (Stern, 2006). In 2009, the UK energy sector was responsible for 195 million tonnes of carbon dioxide equivalent emissions (DECC, 2011).

5.1.5 The impact of climate change is to potentially threaten the basic elements of life for people around the world – access to water, food, health and use of land and the environment generally. One of the ways in which this would occur would be through rises in sea

[1] Carbon dioxide (C02), Methane (CH4), Nitrous oxide (N20), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), Sulphur hexafluoride (SF6), as defined in the Kyoto Protocol

levels, inundating coastal areas around the world. Accordingly, the UK Government is a signatory to International commitments on climate change and European and national legislation has been developed that provides a statutory framework for the reduction of greenhouse gas emissions over the next few decades.

5.1.6 The Kyoto Protocol was developed to limit the growth of greenhouse gas emissions. Under the protocol, industrialised countries and those in transition to a market/industrialised economy agreed to limit or reduce their emissions of greenhouses gases. It came into force on 16 February 2005 and commits signatories, including the United Kingdom, to reduce or limit their greenhouse gas emissions to a specified target value relative to their 1990 emissions in the period 2008-2012.

5.1.7 The UK government has achieved its target reduction for emissions. Since the Kyoto Protocol, however, it has become evident that more significant action is required to limit climate change. Accordingly, legislation has been introduced in the European Parliament, and by the UK Government, to introduce legal obligations compelling a transformation to a lower carbon economy, as described in *Section 5.2*.

5.1.8 In July 2009, the Government issued The UK Low Carbon Transition Plan, (DECC, 2009) setting out a strategy to tackle climate change, maintain secure energy supplies and to maximise economic opportunities in the emerging renewable energy sector.

The Need for Security of the UK Energy Supply

5.1.9 Whilst the development of renewable energy has been mainly driven by concerns over climate change, a new issue is emerging – the role of renewables in contributing to security of energy supplies. This is being driven by global shortages of oil supplies and increased oil demand from the developing economies (particularly China), depletion of national offshore gas reserves (particularly in the UK) and political actions by the world's largest gas supplier – Russia. By contrast, wind is a secure source of energy in perpetuity and harnessing the power of wind for large scale electricity generation is now a proven technology.

5.1.10 In accordance with Section 172 of the Energy Act 2004, the Secretary of State is required, in every calendar year, to:

'publish a report dealing, as regards both the short term and the long term, with the availability of electricity and gas for meeting the reasonable demands of consumers in Great Britain'.

5.1.11 The most recent of such reports, Statutory Security of Supply Report, (DECC, 2010), records that at the end of 2009, the UK as a whole had a total of 85.3 GW of electricity generating capacity of various kinds. In addition, Great Britain had the capacity to import and export the equivalent of 2.5 GW from and to France and Ireland. This compared to a peak demand of 60 GW. However, the annual report also notes that,

'(a) substantial proportion of the UK's electricity generating capacity is expected to close over the next few years. Electricity generation capacity has a finite lifetime, and faces increasingly strict environmental regulation. Both these factors will lead to closures of some existing plant over the next decade. The Large Combustion Plants Directive (LCPD) will lead to closure of around 12 GW of coal and oil-fired fleet by 2016 at the latest4. The Industrial Emissions Directive (IED) could also lead to further closures by 2023. In addition, and according to current timetables, up to 7.4 GW of existing nuclear generating capacity is reaching the end of its operational life and will have closed by 2020'.

5.1.12 The Overarching Energy National Policy Statement EN-1 (July 2011), states that the need for low carbon electricity generating infrastructure is now "urgent" (paragraph 3.3.15) and that 59 GW of new electricity generating capacity should be planned for by 2025 (paragraph 3.3.23).

5.1.13 In summary, offshore wind energy is demonstrably in the public interest, being an essential part of the UK's diverse range of secure, renewable energy supplies in perpetuity.

The Need for Large Capacity Offshore Turbines

5.1.14 The European Strategic Energy Technology Plan (SET-Plan) is the EU's response to the challenge of accelerating the development of low carbon technologies leading to their widespread market take-up, (EC, 2007). It sets out a vision of a Europe with world leadership in a diverse portfolio of clean, efficient and low-carbon energy technologies as a motor for prosperity and a key contributor to growth and jobs. It proposes joint strategic planning and more effective implementation of programmes. One of the key objectives of the Plan is to,

> *'(d)ouble the power generation capacity of the largest wind turbines, with off-shore wind as the lead application'.*

The Need to Rebalance the UK Economy

5.1.15 The concept of a "rebalanced" economy has become central to the debate on how the UK can emerge from recession and generate sustainable growth. One major imbalance is considered to be the level of manufacturing in the UK compared to other industrialised countries. In the UK, manufacturing has declined rapidly in recent decades, falling from 29 per cent of the UK output in 1979 to 13 per cent of output in 2007 (NESTA, 2010). Another imbalance is that between the economic output of different parts of the UK.

5.1.16 The wind industry has its origins in Denmark, and Germany has also provided a solid onshore wind market throughout the past 15 years. This has led to the current dominance of German and Danish companies in the offshore wind supply chain, with the result that 80 to 90 percent of the capital value in UK offshore wind farm projects has been based on imported goods and services and the economic benefits to the UK have been very limited (Garrad Hassan, 2010).

5.1.17 The total cost for installing the Crown Estate's 32.2 GW, Round 3 project, based on outurn costs for Rounds 1 and 2 developments completed so far, is variously estimated to be around £80-100 billion. Accordingly, the UK Government's offshore wind energy programme will give rise to the largest construction project ever undertaken but, to succeed, it requires urgent and significant investment in new manufacturing facilities and port infrastructure. This investment must be market led, and for the UK to benefit significantly from private sector investment in new manufacturing facilities, the country must provide suitable development sites.

5.1.18 Independent reports evidence the significant opportunity for the UK to build a manufacturing base for renewables. For example, Renewable UK has estimated that 22 factories will be required for turbines, foundations and cable manufacturing alone (Douglas Westwood, 2010). In an earlier report they estimated that the sector could generate up to 45 000 jobs by 2020 (Bain and Company, 2008). Elsewhere the Carbon Trust has estimated that,

> *'offshore wind will provide the UK with up to 70,000 jobs and £8bn in annual revenues **if delivered with a proactive UK Government manufacturing strategy**',* (emphasis added).

5.1.19 This level of socio-economic benefit will not be realised unless the UK provides port sites that are suitable for manufacturing offshore wind turbines (OWTs). Without such development sites, employment benefits from the offshore sector will be limited to assembly, installation and operation and maintenance.

The Need for Regional Growth

5.1.20 The past two decades have seen a widening of regional differences in economic growth and job creation in the UK. London and the South East have experienced robust growth, benefiting from the concentration of business and financial services in those areas, whilst the north of England, Northern Ireland and Wales have all lagged behind. This creates economic and social issues that consecutive governments have attempted to rectify. In the short term, regional disparities are likely to become accentuated as heavy public spending cuts hit all regions of the UK in the next few years.

5.2 ENERGY LEGISLATION AND POLICY

Legislation

The Renewable Energy Directive (2009/28/EC)

5.2.1 In 2009, the European Parliament issued the Renewable Energy Directive. The overarching objective of the Directive is to achieve *'a 20% share of energy from renewable sources and a 10 % share of energy from renewable sources in transport in Community energy consumption by 2020'*. The Directive establishes a common framework for the promotion of energy from renewable sources and sets mandatory national targets for the overall share of energy from renewable sources in each Member State. The Directive requires, amongst other things, 15 percent of the energy consumed in the UK to come from renewable sources by 2020. Importantly the Directive states that the, *'main purpose of mandatory national targets is to provide certainty for investors and to encourage continuous development of technologies which generate energy from all types of renewable sources.'*

5.2.2 In identifying that the main purpose of the Directive was to provide certainty to investors, the EC recognises the importance of establishing sufficient private sector confidence to enable the scale of investment that is required in renewable energy. The need for such a high level of confidence should not be under-estimated given the very high costs of developing new technology.

The Climate Change Act 2008

5.2.3 The Climate Change Act 2008 became law on 26 November 2008 and created a new approach to managing and responding to climate change in the UK. Whilst the European Directive limits its targets to the current decade, the Climate Change Act recognises the need, in the public interest, to plan longer term and sets an ambitious and legally binding target of at least an 80 percent reduction in greenhouse gas emissions by 2050, compared to a 1990 baseline.

European Energy Policy

5.2.4 A key environmental target set by the European Council is a reduction of at least 20 percent in greenhouse gases (GHG) emissions by 2020 compared to 1990 levels. However, this objective rises to 30 percent subject to there coming into force an international agreement committing other developed countries to '*comparable emission reductions and economically more advanced developing countries to contributing adequately according to their responsibilities and respective capabilities*'. This policy was reaffirmed in Commission Communication dated 23 January 2008 (EC, 2008).

5.2.5 On 8 March 2011, the EC published a roadmap for moving to a competitive low carbon economy by 2050 (EC, 2011). The roadmap confirmed an EU objective of reducing GHG emissions by 80-95 percent by 2050 compared to 1990 levels. The magnitude of changes necessary in each sector to achieve this objective were set out in Table 1 of the Commission Communication. That table is reproduced in *Figure 5.1* below; in essence, the objective for the power supply sector is for it to become fully decarbonised by 2050.

Figure 5.1 Abstract from Commission Communication COM (2011) 112

Table 1: Sectoral reductions

GHG reductions compared to 1990	2005	2030	2050
Total	-7%	-40 to -44%	-79 to -82%
Sectors			
Power (CO_2)	-7%	-54 to -68%	-93 to -99%
Industry (CO_2)	-20%	-34 to -40%	-83 to -87%
Transport (incl. CO2 aviation, excl. maritime)	+30%	+20 to -9%	-54 to -67%
Residential and services (CO_2)	-12%	-37 to -53%	-88 to-91%
Agriculture (non-CO_2)	-20%	-36 to -37%	-42 to -49%
Other non-CO_2 emissions	-30%	-72 to -73%	-70 to -78%

UK Energy Policy

Meeting the Energy Challenge: A White Paper on Energy 2007

5.2.6 The 2007 Energy White Paper set out the Governments strategy for ensuring secure energy supplies whilst delivering international commitments on climate change. The report states that,

> *'To reach our aspiration of 20% of electricity supplied from renewable generation by 2020, approximately 20GW of renewable capacity would need to be connected to the GB transmission system. Our aim is to connect new renewable generating capacity to the electricity network as quickly and as cost-effectively as possible. The majority of the new renewable generation is likely to be variable onshore and* ***offshore wind****'*, (paragraph 5.3.75, emphasis added).

5.2.7 On energy security the report states that:

> *'In addition, to meet our security of supply challenges, we will:*
>
> - *maximise the economic production of our domestic energy sources which, together with our energy saving measures, will help reduce our dependence on energy imports;'* (pg 19).

The UK Renewable Energy Strategy, 2009

5.2.8 In July 2009 the Government published *The UK Renewable Energy Strategy* (Department for Energy and Climate Change), which sets out the path for meeting the legally binding target established by

EU legislation. The strategy sets a target of producing more than 30 percent of electricity from renewable sources by 2020 (compared to today's 5.5 percent contribution). The Renewable Energy Strategy (RES) establishes that most of this renewable energy will be from wind power (on and offshore), with biomass, hydro, wave and tidal also contributing.

5.2.9 The RES is a step change in government policy and will require significant investment by both the public and private sectors if it is to be achieved in practice. In particular, the offshore wind energy industry is still young and needs to grow rapidly in the next decade. This is recognised in the RES which states that:

> *'ORED [The Office for Renewable Energy Deployment] will support the development of a UK renewables infrastructure – for example building understanding and readiness for investment in suitable UK manufacturing sites and port facilities. As offshore wind turbines grow in size, manufacturing facilities have to be located in coastal areas, and require high quality facilities. We will work with port owners, developers and the financial community to identify key areas with potential for renewable energy development, building on the recent UK Ports Prospectus. Regional Development Agencies, Devolved Administrations, ORED and (Department for Business, Innovation and Skills) BIS will provide coordinated support for infrastructure development in critical areas',* (paragraph 4.87).

5.2.10 The strategy includes numerous assumptions and acknowledges that there is a degree of uncertainty in relation to actually achieving the Governments targets.

A Prevailing Wind: Advancing UK Offshore Wind Deployment

5.2.11 In 2009, the Government completed a full Strategic Environmental Assessment (SEA) of its proposals for offshore wind leasing, oil and gas licensing and gas storage in hydrocarbon reservoirs and concluded that 25 GW of new offshore wind farm development would be permissible. Given an average turbine rating of 5 MW, this amounts to around 5 000 offshore turbines. (For reference, 1 GW of offshore wind capacity would provide electricity for approximately 700 000 homes in the UK.)

5.2.12 Following that decision, The Crown Estate proceeded with its offshore wind leasing competition for its Round 3 development sites. The largest of these sites are located in the North Sea with the Dogger Bank, Hornsea and Norfolk zones accounting for up to 18 MW. The total potential generating capacity for all Round 3 sites is 32.2 GW. In addition to this, there are existing plans (Rounds 1 and 2 including extensions) for 10.2 GW of offshore development around the UK coastline, of which 1.2 GW has been constructed over the past ten years. Finally, the Scottish Territorial Waters round will see projects with a combined capacity of 5.7 GW developed. This leads to a total UK planned potential for 48.1 GW with opportunities for further development.

5.2.13 It is likely that most of the market demand for offshore wind turbines will be met by only a limited number of companies. This is because there are considerable barriers to entry including technical challenges (product development, testing and installation) as well as commercial issues regarding corporate liquidity and the scale of funding required. It is anticipated that future manufacturing facilities will produce between 200 and 600 turbines per year and, because of the physical size and weight of the turbines, the manufacturing facilities will need direct access to a quay.

National Renewable Action Plan for the United Kingdom 2010

5.2.14 In accordance with Article 4 of the Renewable Energy Directive, all Member States were required to notify the Commission of their national renewable action plans by 30 June 2010. The UK proposed the targets set out in *Table 5.1* below, noting that it represented one possible technology mix. The mix proposed by the UK is significantly weighted towards wind power, both offshore and onshore. The Plan recognises that the public interest is not simply served by doing "just enough" to comply with the European Directive and notes that the 15 percent target,

> *'should **not** be taken as an upper limit to our ambition for renewables deployment. We are keen to go further and have commissioned the Committee on Climate Change to provide independent advice on increasing the level of ambition for renewables in the UK',* (paragraph 3.2, emphasis added).

Table 5.1 UK National Action Plan Targets

Renewable Energy Technology	Capacity (GW) 2010	Target Capacity (GW) 2020
Hydro-electric	1.73	2.13
Solar	0.05	2.68
Tidal, wave	0	1.30
Onshore Wind	4.04	14.89
Offshore Wind	1.39	12.99
Biomass	1.92	4.24
Total	**9.13**	**38.23**

Government Planning Policy

Overarching National Policy Statement for Energy, July 2011

5.2.15 The Overarching National Policy Statement for Energy (EN-1) is part of a suite of NPSs issued by the Secretary of State for Energy and Climate Change. It sets out the Government's policy for delivery of major energy infrastructure. The policy recognises that the UK needs to reduce greenhouse gas emissions, and to improve the security, availability and affordability of energy through diversification. The policy acknowledges that, by 2050, fossil fuels will be scarcer, and that prices of them will therefore be far higher. As part of the UK's need to diversify and decarbonise electricity generation, the policy notes that the, '*Government is committed to increasing dramatically the amount of renewable generation... In the short to medium term, much of this new capacity is likely to be onshore and offshore wind*', (paragraph 3.3.10).

National Policy Statement for Ports, October 2011

5.2.16 On energy, the NPS for Ports states that,

> '*Ports have a vital role in the import and export of energy supplies, including oil, Liquid Natural Gas and biomass, in the construction and servicing of offshore energy installations and in supporting terminals for oil and gas pipelines. Port handling needs for energy can be expected to change as the mix of our energy supplies changes and particularly as renewables play an increasingly important part as an energy source. Ensuring security of energy supplies through our ports will however be an important consideration, and ports will need to be responsive both to changes in different types of energy*

supplies needed (and to the need for facilities to support the development and maintenance of offshore renewable sites', (paragraph 3.1.5).

5.2.17 The policy goes on to note that,

'*the Government believes that there is a compelling need for substantial additional port capacity over the next 20-30 years, to be met by a combination of development already consented, and development for which applications have yet to be received*', (paragraph 3.4.16).

5.2.18 It also states:

'*when determining an application for an order granting development consent in relation to ports,* ***the decision-maker should accept the need for future capacity to****:*

...

- ***support the development of offshore sources of renewable energy;***

…

- *ensure effective competition between ports and provide resilience in the national infrastructure; and*
- *take full account of both the potential contribution port developments might make to regional and local economies*', (paragraph 3.5.1, emphasis added).

5.3 THE WIND ENERGY MARKET

Introduction

5.3.1 Wind energy currently supplies around 2 per cent of global energy demand with capacity more than doubling in the last four years. In Denmark, wind already accounts for one fifth of the country's electricity production. According to 'The Energy Report 100% Renewable Energy by 2050' (WWF, 2011), wind could meet 25 percent of global energy demand by 2050. That report found that such an objective would be possible with an additional 1 million onshore turbines and 100 000 offshore turbines, although it is European policy to increasingly develop offshore.

5.3.2 In 2006 Greenpeace published a report entitled, 'Sea Wind Europe' which considered the feasibility of producing 30 percent of Europe's electricity from offshore wind by 2020. The report considered that this required the installation of 240 GW of generating capacity at that time, or 48 000, 5 MW turbines. Whilst it is clear today that such a target will not be realised by 2020, it is nevertheless a feasible aspiration for Europe in the longer term.

5.3.3 In considering whether the offshore wind energy actually needs to be limited to any particular level, National Grid's annual report, National Electricity Transmission System Seven Year Statement (National Grid, 2010) states that,

> '*(i)n the longer term, we do not think it likely that there will be a technical limit on the amount of wind that may be accommodated as a result of short term balancing issues, but economic and market factors will become increasingly important*'.

5.3.4 In summary, wind energy is an established form of renewable energy and the long term potential for wind energy generation is very significant. However, significant expansion of the offshore energy manufacturing sector is needed to enable growth to occur.

The UK Market in the next Decade

5.3.5 *Table 5.2* details the progress of wind energy projects by the first quarter of 2011, (Renewable Energy UK, 2011).

Table 5.2 UK Wind Energy Development November 2011

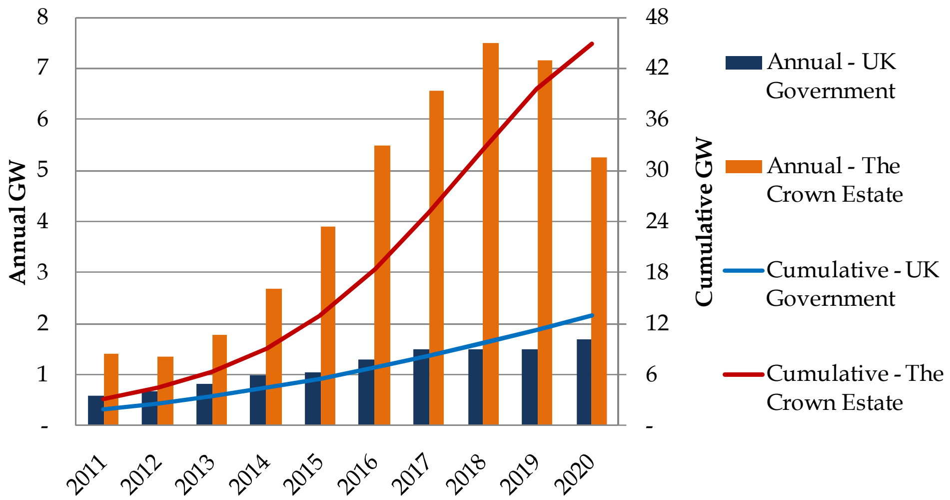
STATUS	ONSHORE (GW)	OFFSHORE (GW)
Operational	4.244	1.524
Under Construction	1.571	2.054
Consented	3.712	1.627
In planning	7.444	2.011
Total	**16.971**	**7.216**

Source: http://www.bwea.com/statistics (accessed 27 November 2011)

5.3.6 In total therefore, the UK's current wind energy generating capacity is 5.768 GW. Given that the average weighted capacity of wind turbines tends to be around 30 percent, average output will be 1.730 GW, or around 4.6 percent of the average demand.

5.3.7 Attempting to predict a reasonable target rate of growth for European offshore wind energy in the next decade is difficult given the scale of investment required and the multiplicity of factors that could affect future growth. *Figure 5.2* illustrates two key UK market predictions, between which actual installation rates will probably fall. The higher growth rate shows the installation rates agreed by The Crown Estate with developers when negotiating development rights. This effectively represents a maximum with an ambitious forecast deployment rate.

Figure 5.2 UK Market Forces



Source: Crown Estate (and the Department of Energy and Climate Change (UK Renewable Energy Action Plan, 2010)

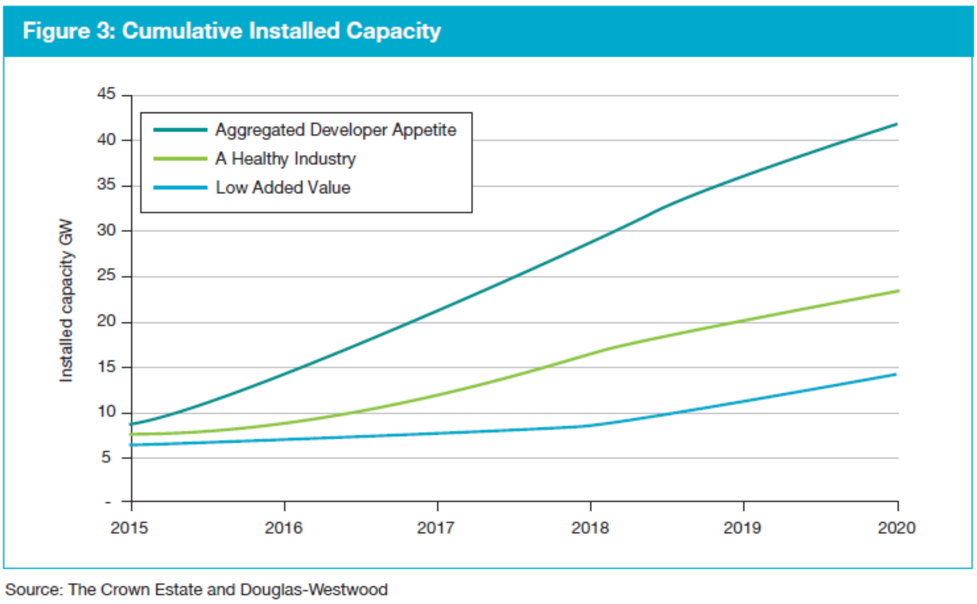
5.3.8 The Crown Estate scenario would require a peak installation rate of nearly 8 GW by 2018, but this would be followed by a rapid decline unless future Rounds maintained this installation pace. By 2020, nearly 45 GW of capacity would be installed. While it is anticipated that most of the capacity committed to by developers will ultimately be built, delays caused by supply chain constraints and difficulties securing finance may extend the actual timeframe. A particular concern is that if any one part of the supply chain is unable to deliver in a rapidly evolving market due, for example, to technological constraints or lack of investment, then that will constrain development as a whole. Other potential constraints include the supply of wind turbine plant and electricity export cables and the availability of specialised installation vessels.

5.3.9 Such challenges are surmountable, even for a burgeoning market, and work is being undertaken to address these factors but they have led the industry to regard The Crown Estate's timetable as being ambitious.

5.3.10 The lower forecast in *Figure 5.2* is the UK Government's scenario and was submitted to the European Commission as part of their statutory national renewable energy action plan for achieving their 15 percent renewable target. This forecast is viewed by the offshore industry as low in the context of its ability to build and install capacity compared with other renewable technology.

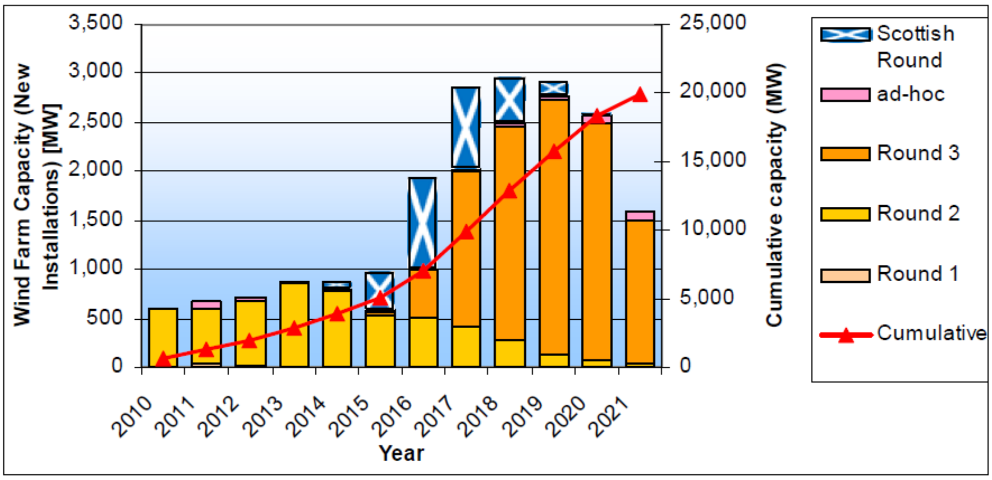
5.3.11 An alternative prediction of future growth, which would ensure a healthy industry, is presented in UK Offshore Wind: Building an Industry – Analysis and Scenarios for Future Development (Douglas Westwood 2010). Figure 3 from that report is reproduced in *Figure 5.3* below and shows a steady installation rate of around 3.3 GW per annum in UK territorial waters alone by 2020.

Figure 5.3 ***Abstract from Douglas Westwood, 2010***



5.3.12 In June 2010, GL Garrad Hassan published Offshore Wind Energy Supply Chain Opportunities, which predicted an installation rate of around 3 GW per annum in UK territorial waters by 2018. An abstract from the report is reproduced in *Figure 5.4*.

Figure 5.4 Abstract from Garrad Hassan, 2010



5.3.13 Taking account of the above predictions, a UK cumulative total of 22 GW is considered a reasonable target for installed offshore wind capacity by 2020. This would require planning for an installation rate of around 3.5 GW per year by 2020 which equates to approximately seven hundred 5 MW OWTs.

The European Market in the next Decade

Overview

5.3.14 As noted earlier, under Article 4 of the Renewable Energy Directive, all Member States were required to notify the Commission of their national renewable action plans by 30 June 2010. A review of these plans shows that eleven other countries have included offshore wind in their action plans, giving a total EU target installation of more than 40 GW by 2020. This equates to a peak annual installation rate of around 8 GW in European waters by 2020. Member States' individual targets are summarised in *Table 5.3*.

Table 5.3 EU Member State National Action Plan Targets

	Total renewable energy generation as a percentage of total energy produced			Offshore wind		
	2005	**2010**	**2020 target**	**Today**	**2020**	**Offshore wind % of renewable electricity 2020**
UK	1%	4%	15%	1 390 MW	12 990 MW	38%
Germany	6%	8%	18%	67 MW	10 000 MW	15%
France	10%	13%	23%	0 MW	6 000 MW	12%
Netherlands	2%	5%	14%	246 MW	5 178 MW	39%
Spain	9%	11%	20%	0 MW	3 000 MW	5%
Denmark	17%	20%	30%	868 MW	1 339 MW	26%
Italy	5%	8%	17%	-	680 MW	2%
Ireland	3%	6%	16%	25 MW	555 MW	13%
Greece	7%	9 %	18%	-	300 MW	3%
Sweden	40%	42%	49%	164 MW	182 MW	0.5%
Malta	0%	2%	10%	-	95 MW	50%
Portugal	21%	23%	31%	-	75 MW	0.5%

Germany

5.3.15 It is expected that Germany will exceed its 2020 renewable energy target of 18 percent and its revised target is now 19.6 percent. As part of this, the country plans to install around 10 GW of offshore wind capacity by 2020. In the longer term, Germany has also stated its intention to develop a total of 25 GW of offshore wind capacity by 2030. A key challenge for developers is that most German projects are located in deep water (20-40 m) and are 20-60 km from shore and both of these critical elements increase relative project costs.

France

5.3.16 Despite strong resources off its coastline, progress for offshore wind has been slow in France with no turbines installed since the first announcements on the subject made in 2005. A strict planning regime has so far limited development proposals to designated zones but new legislation is now being passed to change the arrangement. With a 2020 offshore wind target of 6 GW, a first tender round of 3 GW was announced in October 2010 with a second planned for 2014. Further delays could mean that France will not achieve its offshore wind targets.

Netherlands

5.3.17 Dutch targets would equate to offshore wind being responsible for 14 percent of the country's electricity by 2020. With a national offshore wind target of more than 5 GW, the Government has already allocated almost all of this capacity to developers and it is not expected that any more will be considered until a review in 2012. The current level of activity is considered realistic.

Spain

5.3.18 Having seen strong progress in solar and onshore wind generation, Spain is already expecting to exceed its overall renewable target (20 percent) by more than 2 percent. Spain is still in the early stages of offshore wind development, and has moderated its original target of 5 GW by 2020 to 3 GW. With no projects expected to be installed until 2013 at the earliest, even this moderated target may be ambitious.

Denmark

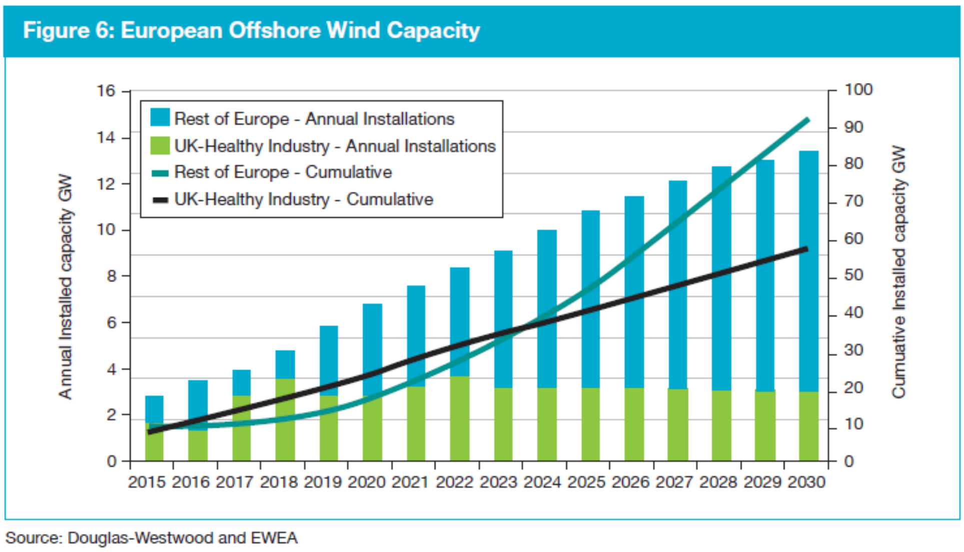
5.3.19 Having led the development of the offshore wind sector, Denmark now has lower ambitions than other North Sea countries, but is still expecting offshore wind to supply a significant proportion of its total electricity need. The country is aiming to generate a large majority of its energy using renewable technologies and, given the country's infrastructure and experience, its offshore wind national target of 1.3 GW is considered low and is likely to be exceeded by 2020.

The European Market to 2030

5.3.20 Predicting development of offshore wind energy beyond the timescale of the national action plans is a matter of professional judgement and there will be competing views on the matter. However, the European Wind Energy Association, which promotes the development of wind power worldwide, is targeting 150 GW of installed capacity by 2030. This is consistent with the Commission Communication on Offshore Wind Energy (EC, 2008) which stated that, '*the potential exploitable by 2020 is likely to be some 30-40 times the current installed capacity* (1.1 GW in 2008), *and in the 2030 time horizon it could be up to 150 GW*'. Achieving such a target would require an installation rate of 10 GW/year in the decade beginning in 2020, and demonstrates the potential long term sustainability of this emerging industry. Furthermore, it is also anticipated that many development sites will be "re-powered" with newer and more powerful turbines when the existing units reach the end of their operating life (around 20-25 years).

5.3.21 In 'UK Offshore Wind: Building and Industry – Analysis and Scenarios for Future Development' (Douglas Westwood 2010), predictions were presented for OWT installation up to 2030. *Figure 5.5* reproduces Figure 6 of the report and shows UK installation at a relatively constant level of 3.5 GW per year and total installation in European waters rising incrementally towards around 13 GW per year.

Figure 5.5 European Demand 2015 - 2030



The European Market beyond 2030

5.3.22 In July 2010, the Government published 2050 Pathway Analysis (DECC, 2010), which projected that by 2050, UK electricity supply needs were likely to double compared to 2010. This is due to the use of electricity for significant parts of the industrial, heating and transport sectors (including the transition to electric cars) causing demand for electricity to rise, even as overall energy use declines. A significant proportion of this increased capacity would need to be from renewable sources. Accordingly the report states that, *'(t)he transmission grid would need to become bigger and more sophisticated. It* ***would draw in electricity from a wider range of providers, likely to include offshore wind turbines*** *and electricity imports,'* (emphasis added).

5.3.23 As noted in *Section 5.1*, the EC is beginning to set out a roadmap towards a zero carbon energy sector by 2050. The prospects for offshore wind manufacturing, installation, operation and maintenance are therefore demonstrably substantial and long term.

5.3.24 A broad estimate of the likely long term need for wind energy in the UK can be calculated using the above forecasts.

- The National Grid's current assessment of annual electricity demand is 325 TWh (National Grid, 2010)
- The Governments 2050 Pathway Analysis, states that the demand in 2040 will double, so can be taken to be 650 TWh.
- Allowing for 40 percent penetration of wind as a reasonable, economic limit at this time, wind power can be used to generate 260 TWh by 2040 (Millborrow, 2009).
- The average generating capacity of plant needed to generate 260 TWh is 30 GW.
- Taking a weighted average capacity for wind power plant of 30 percent, 100 GW of installed wind generating capacity by 2040 is a robust estimate for the UK alone.

5.3.25 At this time, the above is potentially a conservative estimate of the UK's long term needs for wind energy generation as it ignores the possible development of economic means of electrical storage. Since offshore wind is more efficient than onshore, due to higher wind speeds across flat ocean surfaces and the ability to use much larger turbines, offshore can be the dominant wind sector in the future. Taking into account the need for re-powering of obsolete turbines at the end of their service life (currently assumed to be 25 years), a long term need for the UK to produce 3.5 GW of offshore turbines per year is a sound assumption. The UK could sustain a much higher level of manufacturing if it became a location of choice for offshore wind manufacturing and thus a net exporter of components.

5.4 *NEW GENERATION OFFSHORE WIND TURBINES*

Introduction

5.4.1 Onshore wind farms have been the predominant form of wind energy development to date and further significant onshore development can be expected in the next decade and is anticipated in the UK's Action Plan. These developments are constrained by, amongst other things, the limitation on the size and weight of components that can be transported on the existing road networks. Applications for onshore farms are also plagued by some very subjective issues such as the setting of landscapes and of buildings and sites that have statutory protection. These are very difficult risks for developers to assess.

5.4.2 Previous offshore developments have substantially used onshore technology in an offshore environment. However, the widespread adoption of offshore wind energy in national action plans presents an economic imperative for the industry to develop and install much larger wind turbines that current generation onshore machines and so reduce offshore development costs overall and increase output. The most common offshore wind turbine in the UK market to date has been the Vestas 3 MW turbine which has a hub height of 70 m. Utilisation of 6 MW turbines, however, would reduce the number of installations by a half compared to the existing technology enabling significant economies to be realised and reduce environmental impact. The development of such large capacity turbines specifically designed for the offshore market is also the objective of Europe's Strategic Energy Technology Plan (EC, 2007).

5.4.3 Large capacity turbines give rise to a need for new manufacturing plants that are located at port facilities because such machines cannot be transported by road or rail. A number of such portside facilities will be required to enable a healthy and competitive market in offshore wind components to develop. Larger turbines ensure that wind energy becomes more economic; fewer turbines are required overall; the geographic footprint of the windfarms is smaller, and, as a result, there is a smaller environmental impact during manufacturing, installation and operation.

5.4.4 An OWT essentially combines four basic components: a foundation, a nacelle, a tower and a rotor comprising of a hub and blades. As the turbine size increases, so the blade size becomes larger in order to capture greater energy, and with longer blades there becomes a need for a taller tower. The size of foundation is dependent on the depth of water and the size of tower it supports.

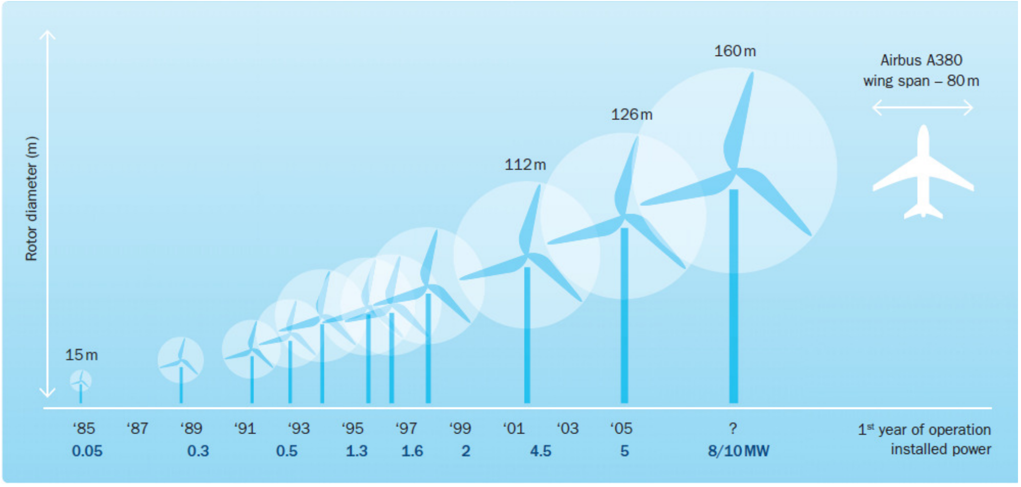
5.4.5 All of the principal components of an OWT will need a portside manufacturing site. All need to be either manufactured at the same location or transported to an appropriate port for assembly before loading onto an installation vessel. It is, important that the nacelle, tower and blades are delivered to the wind farm at the same time and, ideally, by the same vessel. In the future it may be practical to significantly reduce operating costs by fully completing assembly of these components on-shore. Consequently the best strategic solution is to co-locate the manufacturing plants with a construction port.

5.4.6 *Table 5.5* shows how the size and weight of turbine components will increase with increased generating power. Development to date is illustrated in *Figure 5.6.*

Table 5.5 Growing Scale of Current and Future Turbines

	3-4 MW		5-6 MW		8-10 MW	
	Mass (tonnes)	Dimensions (metres)	Mass (tonnes)	Dimensions (metres)	Mass (tonnes)	Dimensions (metres)
Nacelle and hub	180	13x4x4	400	15x8x8	500-700	16x9x9
Blade (3 per turbine)	20	50x5x3	25	65x7x3.5	30	75x8x4
Tower	250	80x5x5	300	85x6x6	500	100x7x7

Figure 5.6 *Size Evolution of Wind Turbines over Time*



Source:(EWETP, 2008)

5.5 *EXISTING WIND TURBINE MANUFACTURING CAPACITY*

Context

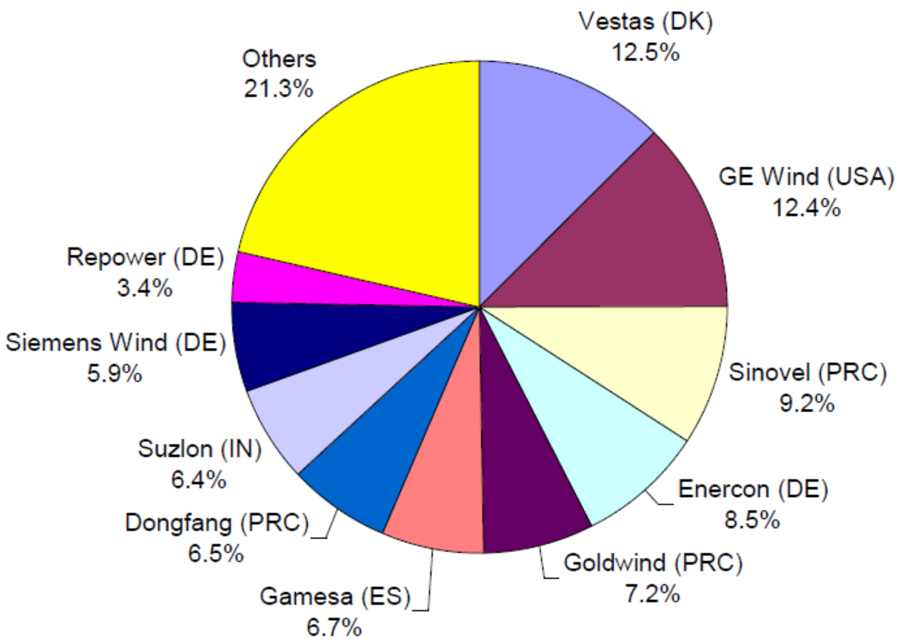
5.5.1 The previous section established that manufacturing plants with direct access to a quay are essential for the commercial development of offshore wind turbines. To quantify the scale of the need for new plants, it is necessary to assess what facilities currently exist across Europe and, by deduction, how much new manufacturing capacity is needed for the new offshore sector.

Turbines (nacelles, blades, towers)

5.5.2 *Figure 5.7* shows the market share of turbine manufactures in 2009. Three out of the top ten manufacturers are from the People's Republic of China.

5.5.3 The European market to date has been dominated by two Denmark-based players, Vestas and Siemens Wind Power, although in recent years three German-based companies, Areva (formerly Multibrid), REpower and BARD, have also entered the market. Nacelle, blade and tower production facilities are spread across various locations throughout the Jutland peninsula of Denmark, with most located 20 km to 80 km from the main export port of Esbjerg and only the Siemens blade facility in Aalborg near to suitable port facilities, see *Figure 5.8*.

Figure 5.7 *Market Share of Turbine Manufacturers in 2009 (38 GW installed)*



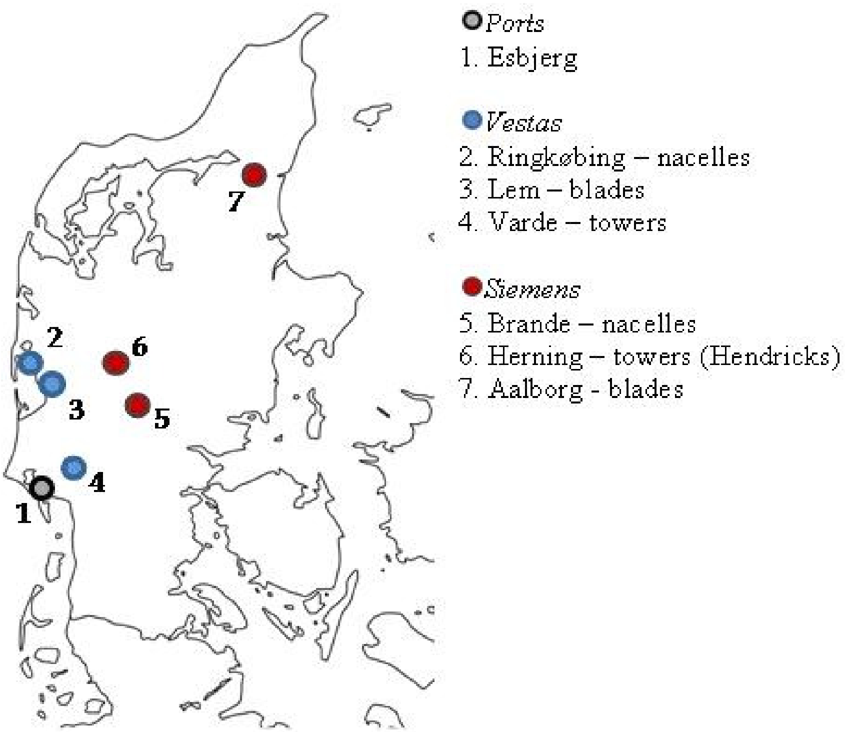
Source:(JRC,2010)

5.5.4 In terms of construction, the area in the port of Esbjerg where activity has taken place so far has 220 m of heavy lift quayside with a 10.5 m draught. The port has no lock gates or height restrictions. The existing Danish industry has been responsible for more than 90 percent of turbines installed to date and it is likely that it will continue to supply sub-4 MW turbines in the short term until more powerful models are produced in sufficient volume.

5.5.5 In contrast to the Danish production operations that were first built to serve their domestic onshore market, the three German companies noted above have facilities that were planned so that they could serve the serve the offshore market, refer to *Figure 5.9*. All three are currently producing turbines with a capacity around 5 MW to 6 MW and all three have waterside locations with suitable quayside facilities available.

5.5.6 Some clustering of manufacturing facilities has taken place with nacelle and blade production facilities co-located in both Bremerhaven and Emden. While there is little sub-component supply chain directly adjacent to the facilities, there is strong industrial capacity within the northwest region of Germany.

Figure 5.8 Danish Turbine Manufacturing/Construction Distribution

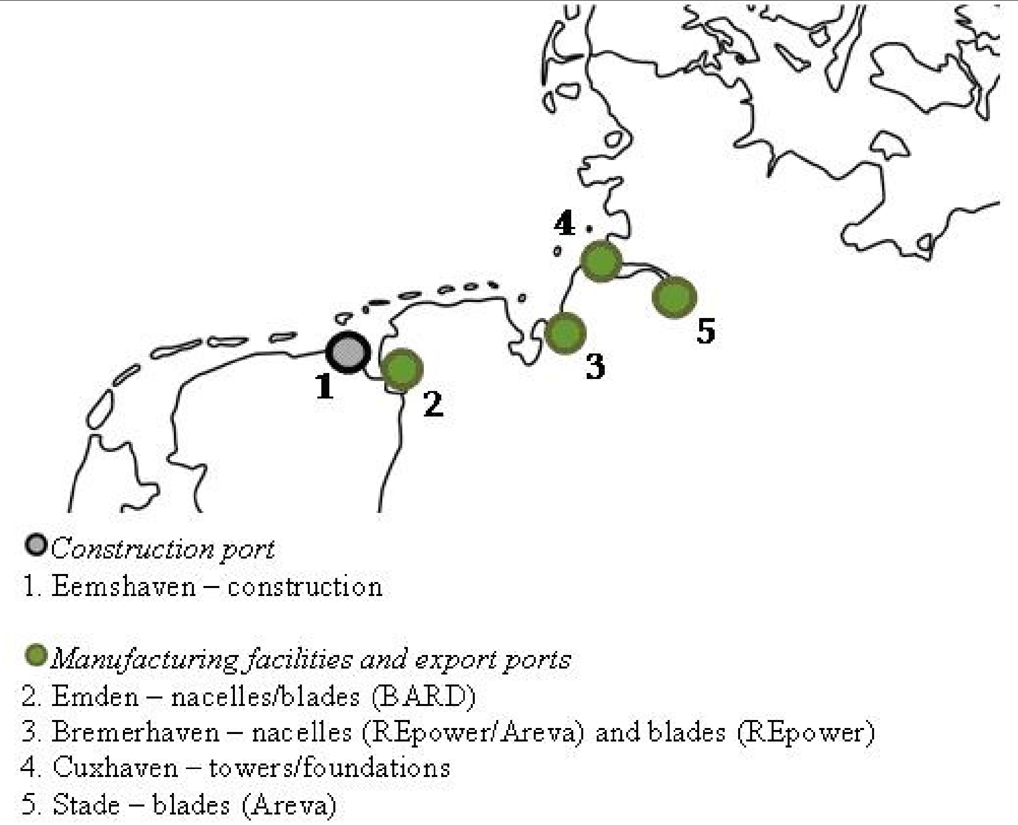


5.5.7 As relatively new offshore market entrants, the German companies have more limited production capacities than their Danish counterparts and have all stated production targets of 100 nacelles a year within the next two to four years.

5.5.8 Both Bremerhaven and Emden are, however, lock-constrained (35 m and 40 m beam respectively) which, in the case of Areva and REpower, has already meant turbine components have needed to be shipped to the Dutch port of Eemshaven for storage prior to loading onto the construction vessels.

5.5.9 Bremerhaven is now planning a significant expansion of its facilities in response to the emerging offshore wind programme in Germany and has identified 200 ha of land for development. It is proposing a new 500 m quay capable of handling 160 completed OWTs per annum for the German, Dutch and Belgium market.

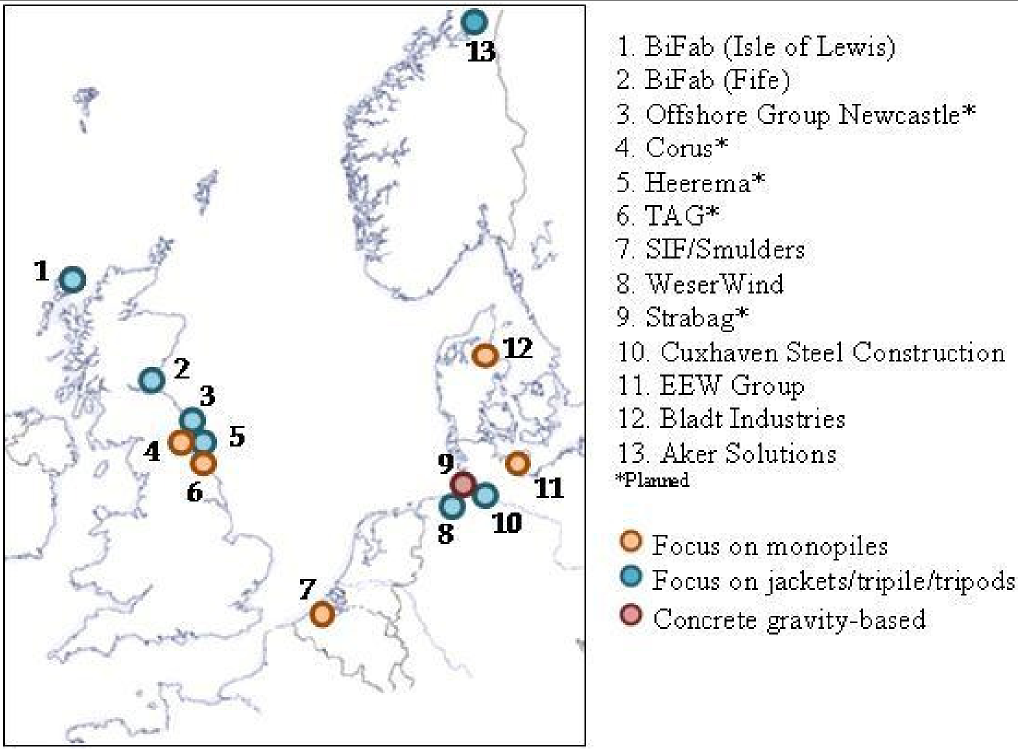
Figure 5.9 German Turbine Manufacturing/Construction Distribution



Foundations

5.5.10 The foundation forms the base to which the OWT is attached and its deployment typically takes place prior to the OWT itself. It does not, therefore, need to originate from the same location as the OWT. While investment is being made in the foundation market to increase production capacity, a large proportion of this is still focused on the current foundation market of monopiles, a technology that is not generally suitable for deep water installations where the Round 3 development zones are located.

Figure 5.10 European Foundation (Existing and Planned) Manufacturing Distribution



5.5.11 A number of companies, such as BiFab, Aker Solutions, Cuxhaven Steel Construction and WeserWind, are producing alternative steel designs suitable for use in deep water (including tripods and jackets), but it is expected that more facilities will be required as the offshore market expands. The location of existing facilities is illustrated in *Figure 5.10.* There are currently no European facilities producing deep water gravity-based (concrete) foundations although Strabag are developing a facility in Cuxhaven that will be specifically targeting the German offshore market.

Overview

5.5.12 Virtually all significant manufacturing is undertaken on the continent or further afield. The existing plants set out above can only provide a relatively small proportion of the projected European demand for offshore wind development. Assuming that 5-6 MW turbines will be typical in the next decade, around 1 500 turbines need to be produced a year by 2020 at port locations around the North Sea. The existing European capacity equates to a few hundred turbines per year and needs to be greatly increased.

5.6 *NEW MANUFACTURING FACILITY REQUIREMENTS*

General

5.6.1 Given the substantial reliance by the UK on future low carbon energy production from offshore wind, and the very limited production capacity in Europe as a whole, it is imperative that the UK provides suitable manufacturing sites, both in scale and location, for the sector to expand. There is however no overall Government strategy for the identification of such sites, beyond the issue by DECC of a UK Offshore Wind Ports prospectus in 2009. The allocation of such sites is entirely market led. Nevertheless, stated Government policy, as set out in the RES, is to maximise the economic benefits for the UK. Government policy is clear: at a speech to the CBI in October 2010, the Prime Minister announced support for the offshore wind sector saying:

> *'(w)e need thousands of offshore turbines in the next decade and beyond yet* ***neither the factories nor these large port sites currently exist****.* ***And that,*** *understandably****, is putting off private investors****. So we're stepping in. To help secure private sector investment in this technology, we're providing up to €67.22 million to meet the needs of offshore wind infrastructure at our ports. And to help move things forward, the Crown Estate will also work with interested ports and manufacturers to realise the potential of their sites. It's a triple win. It will help secure our energy supplies, protect our planet and the Carbon Trust says it could create 70,000 job',* (DECC, press release 2010/111, emphasis added).

5.6.2 On the same day the Secretary of State for Energy and Climate Change stated, in respect of offshore wind:

> *'****We want the jobs, manufacturing*** *and skills base for this exciting new industry to be* ***here in the UK,*** *and we are taking decisions that attract investment. We need world-class infrastructure to support our economic growth.'*

Site Requirements

5.6.3 The land requirements for manufacturing facilities for offshore wind components are influenced by the rate of installation offshore. Experience gained in the last decade conclusively shows that the offshore installation process is extremely weather dependent with many projects delayed due to adverse weather conditions, either heavy swells or high winds. One of the principal reasons for this is that, whilst foundation structures can be installed in a range of airflow conditions and wind force, nacelles and blades require relatively still air; in particular, the assembly of the blades requires nearly calm weather. This means that installation rates are unpredictable and seasonally dependent, with the majority of installation campaigns for the superstructures planned between late spring and early autumn. This gives rise to an extreme stockpiling of towers, blades and nacelles and foundations in order to exploit good weather periods during which there is very intensive installation or servicing work. Accordingly, the components of OWTs need to be stockpiled either at the manufacturing site or at the installation quay to enable the factories to maintain constant rates of production.

5.6.4 To develop a significant offshore wind manufacturing sector in the UK, the country must provide port sites for the industry that enable it to grow and can compete for investment on a European and even a world stage. In UK Ports for the Offshore Wind Industry: Time to Act (DECC, 2009), it is stated that:

> *'(a) number of wind turbine manufacturers have stated clearly that they would not choose to establish turbine assembly facilities in the UK unless there were also sources of supply of key components also in UK. In terms of value added, the component manufacturing facilities also are much more significant than simply turbine assembly. This means that the UK needs to establish a key component supply base in parallel to attracting turbine manufacturers to set up an assembly plant in the UK.*
>
> *A number of turbine manufacturers have a strategy to establish on a **single new coastal site** their own turbine assembly facilities alongside key component manufacturing facilities. Depending on the range of products and scale of operations, these could employ up to 5,000 people on each site.*
>
> *The requirements for such sites are:*
>
> - ***Located on North Sea** or English Channel to enable export to Continental projects as well as supplying to UK offshore projects;*
> - ***Up to 500 hectares of flat area** for factory and product storage;*
> - *Direct access to dedicated high load bearing deep water quayside (minimum 500m length); and*

- *Ease of landside logistics and access to skilled workforce.'*

5.6.5 In the first quarter of 2010, turbine manufacturers Siemens, Clipper, Mitsubishi and GE all committed to a UK presence. In 2011, Vestas announced plans to develop a manufacturing facility. Fundamental to these decisions was the UK's market outlook. Considerable follow-on supply chain development would be expected in the UK, considering the size of the domestic market and the confidence apparently demonstrated by the turbine manufacturers. Nothing however compels the private sector to invest, and it is essential that suitable manufacturing sites that match the needs of the sector are consented for development in order that the potential is realised.

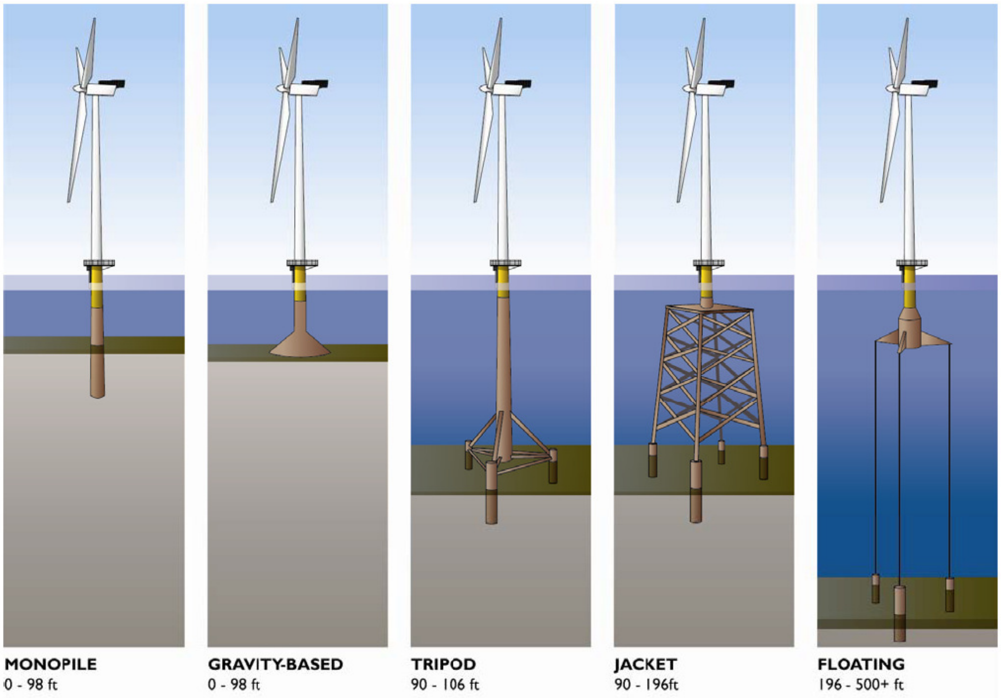
5.6.6 Of the five turbine manufacturers noted above, only Siemens and Vestas have so far announced a preferred site; Greenport Hull and the Port of Sheerness respectively. An application for development consent is yet to be submitted for either site so full details of the proposals are unknown. This commitment however demonstrates the attractiveness of the Humber and the east coast of England to serve offshore wind development in the North Sea.

5.7 PORT FACILITIES

5.7.1 Ports are required for, inter alia:

- **The fabrication of foundations**.
  There are a number of foundation types that are economical in different water depths. These are illustrated in *Figure 5.11* The Round 3 sites are generally in deeper water than earlier developments and steel tripod and jacket foundations or concrete gravity based foundations will be required. These are constructed adjacent to a quay in order that they can be loaded directly onto barges for transport to the installation site. Six jacket foundations were recently constructed at Methil Port in Scotland for the Alpha Ventus demonstrator project in Germany that was located in 30 m deep water. One foundation factory is proposed at AMEP and it will require a load out quay.

Figure 5.11 Foundation Types for Offshore Wind Turbines



Source: Port and Infrastructure Analysis for Offshore Wind Energy Development (Terratech, 2010)

- **The construction of Sub-stations**
  Electricity sub-stations are needed offshore to transform the electricity generated by the turbines to DC before it is transferred to shore. These substations weigh several hundred tonnes and need to be constructed at a port site to enable direct loading onto a vessel for transport to the wind farm site.

- **The pre-assembly of component parts of the OWT**
  OWTs comprise a number of parts that can be manufactured at different locations by different suppliers and they need to be brought together at one site for pre-assembly before shipping to the wind farm. A lot of space is required at the construction port due to the size of the wind turbines when lying down on the ground. Given the delays and greater risks inherent in lifting operations at sea, developers plan the smallest number of lifts possible offshore, and maximise pre-assembly. In the recent Beatrice demonstrator project in Scotland, the turbine was erected complete at the port before being transported offshore.

- **Operation and Maintenance Work**
  Turbines need both routine and emergency maintenance and maintenance teams need a permanent port base with quay facilities for maintenance access vessels. It is anticipated that one O&M job will be created for each OWT installed and a large fleet of vessels will be required to enable these activities.

- **Cable Manufacturing**
  Westwood (2010) estimates that '*over 12,000 km of array cabling is needed and export cable lengths are well in excess of 8,500 km*' for Round 3 alone. Production of these cables needs to be undertaken at port sites to enable direct loading onto cable installation vessels.

5.7.2 In 2010, The Crown Estate published 'A Guide to an Offshore Wind Farm'. This document provides useful data on, amongst other things, the requirements for construction ports serving the offshore wind energy sector. Chapter 5 of that report considers the requirements for installation and commissioning and provides a brief specification for a construction port to be used for the pre-assembly of around one hundred 3 MW turbine components per year. The report states that:

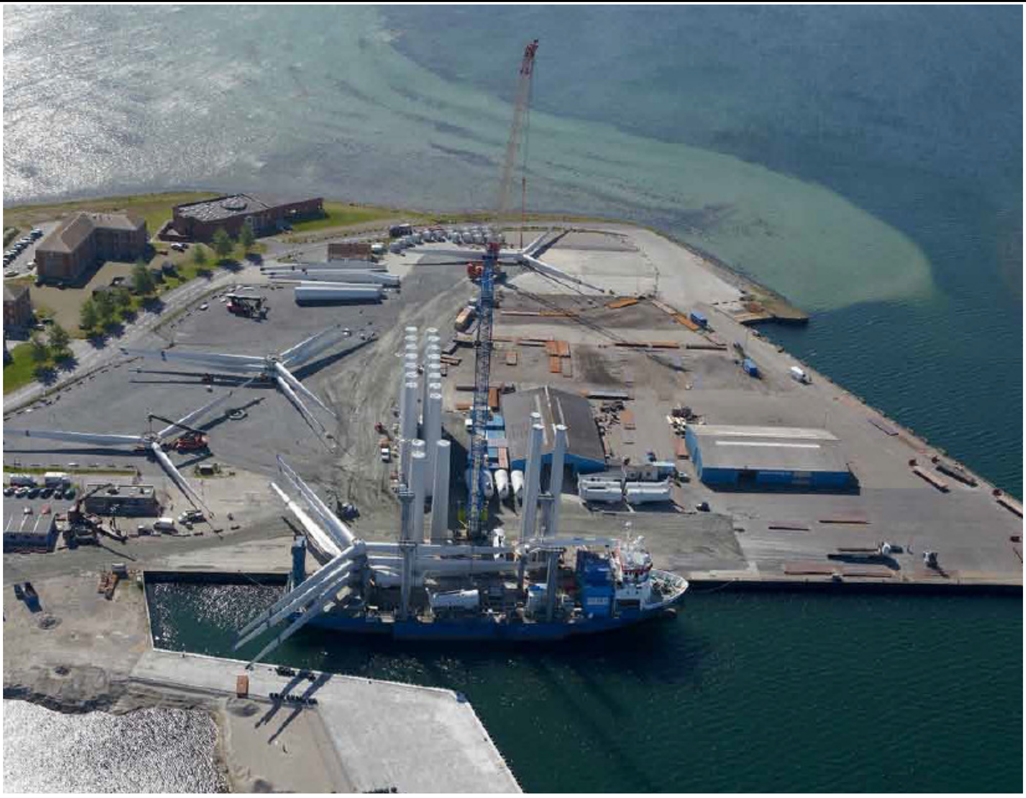
> '*Construction port*[1] *requirements are typically*:
>
> • *At least 8 hectares suitable for lay down and pre assembly of product;*
>
> • *Quayside of length 200–300m length with high load bearing capacity and adjacent access;*
>
> • *Water access to accommodate vessels up to 140m length, 45m beam and 6m draft with no tidal or other access restrictions;*
>
> • *Overhead clearance to sea of 100m minimum (to allow vertical shipment of towers);*
>
> • *Sites with greater weather restrictions or for larger scale construction may require an additional lay-down area, up to 30 hectares'.*

[1] In the context of AMEP, a "construction port" needs to be understood as a single quay with associated land to the rear.

* *Large areas of land are required due to the space taken when turbines are stored lying down on the ground. Two turbines take up nearly 2 hectares of space.'*

5.7.3 *Figure 5.12* shows the Port of Nyborg in Denmark operating as a construction port and illustrates the need for large laydown areas.

Figure 5.12 Port of Nyborg – Land Use at a Construction Port



Source: ADP, 2010

5.7.4 DECC have long recognised that port facilities are critical to the delivery of the Round 3 sites (DECC, 2009). The report provided an indicative number of construction ports required by region based on a predicted installation rate of 1 160 turbines per year by 2020. Relevant tables from the report are reproduced in *Figure 5.13*.

Figure 5.13 Abstracts from UK Ports for the Offshore Wind Industry: Time to Act (DECC, 2009)

Table 4.1 - Number of Offshore Wind Turbines Expected to be Installed off UK (split by year and coastal region), excluding projects in Scottish and Northern Irish territorial waters.
Source: BWEA *UK Offshore Wind: Moving up a gear* (2007) and BVG Associates

Coastal Region	'09	'10	'11	'12	'13	'14	'15	'16	'17	'18	'19	'20
Southern North Sea	160	130	140	290	180	150	100	230	360	450	510	520
North East	0	0	20	0	0	0	20	80	140	190	220	220
Scotland East	0	0	0	0	10	10	30	70	100	130	150	160
Scotland West	0	0	0	0	0	0	0	0	0	0	0	0
Irish Sea	110	20	30	20	120	140	40	60	80	110	130	130
Bristol Channel & Wales West Coast	0	0	0	10	0	0	30	70	100	110	80	80
South Coast	0	0	0	0	0	0	10	20	30	40	50	50
Total	**270**	**150**	**190**	**320**	**310**	**300**	**230**	**530**	**810**	**1030**	**1140**	**1160**

Table 4.1.1 - Indicative Number of Ports Required by Region
(based on a typical installation capacity of 100 turbines per year per port).

Coastal Region	'09	'10	'11	'12	'13	'14	'15	'16	'17	'18	'19	'20
Southern North Sea	2	2	2	3	2	2	2	3	4	5	6	6
North East	0	0	1	0	0	0	1	1	2	2	3	3
Scotland East	0	0	0	1	1	1	1	1	2	2	2	2
Scotland West	0	0	0	0	0	0	0	0	0	0	0	0
Irish Sea	2	1	1	1	2	2	1	1	1	2	2	2
Bristol Channel & Wales West Coast	0	0	1	1	0	1	1	1	2	2	1	1
South Coast	0	0	0	0	0	0	1	1	1	1	1	1
Total	**4**	**3**	**5**	**6**	**5**	**6**	**7**	**8**	**12**	**14**	**15**	**15**

5.7.5 In summary, the Crown Estate estimates that, if the UK is to maximise the economic opportunity of the emerging offshore wind sector, eleven ports will be required along the east coast of Britain by 2020. This amounts to a total quay requirement of 2 200-3 300 m. The report states that:

> *'Failure to make construction ports available will affect the commercial attractiveness of projects as well as making achievement of 2020 targets dependent on Continental ports. Apart from the loss of economic activity in the UK, Continental ports may well be encouraged to support their own national projects as a priority over UK projects.'*

5.8 DEVELOPMENT OPTIONS FOR THE UK

General

5.8.1 As noted earlier in this chapter the UK's strategy for the delivery of the renewable energy targets is to enable the market to deliver the targets. The UK is however competing on a global stage for investment and a number of outcomes remain possible:

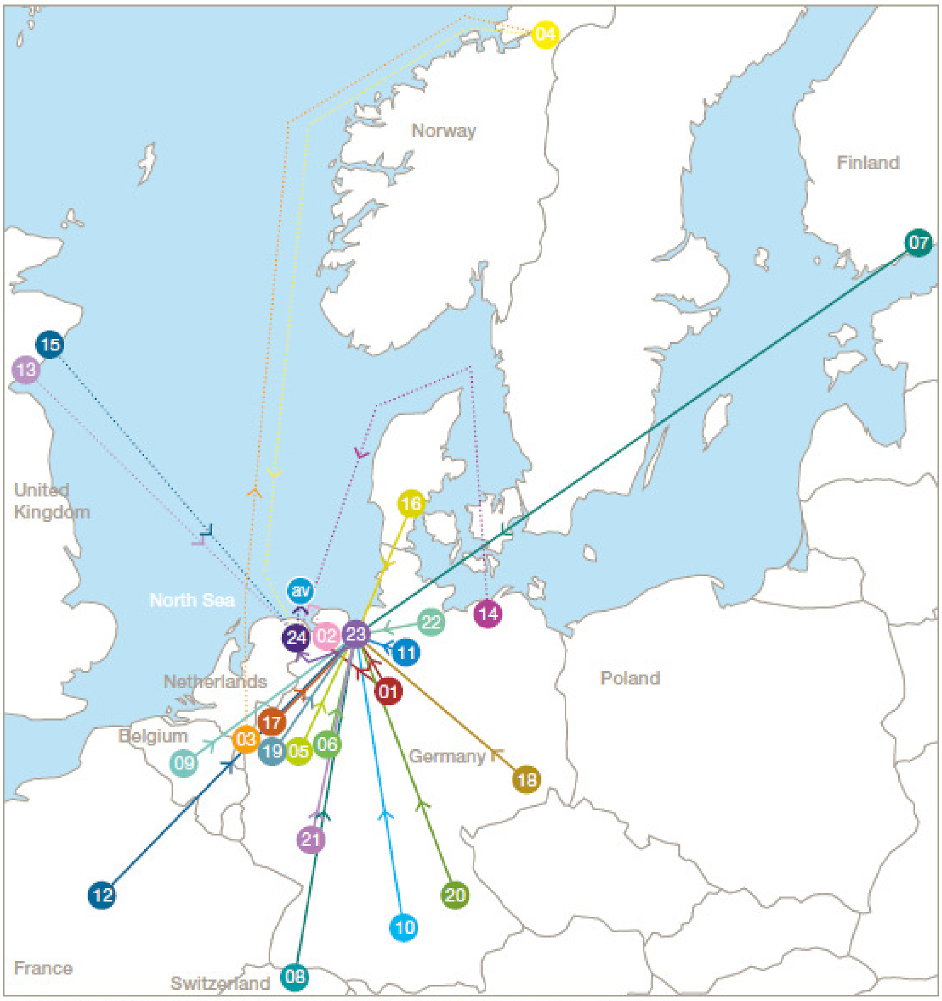
Negligible Investment:	The UK does not attract any significant investment from the manufacturing sector.
Low level Investment:	The UK develops a small manufacturing sector but procures a significant proportion of components from overseas. Installation and O&M is undertaken from UK ports.
Significant Investment:	The UK grows an industrial and knowledge base capable of installing much of its own offshore wind capacity and builds global companies of a scale to capture a significant proportion of the investment in UK and international waters.

The Existing Distributed Supply Chain

5.8.2 To date, offshore wind farm developments have substantially comprised onshore technology with special offshore foundations. The existing onshore manufacturing sector is widely distributed and has led to significant logistical challenges in transporting sub-components to the construction ports for preassembly before shipping to the wind farm site itself. A bespoke offshore industry needs to emerge however with bespoke facilities at port locations to maximise the potential and minimise environmental impact.

5.8.3 The recently constructed German Alpha Ventus Wind Farm comprises 12 wind turbines constructed 60 km from the coast and was completed in 2010 and provides a good example of the existing logistical challenges facing the offshore wind sector. The distributed supply chain for the main components procured for that development is shown in *Figure 5.14* below. Considering the thousands of turbines that need to be manufactured in the next 30 years, there are manifest logistical benefits in ensuring that new manufacturing sites enable supply chain manufacturers to develop in proximity to their principal clients and share the benefit of direct sea access. Sites that are large enough to support manufacturing clusters need to be developed.

Figure 5.14 Logistics of a Wind Farm - Distributed Supply Chain for the Alpha Ventus Wind Farm



Logistics of a wind farm: The map shows various production locations and delivery routes for the components.

Source: www.alpha-ventus.de

Manufacturing Clusters – The Economic Case

5.8.4 In 2008 the British Wind Energy Association commissioned Bain and Company to report on the potential development options in relation to wind energy. Their report, 'Employment Opportunities and Challenges in the Context of Rapid Industry Growth', assessed three possible scenarios:

- The static case – This scenario assumes failure to achieve leadership in offshore development and the absence of manufacturing within the UK that would lead to significant imports and limited exports. By 2020, this scenario would lead to wind capacity of 22 GW, cumulative investment of £19 billion and 23 000 jobs. Design and manufacturing would remain at its current level, i.e. covering 15 percent of the UK market for offshore turbines.

- Solid Progress — This scenario assumes clear political support for wind energy, market leadership in offshore development, the UK becoming self-supplying, and achieving a limited degree of export in knowledge-related activities such as technical consulting and offshore operations. By 2020, this scenario would lead to wind capacity of 27 GW. This scenario would generate cumulative investment of £26 billion and 36 000 jobs. Design and manufacturing would cover 35 percent of the UK's offshore turbine market along with a limited amount of export.

- The Dynamic case - This scenario, assumes strong political support and recognition of the UK as the global centre of expertise in offshore development with the development of **manufacturing clusters** that allow the UK to become self-supplying and a significant exporter of both knowledge and components. This scenario would generate a cumulative investment of £39 billion and generate 57 000 jobs. Design and manufacturing would cover 70 percent of the UK market for offshore turbines and would be exporting a similar volume to continental Europe.

5.8.5 The clear conclusion of the analysis by Bain and Company is that manufacturing clusters that enable the efficient production of offshore components are an essential element of a thriving offshore wind industry. Examples of such clustering are already emerging at Bremerhaven and Cuxhaven in Germany.

5.8.6 Further discussion of the recognised benefits of industrial clustering is detailed in *Chapter 21*.

Manufacturing Cluster at a Construction Port

5.8.7 The European Wind Energy Technology Platform, which is supported by the EC, identified two key major challenges in the assembly and installation of large-scale offshore wind farms (EWETP, 2008). One of these was the transfer of components from suppliers across Europe to wind farm sites. This was acknowledged to be a complex and repetitive logistical process, which required efficient transport links, large drop-off areas and good harbours. To be capable of meeting the needs of an expanding offshore market EWETP noted that:

> *'The installation industry will need to develop safe, efficient, reliable processes that are easy to replicate. In turn these will reduce costs, minimise risks, guarantee standards and deliver investor confidence. In order to achieve these goals, the industry will require a variety of vessels and installation equipment to cope with the range of turbines, sub-structures and environmental conditions that will be encountered.* ***... mobilisation and assembly will require good harbours with suitable drop-off areas; these are a scarce resource in many of the areas designated for offshore development. Substantial investment will be required to develop suitable facilities'****,* (emphasis added).

5.8.8 It is therefore a logical and progressive step to have construction port facilities at the same location as the manufacturing sites. This allows manufactured products to be immediately transferred to a goods handling zone adjacent to a quay that is specifically designed for use by installation vessels. This avoids transhipment of finished components to other ports and provides both a cost saving and an environmental benefit by cutting CO_2 emissions from shipping that would otherwise arise from "double handling" by sea transport. Accordingly, AMEP would be designed for use as a construction port as well as a manufacturing site with import/export facilities. Heavy lifting operations that are a common source of reportable incidents will be reduced and transhipment significantly reduced;

this will be a significant safety benefit to the industry and reduce the logistical challenge.

5.8.9 An integrated manufacturing/construction port cluster will require extensive space to accommodate the optimum configuration of manufacturing plant and enable the ideal layout, with areas for production and storage as well as expansion space for core manufacturing and their associated supply chain(s).

5.8.10 Facilities such as these are however beginning to emerge at Bremerhaven where the offshore industry is starting to mature and the industry fully recognises that its needs are distinct from those of the onshore industry.

The Safety Case for an Integrated Facility

5.8.11 The occupational hazards associated with offshore wind farms have been considered in a major risk study reported by the Health and Safety Executive. This concluded that the principal safety hazards arise from:

> *'Construction and major repair: operation of jack-up construction barges and associated* ***lifting operations*** *during tower and nacelle erection. These* ***health and safety issues may be more challenging in the future, as the new generation of wind turbines become significantly larger and taller****.*
>
> *Operation (maintenance and minor repair operations): primary issues are access and egress (frequent personnel transfers between boats/construction vessels/towers), working at height, and emergency response. It is anticipated that each offshore wind turbine could require up to six maintenance or repair visits per year'*, (HSE, 2006, emphasis added).

5.8.12 With a distributed supply chain exporting to a construction port, a number of heavy lifting operations are undertaken that can be avoided compared to pre-assembly being undertaken at the manufacturing port. Whilst good planning and adherence to good practice can mitigate the risk of an accident occurring during a crane lift, human error remains. Unfortunately where an incident does occur during a heavy lift, the consequences can be severe. Reducing the number of lifts will have a beneficial impact on the number of accidents.

5.8.13 A report on health and safety challenges related to offshore renewable energy detailed 17 incidents that have occurred since 2006 during works to construct, transport, install and maintain offshore wind turbines. Of these, eight incidents, around half of all incidents occurred as a result of crane lifts. Two of the incidents resulted in a fatality (Sintef, 2011). By co-locating manufacturing and pre-assembly, the project will result in fewer heavy lifts and significantly mitigate the risk of further incidents.

5.9 ALTERNATIVE CLUSTERING SCENARIOS

Introduction

5.9.1 In *Section 5.6* it was noted that a manufacturing cluster would require '*up to 500 hectares of flat area*'. To examine this particular requirement in more detail, two indicative clustering scenarios have been developed by BVG Associates to identify the total land and quayside requirements of each.

5.9.2 The indicative scenarios include a range of assumptions on facility sizes, buffer storage space, goods handing zones and the commercial considerations of both the turbine manufacturers and their supply chain. Any ecological mitigation would be additional to the estimated land requirements and would be site specific.

Key Assumptions

Facility Sizes

5.9.3 In order to understand the land requirements of a future production cluster, it is necessary to estimate the size of manufacturing facilities capable of producing larger components, in far greater quantities, than anything that currently exists. The factory footprints included in the scenarios are based on a study of existing facilities and discussions with key players in the industry about their future plans and their understanding of how facility sizes are expected to grow.

5.9.4 One key factor influencing the footprint of manufacturing facilities is the need for large areas of storage space to balance steady production rates with the peaks and troughs (mainly weather related) of installation activity. It is possible to stack blades in their handling frames up to three high and it is also possible to store towers vertically if the ground is sufficiently engineered to support the concentrated loads.

5.9.5 The reasonable estimate of land take for manufacturing facilities is set out in *Table 5.6*.

Table 5.6 Manufacturing Facility Building and Plot Areas

For 1GW/yr of output (200 5MW turbines):	**Site area (ha)**	**Building area (m^2)**
Nacelle and hub	10-15	5 000-10 000
Blade (3 per turbine)	20-25	25 000-30 000
Tower	20-25	15 000-20 000
Supply chain (4 units)	12-16	4x(5 000-6 000)

Berthing

5.9.6 Operational berths require specific work areas for import and export, construction and support activity. The length of the quayside has been assessed to match the output generated by the site. For construction activities, a berth requires a dedicated staging area of 5 ha behind it where turbines can be laid out for imminent loading onto an installation vessel.

5.9.7 The maximum utilisation of installation vessels is considered to be paramount given the high costs of their use and the propensity of that use to be reduced by adverse weather conditions. A construction berth is considered "utilised" not only when an installation vessel is alongside the quay but also when components are being brought up to the staging area for final preparations before loading. Consideration has been given to likely installation cycles for vessels covering expected steaming time, installation time per turbine, weather allowance and maintenance and repair.

5.9.8 Additional land is then included behind the quays to allow for the temporary storage of components being fed through from the manufacturing sites. Pre-assembly work will be undertaken here and complete sets of turbines consolidated and stored in preparation for the final move to the staging area.

5.9.9 For export and import berths, judgements have been made on expected loading times which are then incorporated in the scenario requirements. Higher utilisation has been allowed for these berths compared to the construction berths as it is considered that import/export operations are less affected by weather than construction activities. In terms of berth length, construction vessels up to 160 m in length are now in operation and further scaling up of these vessels can reasonably be expected.

5.9.10 For import/export vessels, 18 000 dwt (deadweight tonnage) vessels with a length of more than 140 m are already in use for transporting turbine components and the offshore market's expected growth means it is likely to require larger vessels to achieve cost efficiencies. Overall, these layouts suggest that individual berth lengths between 160 m and 200 m may be appropriate to accommodate a range of vessel types and ensure the facility is future-proofed for expected vessel growth.

Description of Indicative Scenarios

5.9.11 The indicative scenarios (ISs) assessed are described below:

- IS A – Single nacelle manufacturer (with some supply chain activities)
- IS B – Two nacelle manufacturers (with some supply chain activities)

IS A

5.9.12 In this case a single large offshore wind turbine manufacturer is located on a site alongside a proportion of its supply chain. The site produces around 400 nacelles a year, of which 75 percent are installed with towers and blades directly from the same site with the remaining 25 percent exported to other construction ports.

5.9.13 This scenario has been developed to represent the minimum scale of a viable cluster surrounding a large offshore wind turbine manufacturer. The site would comprise 7 factories and produce around 30 per cent of the main OWT components needed for UK waters. Factories included in this scenario are:

- a single 2 GW per year nacelle assembly;
- an in-house 1 GW blade facility;
- independent 1 GW tower facility;
- independent 2 GW generator manufacturer;
- independent 2 GW slewing ring manufacturer;
- independent 3 GW castings facility; and
- independent 3 GW composite component manufacturer.

5.9.14 Companies supplying all the key sub-components and components are represented on the site, but it is assumed that every supply company exports a share of its capacity to customers elsewhere and that the turbine manufacturer dual sources all components using imported units to supplement on-site production. Monopile production takes place at a combined tower/foundation facility, but no next-generation foundation production has been included and it is assumed that if required they are manufactured elsewhere and delivered directly to the wind farm sites.

5.9.15 This scenario requires a total land area of approximately 150 ha, as set out in *Table 5.7* below.

Table 5.7 Alternative A: Land Area Requirement

Activity	Land area
Main component manufacture	70ha
Sub-component manufacture	33ha
Construction	33ha
Import/export	20ha

5.9.16 In terms of quayside, this alternative allows for two construction berths, two export/import berths and two support berths giving a total quayside length of 960 - 1200 m. Such an arrangement offers a ratio of quayside length to installed capacity of 640 - 800 m per GW. It is estimated that around three such sites would be required in the UK.

IS B

5.9.17 This scenario co-locates two nacelle manufacturers, along with a proportion of their supply chain. The site produces a total of around 700 nacelles of which 500 are installed with towers and blades directly from the site and 200 are exported to other construction ports.

5.9.18 The site would comprise 12 factories and produce around 70 per cent of the main OWT components needed for UK waters. Factories included in this scenario are:

- two nacelle manufacturers assembling a total of 3.5 GW/year;
- two blade facilities manufacturing 2 GW/year;
- two independent tower facilities manufacturing a total of 2 GW/year equivalent;
- two independent generator manufacturers producing a total of 3.5 GW/year equivalent;
- independent slewing ring manufacturer producing a total of 3 GW/year equivalent;
- independent castings foundry and heavy fabrications facility producing a total of 2.5 GW/year equivalent; and
- two on-site suppliers of composite components producing a total of 3 GW/year equivalent.

5.9.19 This alternative requires a total land area of approximately 280 ha, as shown in the *Table 5.8* below.

Table 5.8 Alternative B Land Area requirement

Activity	**Land area**
Main component manufacture	155ha
Sub-component manufacture	44ha
Construction	55ha
Import/export	25ha

5.9.20 In terms of quayside, the design allows for four construction berths, three export/import berths and two lay berths giving a total quayside length of 1 440 – 1800 m. Such an arrangement offers an improved ratio of quayside length to installed capacity of approximately 580 -720 m per GW. It is estimated that an additional 150 ha site would be required to serve the UK market alone, in addition to a site that is the equivalent of IS B.

Conclusion

5.9.21 The above analysis demonstrates that:

- Land areas in excess of 100 ha are required to support a significant manufacturing cluster.
- The UK will need more than one Marine Energy Park (MEP).
- Larger MEPs will deliver economies of scale.

Benefits of Clustering

5.9.22 MEPs will also serve to minimise the carbon footprint of the offshore wind sector both during manufacturing and during construction by reducing transport impacts. Manufacturing all the main components on a single site from which they can be directly exported to the wind farms, avoids the double handing of goods from the manufacturer to the construction port and will significantly reduce the safety risks inherent in handling large components and will also reduce sea miles arising from transhipment. Shipping is a major contributor to carbon dioxide emissions and this particular issue is considered further in *Chapter 6* with regard to the choice of the site for a MEP.

5.10 QUAY REQUIREMENTS

5.10.1 Quay requirements are dependent on a number of factors:

- The specification for vessels using the quays.
- The rate of installation of OWT's and foundations by a single vessel.
- The quantum of a material imported and exported by sea.

Vessel Specification

5.10.2 AMEP will need to provide berthing facilities for vessels importing raw material, exporting products and for installation vessels. Typical specifications for vessels currently operating are detailed in *Figure 5.15.*

Figure 5.15 Typical Vessel Specification for Turbine Transport and Installation (Abstract from Terratech, 2010)

Table 3-10
Principal Dimensions of Specific Turbine Import Vessels
(Source: The Glosten Associates 2009)

Vessel Name	Length Overall	Beam	Design Draft
BBC ELBE	143 m (470')	23 m (74.8')	9.7 m (31.8')
BBC KONAN	127 m (416')	21 m (68.2')	6.7 m (21.8')
Beluga F-Series	138 m (453')	21 m (68.9')	8.0 m (26.2')
Clipper MARINER	101 m (331')	20 m (66.3')	8.2 m (26.9')

Table 3-11
Typical Dimensions of Turbine Installation or Transport Vessels
(Source: The Glosten Associates 2009)

Length Overall	90 – 140 m (300' – 450')
Beam	30 – 40 m (100' to 130')
Navigation Draft	3.6 – 4.9 m (12' to 16')
Air Draft (legs in up position)	varies, approximately 46 m (150')
Air Draft (tower sections, bunny ears)	46 m (150')
Air Draft (crane in stowed position)	varies

Source: Terratech, 2010

The Number of Vessels operating from the Humber

Installation Vessels

5.10.3 In order to estimate how many installation vessels are likely to require a berth at AMEP, it is necessary to estimate the rate of installation of these vessels. As noted in *Section 5.7*, The Crown Estate's publication, 'A Guide to an Offshore Wind Farm', provides useful data on the requirements for quays serving the offshore wind energy sector. (Whilst the Guide uses the term "construction port", in the context of AMEP, the term needs to be understood as a quay with associated land behind. The term "construction port" reflects the principal installation methods in use at the moment which is a distributed supply chain transporting all of the component parts for a single project to a "construction port" for pre-assembly). The Guide indicates that a single 200 m quay can pre-assemble and export up to one hundred 3 MW, OWTs per year.

5.10.4 Using historical installation rates is not necessarily relevant to future needs however, as most installations to date have used either 3 MW or 3.6 MW turbines which are considerably smaller than those likely to predominate in Round 3. In addition, Round 3 zones are in deeper water and further offshore than Round 1 and 2 projects developed to date.

5.10.5 The recent Alpha Ventus offshore project involved the construction of twelve 5 MW offshore wind turbines in 30 m deep water in the German economic zone, 45 km offshore. This was a demonstrator project that will inform future planning of similar schemes. Installation of six tripod foundations commenced in April 2009 and was complete on 1 June. The six jacket foundations were installed in only six days during September, though this was because all the piles for the jackets had been driven in advance of the "jackets" arrival on site; this was facilitated by using a template set on the seabed. Erection of the turbines was undertaken in a series of lifts: three tower sections, the nacelle and the blades – five lifts in total. The project Factsheet (January 2011) records the impact of weather on the erection sequence:

> '*Weather plays a decisive role in offshore work in the North Sea. For the installation of the foundations, the sea should be as calm as possible. The same is true for the winds during the construction of the wind turbines above sea level. These weather conditions occur in the North Sea, but never for long periods at a time. Therefore, the construction phases of the wind farm had to use flexibly "windows of opportunity", during which the wind turbines could be erected under good conditions. To some extent, **these windows of opportunity opened up only for individual days at most**. If one were to calculate the total time in which those windows of opportunity occurred, it would be equal to **several months of the year**. The time period from the placing of the first foundation until the actual final assembly of the last wind turbine amounted to seven months, from mid April to mid November 2009 – with breaks due to bad weather calculated in. Added to this is the time needed for the commissioning of the turbines. While work is in progress, the weather conditions are kept under close observation with detailed local weather forecasts. Construction planners have to take account of the difficult weather conditions by keeping plans in reserve that enable them to abort operations or adopt alternative approaches – and*

have to be able to respond flexibly at all times. This flexibility places high demands on the planning of the logistics to be employed: Weather-influenced construction progress and employed logistics must both come together in order to successfully erect a wind farm.'

5.10.6 Wind and wave frequency distributions for sites around the British Isles is reported by the Health and Safety Executive (Fugro GEOS, 2001). Abstracts for the Dogger Bank zone are reproduced in *Figure 5.16*.

Figure 5.16 Wind and Wave Frequency Distribution for Dogger Bank

Mean Wind Speed – Percentage Exceedence Distribution

m/s	knots	BF	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
0.0	0	0	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
0.3	1	1	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1.6	4	2	100.00	100.00	100.00	99.97	99.96	99.72	100.00	99.97	99.98	100.00	100.00	99.97	99.96
3.4	7	3	97.76	97.61	97.30	95.74	90.22	87.39	90.39	93.22	97.16	97.76	98.46	97.36	95.01
5.5	11	4	88.90	87.02	88.36	81.96	66.42	67.31	63.71	74.89	80.52	85.99	89.26	88.22	80.16
8.0	17	5	71.76	67.94	68.81	54.70	33.46	30.48	31.31	38.53	57.53	60.67	68.83	68.86	54.32
10.8	22	6	49.13	43.87	42.25	24.48	10.41	8.63	7.89	13.40	28.89	32.34	45.48	45.52	29.27
13.9	28	7	25.06	21.53	19.94	6.25	1.11	1.25	0.73	2.57	10.11	9.76	18.67	21.33	11.47
17.2	34	8	9.79	8.15	4.32	1.45	0.01	0.08	0.07	0.03	2.16	2.67	4.72	6.68	3.32
20.8	41	9	2.00	1.80	0.18	0.00	0.00	0.00	0.00	0.00	0.14	0.64	0.80	1.28	0.56
24.5	48	10	0.09	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.06	0.02
28.5	56	11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
32.7	64	12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mean WS			10.95	10.46	10.25	8.61	6.95	6.81	6.74	7.48	8.96	9.31	10.37	10.51	-

Significant Wave Height – Percentage Exceedence Distribution

m	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
0.0	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
0.5	99.16	100.00	100.00	98.02	90.56	90.00	89.47	93.10	97.38	99.57	100.00	99.46	96.36
1.0	90.21	87.84	91.65	76.88	57.26	54.01	48.09	56.93	76.76	84.82	90.23	87.41	75.08
1.5	75.69	67.30	68.64	49.75	29.31	23.97	22.96	29.82	53.10	60.02	68.66	72.55	51.72
2.0	57.89	50.18	49.81	29.28	14.46	10.20	10.02	15.31	33.78	39.44	51.59	55.27	34.69
2.5	40.93	36.67	35.48	17.30	6.11	5.42	4.77	7.86	20.65	23.71	37.19	41.11	23.02
3.0	29.98	24.56	24.50	9.87	1.96	2.24	2.26	4.03	12.05	13.10	24.55	28.43	14.75
3.5	21.97	17.78	15.82	5.98	0.48	0.65	0.67	2.05	7.30	7.65	14.91	18.50	9.44
4.0	14.00	12.34	9.73	3.86	0.06	0.28	0.15	0.63	4.34	5.21	7.90	11.81	5.83
4.5	9.80	7.78	4.69	2.02	0.01	0.00	0.00	0.00	2.73	2.72	4.95	7.18	3.47
5.0	6.25	4.74	1.97	1.11	0.00	0.00	0.00	0.00	1.45	1.51	3.15	4.17	2.01
5.5*	3.74	3.39	0.84	0.57	0.00	0.00	0.00	0.00	0.82	1.12	1.62	2.23	1.18
10.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mean HSIG	2.52	2.34	2.27	1.72	1.26	1.19	1.15	1.30	1.80	1.97	2.29	2.42	-

* Note that for all significant wave height presentations, class intervals of 0.5m are used up to a value equivalent to the 1% exceedence level, in this case 5.5m. Thereafter, all higher wave heights are grouped into a single class, in this case 5.5m to 10.5m.

Source: Fugro GEOS, 2010

5.10.7 The above data shows, for example that:

- in January, the wind speed exceeds BF6 (strong breeze) 49.13 per cent of the time and the average wind speed is 10.95 m/s;
- in January, the average significant wave height is 2.52 m; and
- in June, the wind speed exceeds BF3 (light breeze) 67.31 per cent of the time.

5.10.8 The above figures are significant because jack-up vessels which are used to install the turbines can only jack when weather conditions permit; limiting conditions are typically a significant wave height of less than 2 m and winds less than BF6. In addition, lifting the hub and blade assembly requires very calm weather conditions. Thus, it may not be practical to use such vessels at Dogger Bank for several months of the year and there would be limited windows during the remainder of the year.

5.10.9 The data for Norfolk Bank is reproduced in *Figure 5.17.*

Figure 5.17 Wind and Wave Frequency Distribution for Norfolk Bank

Mean Wind Speed – Percentage Exceedence Distribution

m/s	knots	BF	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
0.0	0	0	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
0.3	1	1	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1.6	4	2	100.00	99.95	99.96	99.97	99.88	99.81	99.85	99.84	99.98	99.96	99.98	100.00	99.93
3.4	7	3	96.26	93.86	95.17	93.41	86.78	84.68	85.57	87.90	93.07	95.22	96.98	96.52	92.10
5.5	11	4	84.70	77.68	81.01	74.75	62.83	56.44	58.07	62.92	72.10	80.53	84.23	82.24	73.10
8.0	17	5	62.01	52.95	54.56	40.19	28.59	23.80	23.08	29.06	41.85	50.81	62.15	61.60	44.18
10.8	22	6	36.25	27.79	24.04	13.82	6.50	3.66	3.44	8.86	15.94	24.50	34.61	38.14	19.76
13.9	28	7	15.65	10.12	6.54	2.75	0.39	0.11	0.10	1.70	3.19	6.98	12.25	15.88	6.29
17.2	34	8	3.93	3.21	0.39	0.32	0.00	0.00	0.00	0.01	0.20	1.00	2.27	4.14	1.28
20.8	41	9	1.00	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.14	0.87	0.22
24.5	48	10	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.10	0.02
28.5	56	11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
32.7	64	12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mean WS			9.64	8.70	8.54	7.54	6.52	6.12	6.15	6.65	7.60	8.49	9.45	9.65	-

Significant Wave Height – Percentage Exceedence Distribution

m	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
0.0	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
0.5	93.93	92.57	93.61	91.10	81.40	77.73	78.46	78.68	87.90	91.43	94.23	93.64	87.85
1.0	66.02	57.35	57.69	47.57	37.20	30.32	27.53	33.69	47.50	57.80	65.93	67.98	49.67
1.5	41.60	33.67	29.03	20.57	13.25	6.40	6.33	12.88	20.51	30.31	41.44	44.97	25.04
2.0	26.72	18.93	14.34	8.08	4.45	1.27	1.22	5.06	8.78	16.13	24.12	28.41	13.11
2.5	14.87	10.69	6.33	3.43	0.52	0.26	0.27	1.48	3.41	7.89	12.05	14.62	6.30
3.0	6.75	5.21	1.94	1.76	0.10	0.00	0.00	0.18	1.10	3.63	4.34	7.33	2.69
3.5*	2.62	3.00	0.46	0.36	0.00	0.00	0.00	0.00	0.31	1.18	1.87	3.12	1.07
6.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mean HSIG	1.52	1.37	1.27	1.11	0.94	0.83	0.82	0.91	1.10	1.29	1.48	1.56	-

* Note that for all significant wave height presentations, class intervals of 0.5m are used up to a value equivalent to the 1% exceedence level, in this case 3.5m. Thereafter, all higher wave heights are grouped into a single class, in this case 3.5m to 6.0m.

Source: Fugro GEOS, 2010

5.10.10 The above data is very different to Dogger Bank, for example:

- in January, the wind speed exceeds BF6 36.25 per cent of the time and the average wind speed is 9.64 m/s;
- in January, the average significant wave height is 1.52 m; and
- in June, the wind speed exceeds BF4 (moderate breeze) 56.44 per cent of the time.

5.10.11 Accordingly, vessel utilisation for Norfolk Bank is likely to be significantly higher than for Dogger Bank. This illustrates the difficulty of assessing berth requirements. However an estimate of installation rates has been undertaken using the following assumptions:

- when utilised vessels operate 24/7;
- vessels have a payload capacity of 3 000 T, allowing three 5 MW turbines to be transported together;
- vessel loading takes 24 hours;
- vessels have a transit speed of 8 knots;
- vessels are not used in months when the average significant wave height exceeds 2 m or the average wind speed exceeds 8 m/s. This translates into around 120 operational days at Dogger Bank or 180 operational days at Norfolk Bank;
- vessel jack up takes 8 hours allowing for adverse weather conditions;
- installation of one complete turbine takes 12 hours; and
- vessel jack down takes 4 hours.

5.10.12 On the above basis, it is estimated that a reasonable annual installation rate might be in the range 70 – 110, depending on the particular zone. This would mean that between seven and ten installation vessels would be operating at any particular time around the British Isles, requiring a commensurate number of quays. For AMEP to assemble the majority of its products on site, around 500 complete turbines, then between four and six construction quays are needed, each around 200 m in length. This equates to an overall quay length for installation vessels of up to 1 200 m.

5.10.13 It must also be recognised however, that new methods of installation are emerging that will allow the complete turbine to be erected in a single lift. One such proposal is that promoted by Strabag and illustrated in *Figure 5.18* below. The vessel is expected to install 80 complete turbines per year. The vessel needs a stern loading facility that is also incorporated into the AMEP quay.

Figure 5.18 *The Strabag Installation Vessel*

Source: www.strabag-offshore.com [accessed 9 September 2011]

5.10.14 In summary, AMEP needs five construction quays of 1 000 m overall length and a dock capable of stern loading to enable future technologies to be accommodated. In addition to this an import/export quay is required.

5.11 *UK DELIVERY PLAN*

5.11.1 At the beginning of this chapter the imperative need for the development of new manufacturing facilities for the offshore wind sector was derived from the following premises;

- world production of energy needs to be decarbonised;
- the UK must ensure security of its energy supply whilst managing its own transition from fossil fuels to renewable forms of energy over the next few decades; and
- the UK needs to increase its manufacturing base and target investment in areas of relative deprivation to reduce social imbalance between regions.

5.11.2 Whereas there is a demonstrable need for new manufacturing and for construction port facilities in the UK, and whereas there is a Government aspiration to maximise the socio economic benefits of the emerging renewable energy sector, there is no strategic UK delivery plan. It is, instead, for the private sector to promote and finance projects that provide the necessary infrastructure for offshore wind development.

5.11.3 The emerging offshore industry needs bespoke development sites and an unplanned, piecemeal approach needs to be avoided to ensure that the sector has the confidence to invest and to ensure that the environmental impacts of an extended logistics chain is avoided. MEPs that support significant manufacturing clusters will enable the UK to maximise the economic benefits of growth in the manufacturing sector. Sites in excess of 150 ha which combine a construction port and a manufacturing cluster capable of producing up to several hundred complete OWTs per year are necessary to address the urgency and scale of these needs.

5.12 CONSULTATION

5.12.1 A number of responses were received during the statutory consultation period. The responses of relevance are summarised in *Annex 2.1*.