POWER: Pushing Offshore Wind Energy Regions

Transnational Offshore Wind Supply Chain Study

Final Report – May 2006

A Report to the POWER Project

DOUGLAS-WESTWOOD

This study was commissioned by Suffolk County Council on behalf of the following partners of POWER's supply chain / economic development work stream:

- Denmark: Offshore Center Denmark
- Germany: Business Development Corporation Nordfriesland (WFG NF); The Senator for Construction, Environment and Transport of the Free State of Bremen; Wind Energy Agency Bremerhaven/Bremen (WAB)
- The Netherlands: Stichting Bedrijfsregio Kop van Noord-Holland, Den Helder; City of Den Helder
- The UK: Suffolk County Council; EEEGr - East of England Energy Group; Waveney District Council

The study is co-financed by European Regional Development Funding (ERDF) through the Interreg North Sea Programme. An electronic copy is available for download at the POWER website: www.offshore-power.net

The separate appendices document to this report is available from the POWER website

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Appendices are available as a separate PDF file

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1 Summary & Conclusions

1.1 Introduction

The POWER Project regions who have commissioned this study, in Denmark, Germany, The Netherlands and The UK are the centre of the world's offshore wind industry. It was here that the first offshore wind farms were built and it is here where the industry is forecast the strongest growth in the future.

The POWER Project seeks to identify future markets and develop co-operation between individual countries in order to achieve maximum benefit for the Southern North Sea region, and the industry as a whole.

1.2 Market Forecasts

There is currently over 700 MW of offshore wind capacity installed worldwide across 20 offshore wind farms in 7 countries. 96% of all current capacity is from the four POWER countries.

The total global offshore wind capacity forecast for installation between 2006 and 2010 stands at 7.4 GW. The four POWER Project countries have a total of 4.2 GW of this total capacity, over half the world market. This shows the considerable importance of Denmark, Germany, The Netherlands and the UK on a global scale.

Total global expenditure in offshore wind is forecast to exceed €13 billion for the 2006-2010 period. Annual expenditure will quickly grow until the end of the period to a level in excess of €5 bn/yr.

The POWER Project countries are forecast a total expenditure of €7.7 billion over the next five years which is 61% of all global offshore wind expenditure.

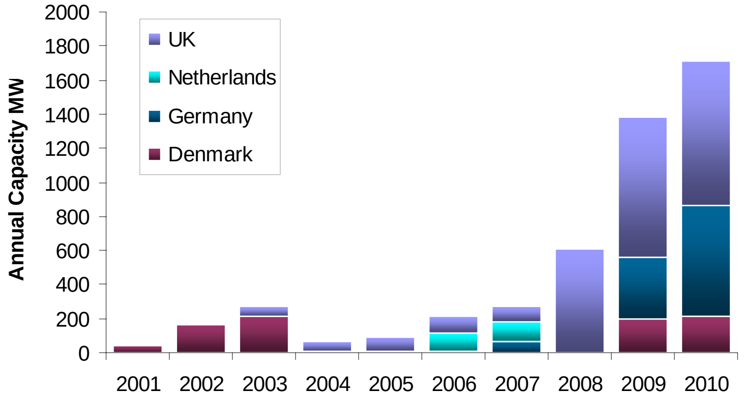

Figure 1-1: Annual Capacity

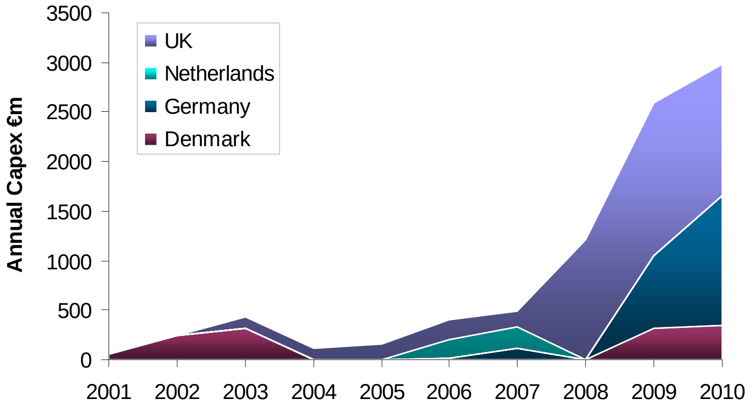

Figure 1-2: Annual Expenditure

1.3 Employment Forecast

As part of the research undertaken for the study, the potential for job creation in each of the POWER countries was investigated for the size of the offshore wind market that is forecast. The job creation figures below are from across the project lifecycle – development through construction to operation.

	2006	2007	2008	2009	2010	Total
POWER	394	198	1,463	2,996	615	5,666
Others	0	745	1,008	1,473	1,663	4,889
Total	394	943	2,471	4,469	2,278	**10,555**

Table 1-1: Employment Forecast

A total of the equivalent of 10,555 new jobs in offshore wind power could be created between 2006-2010. It is forecast that 5,666 of these jobs would be in the POWER Project countries.

The full set of assumptions made in forecasting man-hours and job creation is stated in the Market Forecasts chapter of the report.

1.4 Supply Chain Capability

The POWER regions currently have varied offshore wind supply chains that have developed around existing domestic and international wind power markets. Denmark and the German regions, for example, have a very high capability in procurement and manufacturing, being home to the world's biggest turbine manufacturers and the supply chains that have been established around them. The UK and The Netherlands POWER regions' supply chains are structured differently, being stronger in servicing functions and weaker in manufacturing.

Whilst no individual region can demonstrate excellence in every aspect of the offshore wind supply chain, **together, the individual POWER regions have full capability throughout all identifiable supply chain activities.** This has already been proven in the establishment of the world offshore wind market here. Already home to market leaders, as the offshore supply chain grows, the focus of it will continue to be based in the POWER region.

The POWER region contain the world's leading suppliers to the offshore wind industry and together with their supply chain they have the ability to present an unequalled offering in European and global markets.

The development, procurement, installation and operation of offshore wind farms in the Southern North Sea region already utilises skills and experience from the entire region. This will increasingly be the case as companies with key competences undertake international work.

The combined excellence possessed by the POWER region as a whole will be further proven as the offshore wind industry enters the forthcoming high-growth period from 2008 onwards. The region is fully capable of supporting projects undertaken within its own area, in Europe as a whole, and holds potential to gain value from market developments elsewhere in the world.

1.5 Challenges

Offshore wind is a high risk industry and its growth has been constrained through challenges which continue to prove difficult to overcome. Through co-operation each of these challenges must be overcome for the POWER region as a whole to maintain and build upon it's world-leading status. The major issues that have been identified throughout the POWER regions are centered on the issues of:

- **Planning** – The offshore wind planning and approval process is often vague, inadequately structured and frequently slow. It does not currently fit with country's offshore wind development scenarios.

- **Cost** – The main issue at present in the industry relates to the cost of offshore wind development which is estimated in this report to be approximately 20% too high. Cost savings must be found.

- **Risk** – Strongly related to the issue of cost is risk. Improperly managed it inflates project costs to inoperable levels. The imbalance of risk on developers and contractors is causing real problems.

- **Contracting** – Contracting strategies are currently changing from an EPC basis to a multiple-contract approach in an effort to address the issue of risk and with the aim of reducing costs.

- **Financing** – Financing provided via subsidies or grants remains crucial to offshore wind development and will do so until the industry can demonstrate cost-competitiveness without them.

- **Technology** – Technology development is crucial to maximise the potential of offshore wind. Primarily surrounding larger models of turbines, the introduction of new technologies needs to be carefully assessed to avoid costly failures that have already impacted on the industry.

- **Politics** – Politics remains the single largest driver for the development of offshore wind. Whilst offshore wind remains so costly continued support is vital through renewable energy targets and government coordinated development programmes. Energy need is secondary to this but is of growing importance.

1.6 Recommendations

The POWER region is the world leader in offshore wind, both in operational and planned capacity, and in capability. This is not enough to ensure the successful development of offshore wind projects in the region. Actions must be taken to increase knowledge and build relationships between individual regions and the companies in them.

At present the POWER regions are clearly ‘ahead of the game’ and have major advantages in seeking export business. The challenge is now how to use this position to maximum long-term advantage to realise the considerable offshore wind potential of the southern North Sea and to capture and defend future export markets.

The recommendations made in this report are targeted at government, public bodies, development agencies and individual companies. Examples of the recommendations include:

Market information
There is a lack of easily accessible information dissuades companies from considering market entry.

- Offer a free market intelligence service to companies including a future projects database, a database of supply chain companies and a tendering opportunities database.

Coordinated policies & agencies
Competing publicly funded organisations duplicate work and generate confusion.

- Initiate a series of workshops to bring together public bodies involved in offshore windpower

Offshore oil & gas expertise
This considerable experience has not been fully utilised.

- Seminars / share fairs
- Participate in O&G trade shows
- Articles in O&G magazines

Business to business linkage
Considerable benefits to new entry companies.

- ‘Speed dating’ (introductory service) via POWER website

2 Introduction

The POWER (Pushing Offshore Wind Energy Regions) project is a three year European project co-financed by the European Regional Development Fund through the Interreg IIIB North Sea Programme. POWER creates a North Sea competence network for offshore wind energy. The project assesses environmental and planning as well as acceptance issues of offshore wind farms, supports the development of a reliable regional supply chain for the sector, and elaborates skills development measures. The project runs from July 2004 to July 2007.

The aims of the POWER Project are:

- to unify offshore wind competence regions around the North Sea
- to exchange experience and to learn from each other
- to set up common strategies and real business to business contacts overcoming economic changes
- to respond to new educational needs on the university and further education levels
- to disseminate the obtained results to others.

One workstream of the POWER Project focuses on the supply chain and economic development in the offshore wind sector within regions with the ambition and opportunity to benefit economically from the evolving offshore wind industry. As part of the work package, each of the participating partner regions conducted a regional study on the offshore wind energy supply chain. These studies aimed to inform the regions on specific strengths and gaps within their supply chain to the offshore wind sector and to facilitate the development of strategies supporting supply chain development.

The Transnational Study combines the findings of each supply chain study within the participating regions to provide an overview of the offshore wind energy supply chain within the Southern North Sea region. Specific focus is paid to identifying regional gaps, complementarities, opportunities for further collaboration and the different timescales envisaged for the construction of offshore wind farms in the respective countries and their impact on pinch points of the supply chain.

This study is based on the following regional studies:

- **Denmark**
  Study conducted by Offshore Center Danmark and AC Consult

- **Germany**: Lower Saxony, Bremen and Schleswig Holstein
  Study conducted by Logistik-Service-Agentur

- **The Netherlands**: Kop van Noord-Holland
  Study conducted by Bedrijfsregio Kop van Noord-Holland

- **The United Kingdom**: East of England
  Study conducted by Douglas-Westwood Ltd

Analysis undertaken in this study is based on previous work undertaken for the specific regions above. Please be aware that the reports above are all downloadable from the main POWER website at www.offshore-power.net

It should be noted that the Danish study looked at Denmark as a whole, whereas the other three country's studies were focused on individual regions within each country.

2.1 Aims & Objectives

The transnational study will combine the results from the four regional studies done under the POWER Project and the Dutch study conducted in advance of it. The aim is to provide a North Sea overview of the offshore wind energy supply chain, establishing regional gaps, complementarities between the regions and opportunities for further collaboration. The transnational study recognises the global scale of the offshore wind market and looks at the role the POWER regions can play in it, looking at potentials for joint offers to cover all the requirements of an increasing market.

Specific objectives of the study are to:

- Combine the study results from the regional POWER studies, looking at the North Sea Region as an international market
- Explore the different timescales for the industry in the different countries – what are the challenges deriving from this and doe this timeframe possibly offer opportunities for cooperation?
- Assess compatibility and/or complementarity of the supply chains in the POWER regions
- Assess implications for the supply chain and the potential for cooperation
- Recommend areas for cooperation and potential mechanisms for such cooperation
- Forecast the total value in terms of expenditure and man-hours regarding offshore wind development in the North Sea region.
- Develop a market complementarity matrix showing regional capabilities and areas of complementarity and competition between the North Sea Regions
- Produce profiles for all planned and operational offshore wind farms in the North Sea
- Produce a database of all planned and operational offshore wind farms in the North Sea.

A summary document will additionally be issued in March 2007 as an update to this study.

2.2 Methodology

2.2.1 Research Procedures

The methodology used for the production of this study was principally based on desk-research. The desk-research largely involved the use of the four regional POWER studies from Denmark, Germany, The Netherlands and The UK. Other in-house sources of data used included Douglas-Westwood's *The World Offshore Wind Database*, which tracks all planned and operational offshore wind farms worldwide. Use was made of regional and industry-wide supply chain databases to assess regional capability across the range of offshore wind industry activities.

2.2.2 Market Forecasting

The forecasting process is based on a thorough independent scrutiny of the available data on a project-by-project basis. Each project is carefully evaluated, taking into account factors such as current status, project size, location, progress to date, operator, legislation, financing, etc.

As a result of this evaluation, some projects have been postponed by one or, in some cases, two or more years. This 'slippage' of projects allows this forecast to reflect the delays and schedule overruns that are common in the industry. Also, it is likely that a number of projects will not move beyond their early evaluation stages and will not become reality.

To generate the estimates of the Capex associated with the historic and forecast installations, the information used has been released into the public domain by operators and their contractors. This has, on occasion, been supplemented by additional information gathered from discussions with informed sources within the manufacturing, operating and contracting communities. Where no cost-related information is available forecasts are based on estimates of analysis of unit size, development size and conditions at the field location. These parameters are then cross-compared with costs reported for similar units installed in comparable circumstances.

2.2.3 POWER Regions

From inception Douglas-Westwood has strived to give equal weighting to each POWER Region in this report wherever possible. The principal resources used in the creation of this report were the individual regional studies.

Please note that each region is listed alphabetically in all tables in this document.

2.3 Development Scenarios

Supply chain analysis will be based upon two scenarios, reflecting the differences between the existing supply chain for smaller turbines in relatively shallow waters and the required future supply chain for large-scale deeper water offshore wind farms. The two scenarios are defined as:

- **Scenario 1** – developments using turbines with a capacity of up to 3.9 MW, located at sites with a water depth not exceeding 25 metres. This scenario covers all already realised offshore wind farms, and some planned developments, and requires an assessment of supply chains of already known and used techniques – both with regard to turbine size and foundation type.

- **Scenario 2** – developments using turbines with a capacity in excess of 4 MW, located at sites in water depths of more than 25 metres. This scenario covers the planned larger farms in deep waters, where tripod or other types of foundation are necessary, and required installation equipment may differ from Scenario 1 developments due to the increased size and weight.

The project databases and profiles included in the Appendices of this report identify which specific projects belong in each category for each country.

3 Offshore Wind Markets

3.1 Industry Drivers and Trends

3.1.1 Energy Consumption

World primary energy consumption increased by 4.3% in 2004. Asia was responsible for much of this consumption, with a 8.9% annual growth energy consumption. China in particular is experiencing surging growth and the country saw a 15.1% growth in consumption in 2004.

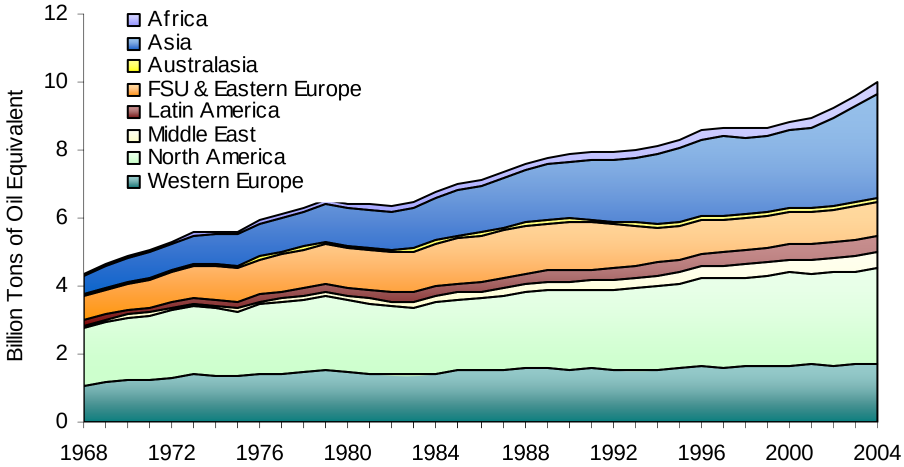

Figure 3-1: Primary Energy Consumption – Billion Tonnes of Oil Equivalent
Data Source: BP Statistical Review of World Energy 2005

3.1.2 Energy Price Increases

"…the world is at the start of a second phase of a three-stage oil super cycle that could last 'till 2012"
Goldman Sachs, Dec 2005

The main impact of this increase in energy demand has been a considerable growth in oil prices, again to a great extent driven by China, where oil demand has increased by 122% in a decade. Demand is also increasing from the other developing economies such as India.

Oil supplies have been unable to meet growth in demand and oil prices have rocketed. The situation has been compounded by a decline in oil production from mature areas of the world such as the North Sea. Although there is some potential for oil price falls in the short term (as more large fields come onstream across the world) the beginnings of much higher and sustained prices could be seen before 2010.

Like most other commentators Douglas-Westwood expect high oil prices to continue. Price forecasts for 2006 from some major sources include:

- $64-$65 – EIA
- $61 – Barclay's Capital
- $56 – Standard & Poor's
- $30s (mid) – CGES

High oil prices result in increases in demand for other energy sources and their prices also increase, particularly coal and gas.

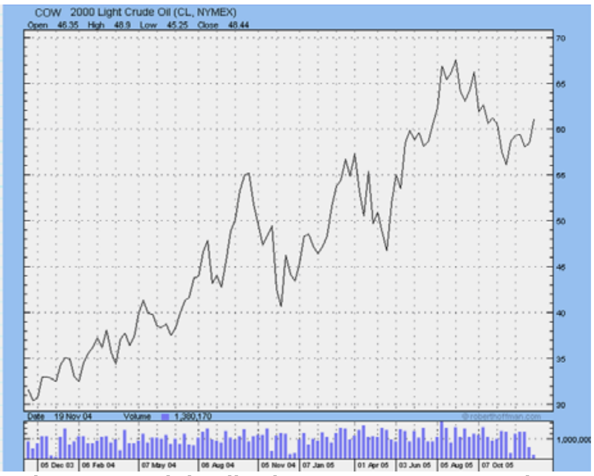

Figure 3-2: High Oil Prices Seem Set to Continue
Source: Futures Trading Charts

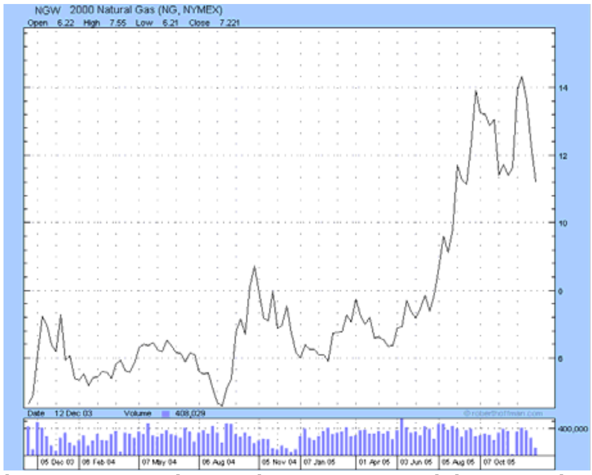

Figure 3-3: Local Gas Shortages are Driving up Prices
Source: Futures Trading Charts

Problems have also developed in gas with declines in gas production in the US and UK causing shortages of supply and major price increases and this is impacting on power generation costs.

"(UK) gas for delivery the next day touched 80p a therm – up from 43p a week ago"
Financial Times, Nov 18th 2005

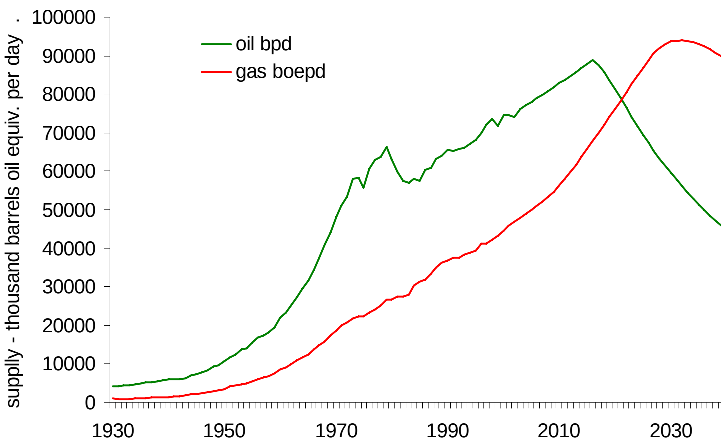

Figure 3-4: Oil Supplies Could Peak in the Next Decade
Source: '*The World Oil Supply Report 2005*' (Douglas-Westwood)

Looking ahead the energy supply situation could become more acute. It is now widely forecast that the growth in oil supplies could reach a peak within the next decade.

However, this situation holds an upside for renewable energy in that increasingly constrained oil supplies will boost overall energy prices and improve the comparative economics of offshore wind power.

3.1.3 Security of Energy Supplies

The recent interest in the development of renewable energy has been mainly driven by concerns over global warming. However, a new issue is now 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 US) and political actions by the world's largest gas supplier – Russia.

"The era of easy access to energy is over.
There is more competition for energy resources all over the world"
David O'Reilly, Chief Executive, Chevron - Wall Street Journal, April 18th, 2005

As individual countries increasingly compete for ever-more limited oil & gas resources worldwide, considerations of security of supply have become a strategic issue. The risks of not addressing this problem have become more prominent as a result of Russia's restrictions of gas supplies to several former Soviet states in January 2006 – however, these same pipelines also deliver 25% of Europe's gas supplies and the major use of this gas is in power generation.

Given the circumstances outlined above, it seems reasonable that both the EU and national governments must review energy supply security to produce policies and budgets consistent with impending shortfalls in the coming years. Japan and China are competing for Russian oil whilst a number of countries in Western Europe and Asia are already facing up to the prospect of energy supply shortfalls and are beginning major programmes to encourage renewables and alternative energy. However, some alternative transport fuels such as hydrogen made from natural gas would probably require at least 15 to 20 years to bring fully on-stream and the economics remain difficult.

"Access to energy is shaping up as one of the key issues of the century"
The World: 2006 – Financial Times Special Report, January 25th 2006

Ultimately, energy suppliers and countries alike must cope with declining oil production and locate and compete for new energy supplies by diversifying, increasing imports and/or developing indigenous alternatives. When and to what extent they can do this, and the degree to which the exporting countries can and will rapidly increase oil and gas production to meet new external demands are fundamental to Europe's economic health.

With no associated "fuel" supply risk, renewables such as wind, wave and tidal power have a valuable part to play in Europe's future energy supply equation.

3.1.4 Coastal Population Growth

The pictures below show the change in light emitted over the past 30 years. They also clearly demonstrate how coastal populations have grown – a global phenomenon. 44 % of the world's population (more people than inhabited the entire globe in 1950) live within 150 kilometres of the coast. In 2001 over half the world's population lived within 200km of a coastline. The rate of population growth in coastal areas is accelerating and increasing tourism adds to the pressure on the environment. One example of this incredible growth is Casablanca who's population soared from 600 in 1839 to 29,000 in 1900, and to almost 5 million today. In the United States, around 53% of the population lives near the coast and since 1970 there have been 2000 homes per day erected in coastal areas. In China alone, where the urban population is expected to increase by over 125% in the next twenty five years, over 400 million live on the coast.[1]

Figure 3-5: Growth in European Light Levels and Hence Electricity Use: 1970's and 2000

[1] UN Atlas of The Oceans

Offshore wind power has advantage in this situation by offers the prospect of generating large amounts of non-polluting renewable energy from a source within a few kilometres of end users. The implications are that a considerable global market could be available to developers of windpower technology and the supply chain. On addition to the five-year market forecasts we give in this report, we understand that China is in the early stages of planning a massive growth in offshore windpower with the aim of installing enormous levels of capacity within a decade to support the country's rapid economic development.

3.1.5 Government Support

Fourteen years after the first offshore wind farm was built, the single most important driver for offshore renewable energy at present is government support. It remains the single factor with the highest influence on offshore renewable energy projects and technologies from conception, through planning to construction.

The countries that are forecast to see the highest levels of activity are primarily those that have the most cohesive and sustained support. Natural resource is obviously a determining factor, but at this stage in the industry that is only relevant if there is enough political determination to enable projects to be realised.

Project financing and planning are the two biggest stumbling blocks for offshore wind at present. Projects, in the majority of cases, are simply not economic without financial subsidies of one kind or another. Whether this be through payments made per kWh generated, or otherwise, an offshore wind farm cannot reach economic viability without it. This will certainly not be the case in the long-term, but until the industry can achieve greater cost efficiency through advanced technologies, contractor experience, and economies of scale, government level subsidies will continue to be required.

This requirement is also necessary to build confidence in the industry for external investors which are often needed for the financing of projects. Investors need to be confident that governmental support is going to be present throughout the 20-year life of the installation. Short (5 years) and mid-term (10 years) renewable energy targets are valued, but it is the long-term (15-20 years) outlook that is proving to be most important.

3.2 Market Forecasts

Analysis of the future world offshore wind market is presented below for forecast installed capacity and capital expenditure. The four POWER Project countries are clearly shown. `It should be noted that these figures represent projects installed anywhere off the respective countries and not just inside the specific study areas.

3.2.1 Forecast Capacity

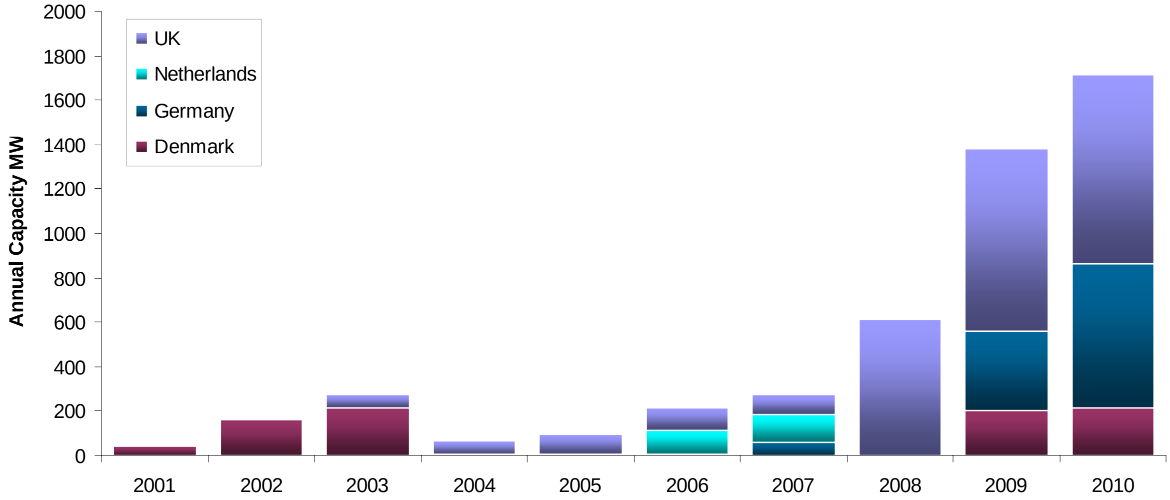

Figure 3-6: Forecast Annual Capacity MW

Table 3-1: Forecast Annual Capacity MW

Capacity MW	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2006-2010
Denmark	40	163	213.4	0	0	0	0	0	200	215	415
Germany	0	0	0	4.5	4.3	4.5	62	0	360	650	1077
The Netherlands	0	0	0	0	0	108	120	0	0	0	228
UK	0	0	60	60	90	100	90	611	820	850	2471
Others	21			27			223	526	968	1467	3184
POWER Total	40	163	273	65	94	213	272	611	1380	1715	**4191**
Global Total	61	163	273	91	94	213	495	1137	2348	3182	**7374**

The total global offshore wind capacity forecast for installation between 2006 and 2010 stands at 7.4 GW. The four POWER Project countries have a total of 4.2 GW of this total capacity, a 57% world market share. This shows the considerable importance of Denmark, Germany, The Netherlands and the UK on a global scale.

The UK is the world's largest market for the forthcoming five year period. A total of 2.7 GW is forecast here, representing 34% of the entire world market. The UK's prospects are expected to be twice those of Germany for this period, although the German market at 1.1 GW is still the second largest in the world. Long-term prospects are excellent off Germany but in the short and mid-term future the industry has much to overcome. Denmark has only two main projects planned for completion by the end of the decade with 200 MW each at Horns Rev and Nysted which are now making progress. The Netherlands has just two confirmed projects which will be commissioned in 2006 & 2007. No firm prospects have emerged from the last licensing round but long-term potential is there.

3.2.2 Forecast Capex

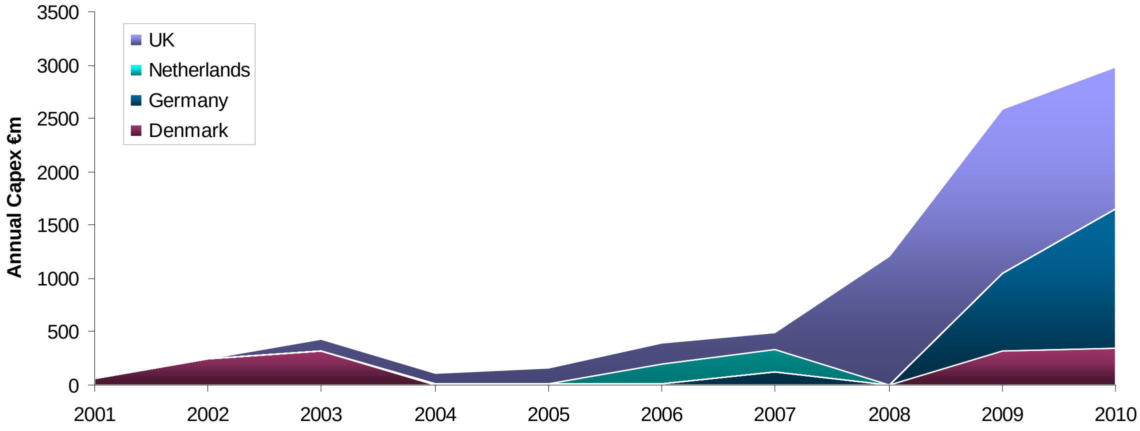

Figure 3-7: Annual Capex €m

Table 3-2: Annual Capex €m

Capex €m	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2006-2010
Denmark	64	250	320						320	351	671
Germany				7	7	8	120		731	1,300	2,159
Netherlands						189	218				407
UK			114	108	154	199	153	1,212	1,541	1,330	4,435
Others	29			44			341	846	1,712	2,464	5,363
POWER Total	64	250	434	115	161	396	491	1,212	2,592	2,981	**7,672**
Global Total	93	250	434	159	161	396	832	2,058	4,303	5,445	**13,035**

Total global expenditure in offshore wind is forecast to exceed €13 billion for the 2006-2010 period. Expenditure is expected to be around €400 million in 2006 which will quickly grow until the end of the period when annual expenditure will exceed €5 billion.

The POWER Project countries are forecast a total expenditure of over €7.6 billion over the next five years which is 59% of all global offshore wind expenditure. The UK alone has an expected spend of €4.4 billion.

Overall, the two combined forecasts for capacity and expenditure suggest a development cost of €1.67 per MW which represents an optimistic cost target given some recent project costs. As the industry grows it is hoped costs will fall, an issue that is examined elsewhere in this report.

3.2.3 Forecast Man-Hours

Following on from assumptions made in the East of England POWER study and scaling these findings up to the total forecast capacity presented earlier in this section an estimate of the total work required for the realisation of the identified offshore wind capacity can be made.

Table 3-3: Forecast Man Hours & Man Years

Activity	Total Hours	Total Years*	POWER Hours	POWER Years*
Development Design	1,138,301	593	672,686	350
Environmental Monitoring	128,436	67	75,900	40
Insurance/Legal	53,367	28	31,538	16
Surveys	116,760	61	69,000	36
Project Management	3,405,391	1,774	2,012,436	1,048
Detailed Design	2,324,053	1,210	1,373,413	715
Procurement & Manufacture	12,042,735	6,272	7,116,724	3,707
Transport & Delivery	610,017	318	360,493	188
Onshore Pre-Assembly	3,188,529	1,661	1,884,280	981
Onshore Installation	6,597,734	3,436	3,898,969	2,031
Offshore Installation	6,495,079	3,383	3,838,304	1,999
Commissioning	3,682,642	1,918	2,176,278	1,133
Operations & Maintenance	8,403,139	4,377	4,965,884	2,586
Miscellaneous	1,622,590	845	958,879	499
Total	**49,808,773**	**25,942**	**29,434,784**	**15,331**

*Man years assumes a standard working year of 1920 hours

A total of almost 50 million man-hours of work will be undertaken for the development, procurement, installation and operations & maintenance (5 years) of offshore wind in the 2006-2010 period. This equates to 26,000 years of work in total.

Over 29 million man-hours of work is expected to be carried out in the offshore wind industry in the POWER Project countries in this same time period, a total of over 15,000 man-years.

The most labour intensive part of the whole industry is procurement and manufacturing which accounts for over 24% of all work forecast over the next five years. Operations and maintenance is another large area with over 8 million man hours expected to be needed for projects built over the period (see note on O&M in assumptions below). Installation work both onshore & offshore are the next largest work packages, each accounting for approximately 13% of total work conducted.

The tables below consider in detail the extra man-hours/man-years needed each year in relation to the annual market growth. This can form the basis of estimating the number of jobs that can potentially be created in the industry each year and in total. For instance, in 2008 there would be a need for approximately 1500 new jobs in the industry in the POWER regions.

Table 3-4: Estimated Additional Industry Employment Needs Per Year – Global

	2006	2007	2008	2009	2010	Total
MW per year	213	495	1,237	2,578	3,261	7,784
Total man hours	1,359,788	3,170,065	7,914,283	16,495,342	20,869,059	49,808,536
Total man years*	708	1,651	4,122	8,591	10,869	25,942
Extra man hours from previous year	756,362	1,810,277	4,744,219	8,581,059	4,373,717	20,265,633
Extra man years from previous year*	394	943	2,471	4,469	2,278	10,555

*Man years assumes a standard working year of 1920 hours

Table 3-5: Estimated Additional Industry Employment Needs Per Year – POWER Countries

	2006	2007	2008	2009	2010	Total
MW per year	213	272	711	1610	1795	4,600
Total man hours	1,359,788	1,740,528	4,549,689	10,302,390	11,483,006	29,435,400
Total man years*	708	907	2,370	5,366	5,981	15,331
Extra man hours from previous year	756,362	380,741	2,809,161	5,752,701	1,180,616	10,879,580
Extra man years from previous year*	394	198	1,463	2,996	615	5,666

*Man years assumes a standard working year of 1920 hours

In total, and bearing in mind the assumptions stated below, it is suggested that the global offshore wind industry will create the equivalent of over 10,000 jobs in the 2006-2010 period.

Our research suggests that over the period, the equivalent of 5,600 offshore wind jobs, more than 50% of the world's total, will be created in the POWER countries of Denmark, Germany, The Netherlands and the UK.

Assumptions made in forecasting future employment needs

By scaling man-hours/man-years in this way, assumptions must be stated. Firstly, we have assumed that a new man-year of work is equal to one new job.

Furthermore, the assumptions made include the fact that an increase in the amount of production, installation etc does not necessarily lead to a corresponding increase in man-hours because factors such as economies of scale come into effect.

Difficulties also arise when comparing differences between technologies which will change over the forthcoming five-year period, for instance, the man-hours needed to produce a 5 MW turbine are not directly correlated to the man-hours needed to produce a 3 MW turbine.

The above figures by their nature would assume that 100% of all work undertaken in the POWER countries is carried out in those countries. It also allocates work to the year projects come online – some procurement and manufacturing work would be carried out in the year(s) before this.

It should also be noted that the figures for operations & maintenance cover five years O&M for each project installed each year (the standard length of manufacturer's initial warranty contract).

Whilst very important for development of the sector, the subject of skills/education is addressed in Work Package 3 of the POWER Project and is, therefore, not specifically addressed in this report.

4 Combined Regional Studies

This chapter of the report gives a summary of combined project finding and investigates areas of similarity and difference between the experiences of the individual regions. Areas where regions can co-operate are highlighted and areas of direct competition examined.

4.1 Regional Industry Timeframes

Each of the individual POWER countries has different past, current and future market conditions and prospects. These differing timeframes have occurred because of a range of conditions which will be explained.

For example, there is Denmark which was the first country to build offshore, is the current world leader in terms of installed capacity but has no current activity and limited prospects. In comparison there is Germany which has had no commercial activity whatsoever but which has the highest amount of proposed capacity in the world.

4.1.1 Summary of Market Development in POWER Regions

The table below shows the differences between the regional timeframes when comparing installed capacity with forecast capacity and the period of initial major development and the forecast period of market 'take-off'.

Table 4-1: Summary of Market Development in POWER Regions

	Installed Capacity	Forecast Capacity	Initial Development*	Market Growth
Denmark	426 MW	415 MW	2001-2003	2009-2010+
Germany	7 MW	1,249 MW	2008-2009	2009-2010+
The Netherlands	13.4 MW	228 MW	2006-2007	2010+
The UK	304 MW	2,708 MW	2003-2007	2008-2010+

*Although some small projects may have been installed prior to these periods, the dates given represent commercial growth.

4.1.2 Denmark

Installations to date – Following a strong history in onshore wind, Denmark installed the first offshore wind turbines in 1991 at Vindeby and installed a second project in 1995 at Tunø Knob. The first large project, a 40 MW site, was completed at Middelgrunden in 2001. In 2002, the 160 MW Horns Rev project was completed, which was the largest project ever built. The 165 MW Nysted project at Rødsand followed it in 2003 with several smaller sites also coming online.

Current status – Since 2003 no further installations have occurred. The Danish government had originally planned for several other major projects to be built, but this policy changed and they were stalled. Later the government announced the intention to build two 200 MW 'extensions' to the Horns Rev and Nysted projects.

Future prospects – Horns Rev II is currently scheduled for completion in 2009. In June 2005, the Danish Energy Authority (DEA) awarded Energi E2 the contract to build the wind farm. The wind farm will be built 10km west of the Horns Rev wind farm and is currently expected to become operational in 2009. The 200 MW Nysted II project will be built by a consortium consisting of Energi E2, E.ON Sweden and DONG VIND. It is expected online in 2010.

Beyond these two main wind farms there are no other currently planned projects.

Timeframe summary:

- Initiator of offshore wind industry in 1991
- First large scale projects
- From 2003 progress stalled
- Current prospects: 2x 200MW projects for construction 2009/2010
- Further development remains unclear

4.1.3 Germany

Installations to date – Germany has a very strong onshore wind industry but its offshore wind installations have barely yet begun. A 4.5 MW prototype turbine was installed at Ems Emden in 2004 and in 2006 a 2.5 MW turbine was installed at Rostock. These are both nearhsore turbines – no full offshore projects have yet been built. Two 5.0 MW prototype turbines are installed in Bremerhaven and Brunsbüttel on land near the coastline. Further 5.0 MW prototype turbines will be installed in 2006 in Bremerhaven and Cuxhaven.

Current status – The German offshore sector has approximately 10 fully approved projects, but none of these have received a cable permit and they cannot progress until they do so. As already mentioned in this report, the majority of sites suitable for offshore wind development are in deep waters and/or far offshore. These technically difficult conditions naturally mean the German sector will develop later than other countries, but progress is currently being held back by the permitting issues.

Future prospects – Germany has set a government target for the development of offshore wind farms with an installed power of 25 GW by the year 2030. The 10 fully approved offshore wind farms will represent an installed rated power of 3 to 5 GW, depending on the selected turbines, when installed. Many other projects have been applied for and are currently under investigation by the licensing authorities. The construction of the first projects is currently forecast to begin between 2008 and 2010 and several large developments are expected online by the decade.

Germany will ‘take off’ once 5 MW class turbines are widely available as many of the proposed wind farms plan on using these to make overall project economics more viable. A proposed 12-turbine development at Borkum West phase 1 for 5 MW turbines is currently planned for 2007. This test site will be home to prototype 5 MW turbines from the manufacturers Enercon, REpower and Multibrid (see appendix section for a full profile).

Overall, whilst little physical progress has been achieved the industry here holds significant promise, it just desperately requires initial projects to hit the water and firm commitment from the government to the sector.

Timeframe summary:

- Only individual nearshore prototype turbines recently installed
- No full-scale projects
- Technically difficult project locations
- Very high number of projects planned
- Large scale development only begins late this decade

4.1.4 The Netherlands

Installations to date – The Netherlands has two small nearshore shallow-water projects at an inland lake, the first of which Lely was completed in 1994. The second larger project was complete in 1996.

Current status – There is two projects underway off the Netherlands, both at an advanced stage. The 108 MW Near Shore Windpark off Egmond is in construction at present and due online by the end of the year. The 120 MW Q7-WP project off Ijmuiden is expected to be complete in 2007.

Future prospects – Policy on offshore wind in the Netherlands is frequently changing which causes a great deal of uncertainty. The new support mechanisms are workable but are taking time to take effect. The most recent call for proposals to meet the governments aim of 470 MW of capacity by 2010 saw 59 proposed projects but none of these have yet moved forward. Long-term future development seems likely judged on the very high level of interest in the market but there are presently no projects in planning that are likely to be built this decade.

Timeframe summary:

- Early adopter – Two small projects in 1990's
- Two projects nearing construction
- Moderate future prospects, but not for some time.
- Market conditions are uncertain and have fluctuated

4.1.5 The UK

Installations to date – The UK's first entrance into offshore wind came in 2000 with the two turbine Blyth project. The first commercial scale projects began in 2003 with the 60 MW North Hoyle wind farm off the Welsh coast. Scroby Sands, another 60 MW project, followed in 2004 off the East of England. In 2005 the 90 MW Kentish Flats project was completed and work began on the 90 MW Barrow project which will come online in spring 2006. Current capacity stands at 304 MW, second to only Denmark.

Current status – In 2006 the only major project completed will be Barrow. The Beatrice demonstration site will see two 5 MW turbines installed in over 40m of water later in the year. The UK until recently was expected to have a busy offshore season in 2006 and 2007, but many project delays mean that the boom has fallen back to 2008. Concerns on project costs are currently being raised – these were the reasons for project delays off the UK.

Future prospects – The UK is the strongest offshore wind market in the world with excellent mid-term and long-term prospects and supportive mechanisms in place to structure offshore wind development. Each year from 2008 to 2015 significant activity is forecast.

Timeframe summary:

- Pilot project in 2000
- Three full-size projects in operation, 1 in construction
- Many projects planned for next 10 years
- Very good market prospects
- Structured and supportive development framework

4.1.6 Regional Strengths and Weaknesses Overview

Key strengths and weaknesses have been assessed for each individual region and are displayed below. Note that this is representative of the current time, in the future some of these factors will certainly change as each region develops. Note that the Danish study looked at Denmark as a whole rather than a single region.

Table 4-2: Key Strengths and Weaknesses of Each Region

Country & Region	Key Strengths	Key Weaknesses
Denmark	• Turbine manufacturing • Established wind supply chain • Early experience in offshore wind • O&G skills/experience • Key industry players	• Few suitable ports • Lack of offshore projects planned • Long-term prospects uncertain
Germany Schleswg-Holstein & Bremen/Niedersachen	• Turbine manufacturing • Established wind supply chain • Good long-term market prospects	• No projects yet • Development of offshore wind is challenging off Germany • Lacks offshore 'leaders'
The Netherlands Kop van Noord-Holland	• Good ports • Manufacturing capability of support structures and turbine components • O&G skills/experience	• Uncertain market conditions
The United Kingdom East of England	• High growth market • Long-term market prospects • O&G skills/experience • Proven O&M capability • Support mechanisms in place	• Very limited manufacturing • Use of ports depends on upgrades • Poor local infrastructure

4.1.7 Opportunities Arising from Differing Development Timeframes

The different experiences of each of the four countries create opportunities for companies and governments to capitalise on the previous experience or predicted growth in neighbouring markets. These opportunities can range from commercial ones for manufacturing or service companies to export their products or services which might be as varied as subsea cables or foundation installation, to knowledge-based benefits that can be gained to help ease future development.

A full examination on the potential for regional cooperation is presented later in this chapter.

4.2 Regional Supply Chain Capabilities

Each of the four individual POWER regions' capability in servicing different stages of the offshore wind supply chain is examined below. This is displayed graphically using charts which show capabilities ranked low, medium or high for the natural lifecycle of wind farm development, procurement, installation, and operations.

Table 4-3: Supply Chain Activity Classification

Capability Category	Description
Development Design	Initial project development. Consultancy, planning, management
Environmental Monitoring	Environmental surveys, wildlife studies, noise monitoring
Surveys	Geotechnical surveying, site surverys
Detailed Design	Detailed project development services
Project Management	Managing construction of projects
Insurance & Legal	Project insurance costs and legal services
Procurement & Manufacturing	Turbine, foundation and cabling manufacturing
Transport & Delivery	Shipping of component parts
Onshore Pre-Assembly	Ports and associated services
Onshore Installation	Onshore cabling and grid connection
Offshore Installation	Offshore turbine, foundation and cable installation
Commissioning	Post-installation turbine connection and testing
Operations & Maintenance	Daily operation of the wind farm and routine & emergency servicing of it

The capability categories used were defined by Douglas-Westwood Ltd and ODE Ltd whilst undertaking the Scroby Sands – Supply Chain Analysis project for Renewables East which looked at local content in the Scroby Sands offshore wind farm in the East of England. Categories were created encompassing all activities within the lifecycle of an offshore wind farm. These were in-line with activities defined within the *Catalogue of Energy Industry Classifications* – a system Douglas-Westwood developed for the East of England Energy Group (EEEGR). This study is included as an appendix to this report.

4.2.1 Denmark

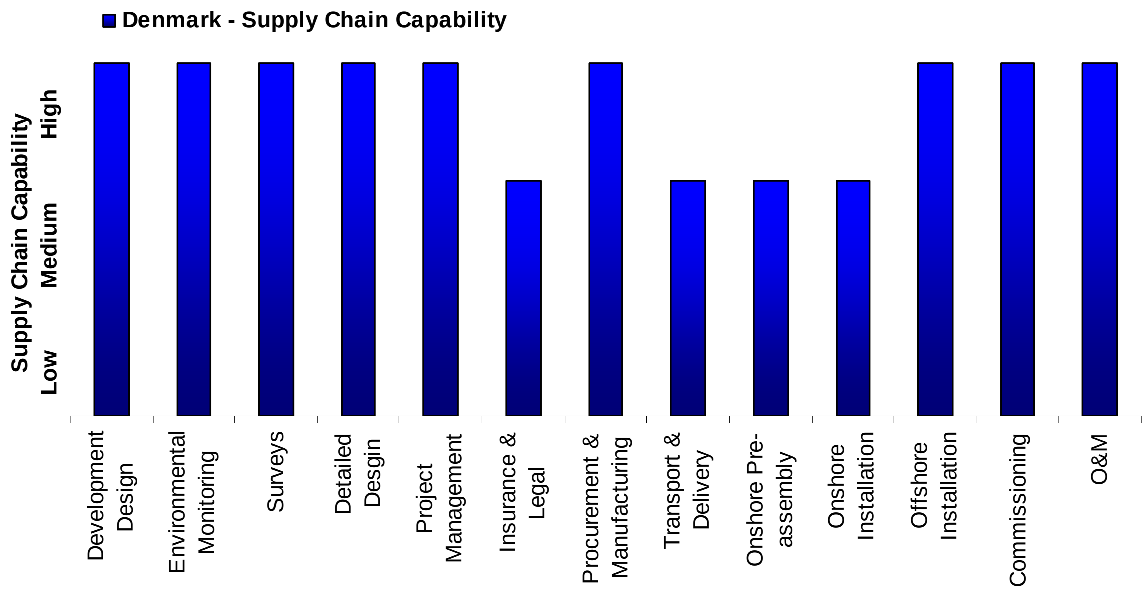

Figure 4-1: Denmark – Supply Chain Capability

Note: The Danish POWER study looked at the entire Danish supply chain, not a single region

Strengths – With its very strong onshore wind sector and early entry into offshore wind, Denmark has a very strong capability across most of the supply chain which ably supported its two recent major projects at Horns Rev and Nysted.

All development work activities are well-proven with existing onshore skills being largely transferable. The major utilities are already experienced in developing and operating projects. Denmark can also boast some world-leading environmental agencies who have produced some very interesting studies.

Procurement and manufacture is varied. Denmark is home to the largest turbine manufacturer in the world, Vestas plus other majors such as Siemens, so the supply chain for turbines is exceedingly strong. Offshore foundations and cabling on the other hand is not so well-developed. Offshore installation capabilities are world-leading.

Weaknesses – Whilst Denmark has adequate port facilities they are not outstanding in an international capacity, hence on the chart above the port-related work is rated as being of moderate capability. The ports have proved to be fully capable of supporting existing projects but if offshore Denmark really takes off further improvements would be worthwhile.

Overview

- Denmark has strong industry capabilities
- All aspects of project design & management are well-proven
- Turbine production established, offshore cables & foundations not as strong
- World-leader for turbine installation
- Has the most experience in operations & maintenance.

4.2.2 Germany – Schleswig-Holstein & Bremen/Niedersachen

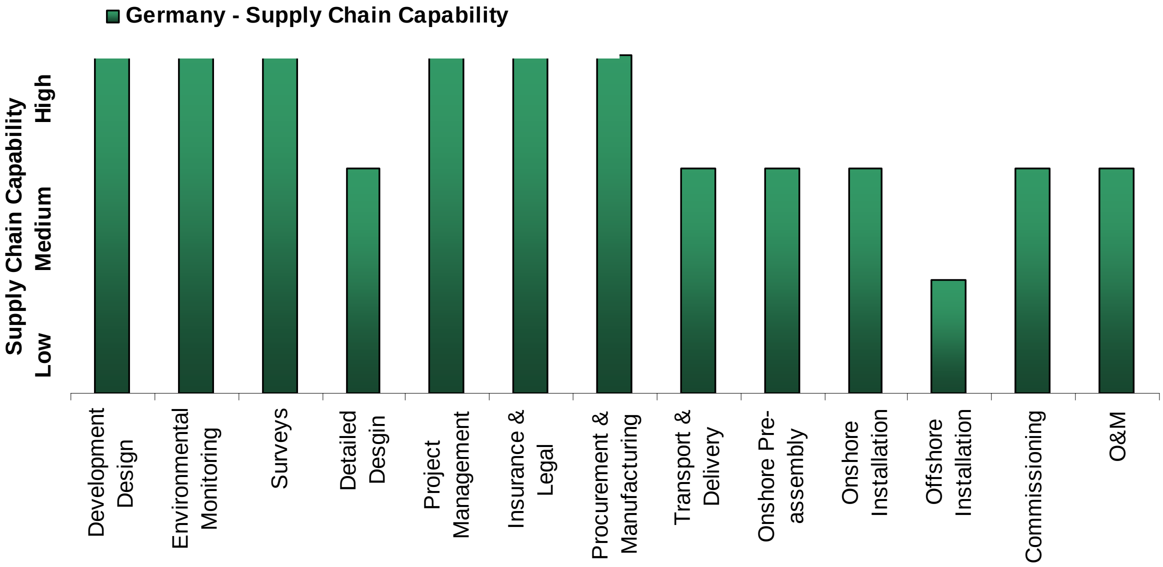

Figure 4-2: Germany – Supply Chain Capability

Strengths – The German POWER regions have a number of key strengths and broad capabilities, mainly centred around the development and procurement phases of the project lifecycle with less capabilities in construction and operations.

Capability in project development work is well-proven from Germany's onshore wind industry and the many ongoing offshore wind project proposals demonstrate the quantity and quality of work being undertaken in this area by German companies. Project management and legal work is very strong as the regions are home to some major companies in these areas.

Procurement and manufacturing is an area of key competence, Germany is home to major turbine manufacturers such as Nordex.

Weaknesses – Port related activities are of moderate capability, but with no projects yet installed off Germany their capability is unproven.

Offshore installation is a weak area with few German contractors available to undertake large-scale work. Whilst commissioning and operations & maintenance is proven onshore the lack of offshore experience results in these activities being rated as moderate capability.

Overview

- German regions' core strength is in manufacturing
- High-value turbine & turbine component supply work
- Ports not yet fully capable of supporting future wind industry
- Undeveloped offshore construction capabilities
- Offshore wind capabilities beyond the development and procurement phase are largely unproven to date.

4.2.3 The Netherlands – Kop van Noord-Holland

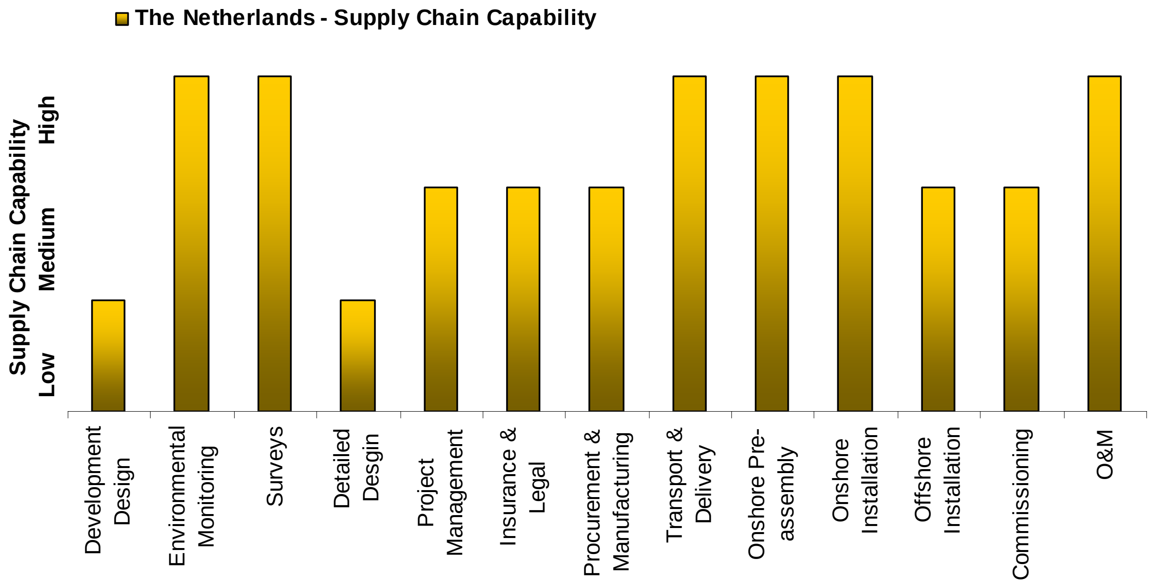

Figure 4-3: The Netherlands – Supply Chain Capability

Strengths – The Netherlands' POWER region has a different set of capabilities to other those in the other countries. Strengths lay in the middle to end of the offshore wind project lifecycle. Project management and legal activities are of moderate capability and can meet the country's needs. In procurement and manufacturing, although not home to any turbine manufacturers, The Netherlands has specific capabilities in cabling and foundation manufacturing which have been well proven with Dutch companies supplying many international offshore wind projects to date.

The core strength is in the regions' ports which are superb and definitely the best in the POWER region. This gives associated activities such as transport, pre-assembly etc a high capability. Additionally the region, with particular focus on the port of Den Helder, is actively marketing itself as a maintenance base for the greater POWER region.

The Netherlands has some existing offshore installation capacity that has been proven internationally and some major contractors are planning specialist installation vessels.

Weaknesses – There is a slight weakness in the region in some of the project development activities with little proven capabilities here other than an excellent strength in site surveying and environmental work.

Overview

- Netherlands has broad range of capability
- Moderate manufacturing capability although strong for cables/foundations
- Extremely good ports for logistics, construction & servicing
- Offshore installation is an area targeted for growth.

4.2.4 The UK – East of England

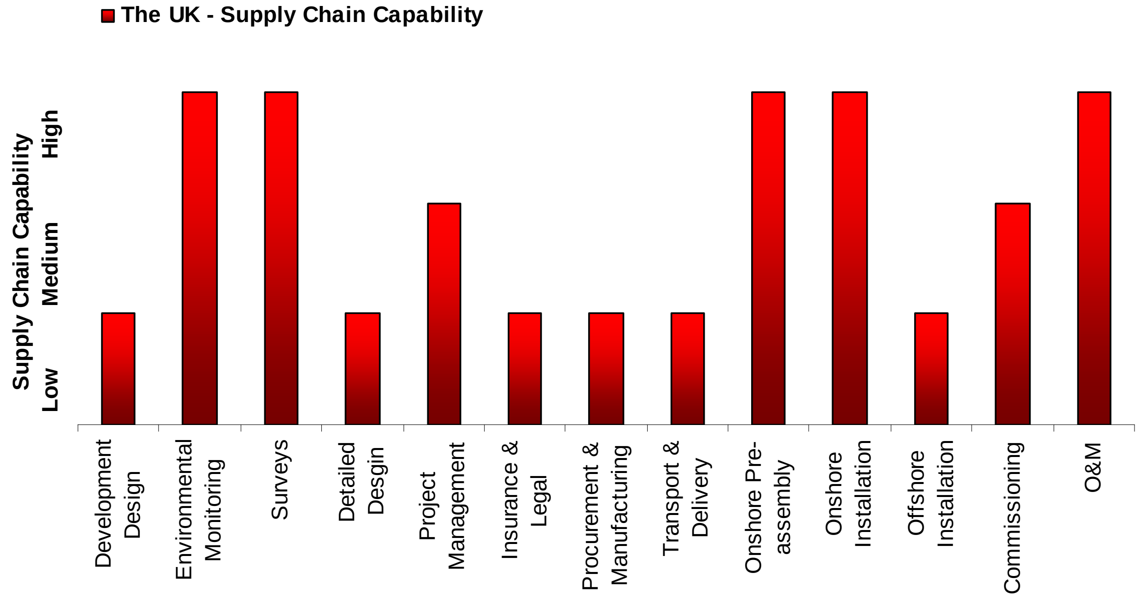

Figure 4-4: The UK – Supply Chain Capability

Strengths – The East of England region has proven its strengths and capabilities through involvement in the Scroby Sands project in 2004. With a background in servicing the offshore oil & gas industry it has unique skills that are transferable to offshore wind.

Key strengths in the development phase appear in the site investigations areas, namely environmental monitoring and site surveys. Project management is a moderate capability; the region is home to such companies, one of whom managed the construction of the Scroby Sands project.

The region has some good ports which support pre-assembly and the ongoing operations & maintenance phases which is particularly strong. Onshore works associated with offshore wind development can be carried out completely by regional companies.

Weaknesses – The region lacks specific offshore wind developers which lowers its capabilities in some aspects of the development phase, although as mentioned, developmental support activities are strong. Insurance and legal work for UK projects is largely conducted from outside the region in London.

Transport & delivery (outside of port-based activities) is a weakness, with the regions' onshore infrastructure being poor. Little capability exists in offshore installation within the region.

The East of England lacks an offshore wind 'leader' in its supply chain which means regional companies are looking elsewhere in the UK or to the continent.

Overview

- East of England region has proven capability
- Small region compared to other POWER regions
- Strong developmental support – surveys/environmental
- Region lacks offshore wind manufacturing
- Ports are an asset and have been used for offshore wind
- Operations & maintenance a key development areas.

4.2.5 Overview of Regional Capabilities

The chart below is a comparison of the regional capability charts above and displays regional capabilities in high, medium and low categories. This begins to establish the areas where regions are sometimes lacking in capability and experience and thus where potential for regional co-operation exists. The same results are displayed in a different format on the following pages.

Capabilities
The key strengths and skills of each region.

Capabilities	**Denmark**	**Germany** Schleswg-Holstein Bremen/Niedersachen	**The Netherlands** Kop van Noord-Holland	**The United Kingdom** East of England
High Capability	Environmental Monitoring Surveys Development Design Detailed Design Project Management Procurement & Manufacture Offshore Installation Commissioning Operations & Maintenance	Environmental Monitoring Surveys Development Design Procurement & Manufacture Insurance/Legal Project Management	Environmental Monitoring Surveys Onshore Pre-Assembly Transport & Delivery Onshore Installation Operations & Maintenance	Environmental Monitoring Surveys Onshore Installation Onshore Pre-Assembly Operations & Maintenance
Moderate Capability	Transport & Delivery Onshore Pre-Assembly Onshore Installation Insurance/Legal	Detailed Design Transport & Delivery Commissioning Onshore Installation Onshore Pre-Assembly Operations & Maintenance	Insurance/Legal Project Management Procurement & Manufacture Offshore Installation Commissioning	Project Management Commissioning
Low Capability		Offshore Installation	Development Design Detailed Design	Development Design Detailed Design Procurement & Manufacture Transport & Delivery Offshore Installation Insurance/Legal

Figure 4-5: Market Matrix – Regional Capabilities

4.2.6 Regional Capability Throughout the Supply Chain Lifecycle

	Development Design	Environmental Monitoring	Surveys	Project Management	Insurance & Legal	Detailed Design
High Capability	Denmark Germany	Denmark Germany The Netherlands The UK	Denmark Germany The Netherlands The UK	Denmark Germany	Germany	Denmark
Medium Capability				The Netherlands The UK	Denmark The Netherlands	Germany
Low Capability	The Netherlands The UK				The UK	The Netherlands The UK

Figure 4-6: Regional Capability Throughout the Supply Chain – Development Phase

	Procurement & Manufacturing	Transport & Delivery	Onshore Installation	Onshore Pre-assembly	Offshore Installation	Commissioning	Operations & Maintenance
High Capability	Denmark Germany	The Netherlands	The Netherlands The UK	The Netherlands The UK	Denmark	Denmark	Denmark The UK The Netherlands
Medium Capability	The Netherlands	Denmark Germany	Denmark Germany	Denmark Germany	The Netherlands	Germany The Netherlands The UK	Germany
Low Capability	The UK	The UK			Germany The UK		

Figure 4-7: Regional Capability Throughout the Supply Chain – Manufacturing and Installation Phases

4.3 Regional Complementarity

It has been established that each POWER Project region has a different set of supply chain attributes with some regions better placed to service different aspects of the industry. The table below presents an overview of the regions in their current status.

Table 4-4: Regional Comparison

Activity	Denmark	Germany	The Netherlands	The UK
Manufacturing	High	High	Moderate	Low
Services	High	High	Moderate	High
Exports	High	High	Moderate	Low
Market to 2010	Small	Moderate	Small	High
Active companies	164	506		142

4.3.1 Complementarity Overview

Together, the four POWER regions have total capability of servicing the entire offshore wind supply chain to the fullest extent. Each region has areas of expertise that it can offer to the development of the industry as a whole.

Due to the open marketplace each region can export products and services for use in regional projects. The differences in each region's supply chain was analysed earlier in the report and showed that international help will be required in bringing each region's offshore wind prospects to realisation. Each region has a different set of capabilities and needs, no one region is entirely self sufficient for it's forecast level of development to 2010.

The range of different projects emphasises these facts, as there is a great deal of variation in project attributes which further increases the need for, and benefit of, an international supply chain.

The highly different industry timeframes in each region further offer the potential for cooperation. When one region is experiencing high growth at a time when others are not, this naturally attracts international companies to the local region's market. Ultimately the sheer size of the industry will result in an increasingly international marketplace.

The industry is moving away from EPC style contracts meaning that multiple-contract and potentially alliance-style contracting will become common. This offers enormous potential for cooperation for regional companies and creates significant benefit. As previously discussed, companies within the four POWER Project countries have extremely high levels of competence and experience and can therefore shape the world's largest offshore wind market and help each other grow to service new markets that will emerge globally in the future.

There are distinct areas of competition already evident but this is natural for any industry. The areas of competition that will be looked at in this section of the report are largely product or service related, which are issues that only occur at company level and only affect individual offshore projects. The *benefits* that can be accrued in the POWER regions are far wider reaching than that and can affect the industry as a whole, value which cannot always be measured.

4.3.2 Specific Areas of Complementarity

Supplier \ Recipient	Denmark	Germany	The Netherlands	The UK
Denmark		Turbine installation Turbine components Consultancy Knowledge	Turbine supply Consultancy Knowledge	Turbine supply Consultancy Knowledge
Germany	Turbine components		Turbine supply Turbine components	Turbine supply Turbine components
The Netherlands	Cable supply Foundation supply Ports O&M	Cable supply Foundation supply Ports O&M		
The UK	Cable supply Foundation supply Foundation installation	Turbine installation Foundation installation Knowledge	Knowledge	

Figure 4-8: Market Matrix – Examples of Areas of Regional Complementarity

Turbines – The major international turbine manufacturers will, of course, be the main suppliers to the offshore wind industry. The turbine market is an international one and this will continue. Opportunities for co-operation exist where manufacturers set up assembly plants in other countries to better service regional markets, or plants for the manufacturing of major in-house components such as generators or blades. The high number of components in turbines are sourced internationally and this is a strong behind the scenes example of the international industry that is already in place.

Operations & maintenance – Whilst there will be much competition for high-value and long-term O&M work, there is potential for co-operation between regions. The Netherlands, and to a lesser extent the UK, have the particular ability to position themselves as service centres for international offshore wind projects. With less manufacturing capability than Denmark and Germany this regional positioning is of strategic value.

Other manufacturing – Likewise, all major manufacturing companies involved in offshore wind have a very large potential market ahead of them and in some cases they may be best placed to service this demand through establishing subsidiaries or partnerships in POWER regions.

Knowledge – The most beneficial ways the POWER regions can complement each other is through the knowledge, skills and experience that has built up from establishing the world's offshore wind industry. Together they have the best experiences of the difficulties that have already been overcome and can offer the best solutions for dealing with future issues as they arise. The industry must adopt further best practice guidelines and establish specific safety regulations that can be adopted worldwide.

4.4 Regional Competition

The figure below shows some areas where regions are directly competing against each other.

	Denmark	Germany	The Netherlands	The UK
Denmark		Turbine supply Turbine components Ports	Turbine installation	Turbine installation Foundation installation Ports
Germany	Turbine supply Turbine components Ports		Ports	
The Netherlands	Turbine installation	Ports		Cable supply Foundation supply Turbine installation Foundation installation Ports
The UK	Turbine installation Foundation installation Ports		Cable supply Foundation supply Turbine installation Foundation installation Ports	

Figure 4-9: Market Matrix – Key Areas of Regional Competition

4.4.1 Competition Overview

Although the offshore wind industry is still very young there is naturally competition being seen already. The level of competition is set to grow as the industry develops and a real market takes-off.

The areas of competition shown in the chart above are effectively examples of common capabilities where regions will be competing against each other for work.

As discussed earlier in the report, each of the four POWER regions is forecast to develop as a market within different timescales. This can create situations where there is increased competition for contracts. In the last two years there has only been a small number of projects built off the UK and the major international offshore wind contractors targeted these jobs en-masse.

The four POWER regions are geographically close and for some activities this creates opportunities for contractors to service international markets easily. Whilst majors like turbine manufacturers are constantly looking to international markets as a matter of course, smaller companies wanting to work in the industry are getting the opportunity to tender for projects in locations they may not do if there are more suitable projects being built locally.

Competition *can* be healthy. A high level of competition is good for the industry as a whole as it should lead to lower prices which is currently of great importance.

4.4.2 Specific Areas of Competition

Turbines – The wind turbine is the highest value part of the offshore wind industry supply chain and is the area where the greatest level of competition is already seen. This is competition between rival manufacturers rather than between individual countries. Other than the competition to win turbine supply contracts between players largely based in Denmark and Germany, it manifests itself in other ways that are ultimately beneficial to the industry as a whole.

The highly competitive segment leads the major manufacturers to put tremendous emphasis on research and development of improved turbines. This is most easily seen in the current drive to achieving commercial production of 5 MW class turbines at a time when 3 MW machines are the most common being installed in today's projects. Their development represents a huge technological step forward and a very important shift for the industry as the 5 MW turbine is seen as being key to the large-scale, economically-viable, development of offshore wind.

Competition and the resulting investment in R&D pushes reliability in turbines, as project operators want minimum downtime for maximum generation potential.

Ports – Ports have a central role in the offshore wind supply chain due to the number and value of activities conducted from them. Competition is already visible between ports in single regions, each trying to gain experience on early projects that can be capitalised on in the future.

Whilst one assumption would be that a local port will be chosen for regional offshore wind farms this in fact will not always be the case. The proximity of Germany & Denmark and The Netherlands & Germany for example gives potential for international ports being used for local projects. The East of England faces specific competition with ports such as Esbjerg in Denmark.

Project logistics such as where manufacturers of key components are located can affect port choice. Such issues are looked at in detail in the Ports & Logistics chapter of this report. The main issue for the future concerns the installation of the large offshore wind farms which will necessitate the use of very large ports or multiple smaller ports to facilitate their construction.

The competition between ports is, therefore, likely to increase in the long-term.

Foundations – Whilst each region has some capability in foundation manufacturing, some of the major suppliers are based in the UK and Netherlands, giving rise to competition between them for contracts.

The size and weight of foundations means that it is preferable to chose a local supplier but the industry has already seen many cases of internationally sourced foundations being used for projects.

Douglas-Westwood believe that foundation production is a likely future pinch point for the industry because demand is likely to outstrip supply if the forecast project installations occur as scheduled. There is a limited number of manufacturers who are capable of producing the type of foundations necessary. So whilst in the short-term future there is high competition regionally and internationally, this situation could be somewhat diverted by high demand whereby the majority of leading manufacturers should be able to win contracts. The very large contracts are in fact likely to be split between companies so that demand can be met on the short lead-times that have become a familiar characteristic in offshore wind.

Cables – Cable manufacturing is another highly competitive market, currently shared between only a handful of major players, the majority of which are based in the UK and The Netherlands. Competition is therefore likely between the two regions for these contracts. Dutch companies have already won UK supply contracts and UK companies will be looking to Dutch waters when the industry further develops there.

Installation – Turbine and foundation installation is high-profile and high-value work. Whilst the first decade of small-scale offshore wind installations was undertaken by standard crane barges and jack-ups, recent large-scale projects have been installed largely by specialist vessels from a small number of contractors. These type of contractors will typify offshore wind installation for the foreseeable future. Leading installation companies for turbine installation include Denmark, The Netherlands and The UK. For foundation installation the same countries are again prominent with The Netherlands and The UK having a stronger capability.

There is already much competition for the limited offshore work that is taking place between contractors from these countries. With only one or two wind farms being installed per year, all the major contractors are naturally investigating each in detail.

The installation market is set to change as the industry picks up pace and a situation where there is a shortage of available installation capacity looks to be likely by the end of the decade. As projects increase in size, the amount of time spent on each increases due to the larger number of turbines and foundations required. A single contractor can, therefore, be tied up on one project for the entire installation season.

As offshore wind farms in the identified Scenario Two category emerge the demands placed on contractors dramatically increases. Few companies are currently capable of installing 5 MW class turbines in 30 metres of water with the heavier and larger components. Although some of the present market leaders are planning new vessels to service the need there will be a definite shortage of specialist vessels. There are, however, a large number of jack-ups and heavy-lift vessels currently employed in oil & gas and marine construction work that could be brought in to meet any short-falls, their disadvantage being the greater amount of time it takes these vessels to do the work.

5 Ports & Logistics

5.1 Introduction

Logistik-Service-Agentur of Bremerhaven, Germany undertook the background ports and logistics analysis in this chapter.

In order to evaluate the current situation specifications of typical transport and installation ships have been used against which the possibilities for each of the ports has been qualitatively analysed. 18 ports within the radius of some 120 nautical miles (222 km) from future wind farms offshore the East of England, the Netherlands and the German North Sea coast have been examined:

- 7 ports within range of the wind farm areas near the East of England projects
- 8 ports within range of the German offshore projects, including the ports of Emshaven (NL) and Esbjerg (DK)
- additional ports in the Netherlands.

The present situation of the ports with regards to the basic infrastructural and superstructural requirements has been examined. However, the general readiness and willingness of the terminal operators and the compatibility with ports' existing business was not investigated.

Particularly large ports such as Harwich/Felixstowe, Tilbury, Rotterdam, Amsterdam, Bremerhaven and Esbjerg have several terminals and these would require further detailed analysis which is beyond the scope of this report.

5.2 General Requirements to Operate as a Turbine Assembly & Load-out Facility

5.2.1 Initial Situation

The demands on an optimally functioning logistic and transport organisation related to offshore windpower projects are very high. The resulting costs from these demands can reach from 10% to 15% of the total wind farm development expenditure and are one of the decisive factors for the successful realisation and economic operation of an offshore wind farm project.

Entirely new transport chains and logistic systems will be developed for offshore wind projects, particularly if the projects are to be realised successively and in the number planned.

Standardised road transportation carriers (HGVs, containers, etc), may not to a large extent, be ideal for some of the offshore modules such as rotor blades, nacelles and towers. These are purchased in several parts of Europe or indeed worldwide, are assembled in coastal areas and then loaded on special ships or sea pontoons which bring them to the site.

A complex network of connections and trans-shipment points for transport, storing, assembling, testing and handling must be developed.

Ports are an important interface; however, they are a part of a logistic network. In this respect, the complete logistic chain – starting with the first supplier, moving on to ports and ending with the final installation on the sea – must be analysed. This is of special importance for port design.

5.2.2 Supply Chain Design is Crucial for the Determination of Ports

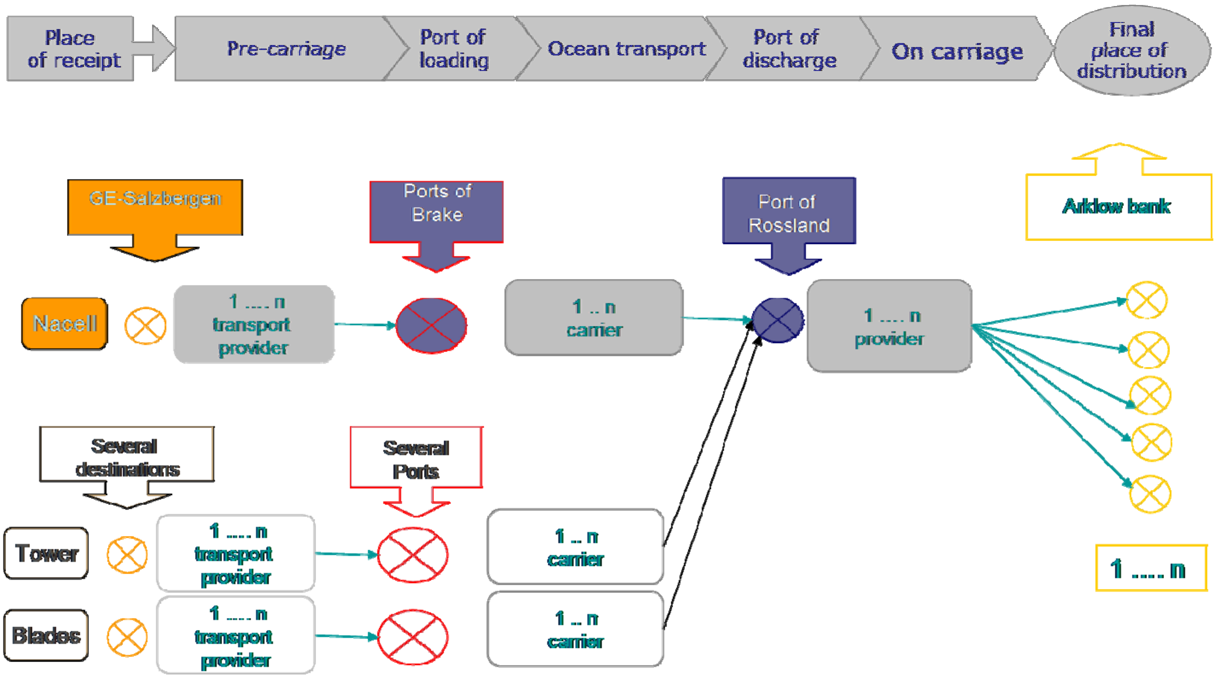

Figure 5-1: Supply Chain for the Arklow Project

Supply chain design pertains to:

- Configuration of logistics structures, meaning the location of production, storage and handling sites in regards to location, type and number, as well as the allocation of transport connections between the sites.
- Destination of processes for the flow of material, information and money within and between the sites.
- Rating of sites and transport based on the planned amount of material, components and finished products.

The significance of supply chain management in the logistics sense (ranging from supply, to production and culminating in installation) is emphasised to different degrees by the different parties involved. However, it can be assumed that an efficient organisation of logistics will contribute to an economic implementation of offshore windpower.

The task sharing between the locations is dependent on their logistic systems.

For example, GE's 3.6 MW nacelles for the Arklow Bank project having been pre-assembled in Salzbergen, Germany and transported to the port of Brake in several heavy loads and shipped from Brake to the Irish port of Rosslare (base port for the main modules). The other modules (rotor blades, tower and foundations) were transported from other ports.

5.2.3 The Possible Logistic Systems of Wind Farms

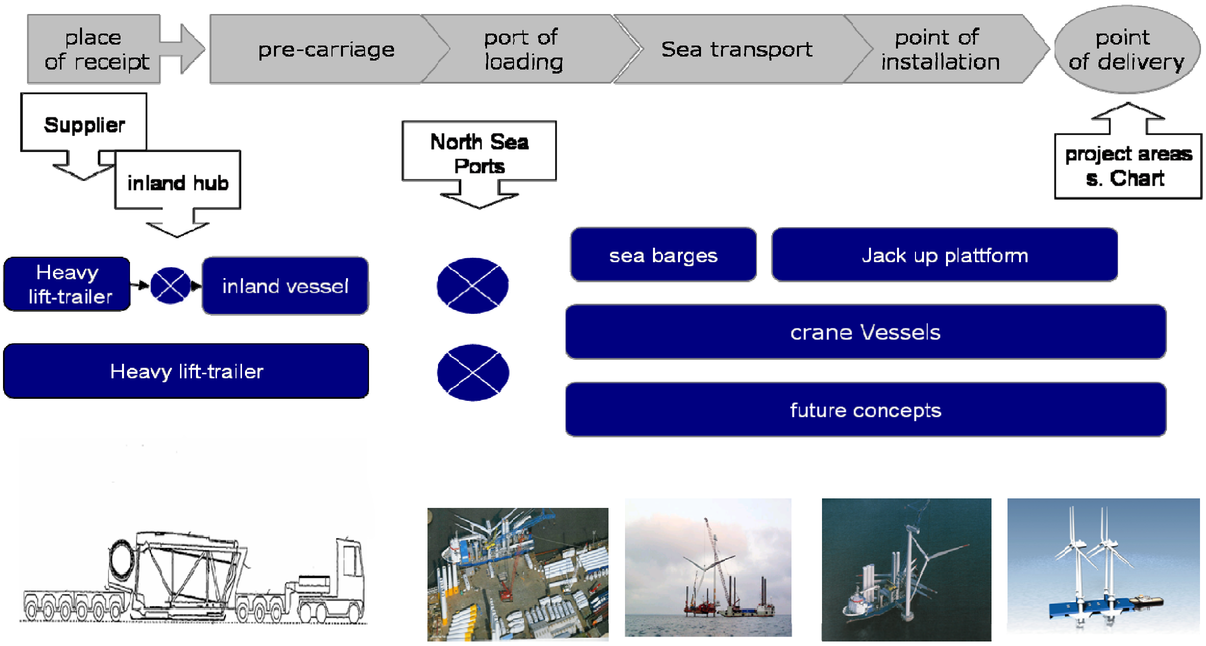

Figure 5-2: Possible Logistic Systems for Offshore Wind Turbines

There are several possible logistic systems for wind farms:

Possible logistic systems for turbines:

1. Basic port: all manufacturers produce in, or deliver to, a central port, which has the capacity to utilise all established shipment systems.
2. Shipment with sea-pontoons from various ports directly to the offshore construction site.
3. Combination of 1 and 2: e.g., blades are delivered directly to a central hub, nacelles are delivered with barges to the same port, and the tower manufacturer delivers with sea barges or pontoons. In other words, all shipping systems are usable and this offers high flexibility.

Possible logistic systems for foundations:

1. Production of modules inland or at a port, assembling at several suitable quaysides.
2. Local module production, then delivery to one central pre-assembly and final assembly area.
3. Local production, central pre-assembly, final assembly once again local.
4. All assembly at one site.

In defining possible supply and transport chains, every potential port must be examined to determine if accessibility for goods and products is geographically, technically and economically possible and any disadvantages that have to be compensated for.

Project managers´ strategic logistic planning remains closely connected to the aforementioned factors. The manager should first define all basic production and logistic requirements (logistic systems) in order to obtain first indications of the possibilities, such as:

- different production, assembly and handling sites
- their function and vertical range of manufacture
- the influence of different shipping and installation methods on logistic processes.

All wind farm installation concepts which have been foreseen so far are based on the assumptions that:

1. Single modules are transported with pontoons and installed onshore with jack-up-platforms, or
2. Transport and installation take place with help of special ships, e.g. A2Sea.
3. Future concepts aim at assembling complete turbines onshore as a single location and transporting them to site with special ships.

In the first case, several port and production sites with their own loading capacities could be considered since transport and installation units can work independently. Ports could consequently be placed close to the production sites of the respective modules (nacelles, towers, rotors). The maintenance of the construction site is coordinated by several ports.

In the second case, consolidating the components in one port is necessary since the transport and installation ship create one unit.

In the case of the first and second installation ideas, existing ports can be considered, although the third forward-looking concept makes new demands on a port's infrastructure and superstructure, which are currently not included in long-term port strategies.

5.2.4 General Requirements for Offshore Wind Ports

The sites placed near to the shores could / should take over several functions in the future:

- assembly and handling of large offshore modules and/or for foundation structures, steel handling
- the day-to-day logistics support of the construction activities
- location for maintenance/spare parts supply
- consolidation centre with added-value logistics services.

It is important to note that the location of ports must meet the requirements of the operating sea barges and special ships, in addition to offering adequate handling and interim storage capacities for large modules.

A significant issue in the current market situation is how to justify major investments in port infrastructure – long-term investments are not yet viable for the existing level of projects.

The smooth flow of construction site logistics is crucial for projects´ success. Provision and daily maintenance of ancillary vehicles and vessels used for the foundation, cabling, surveying, tug boat positioning, and staff change must be guaranteed.

Once constructed, offshore wind farms are expected to function for at least 20 years. Similar to the onshore farms, the offshore wind farms are run with 24-hour-monitoring and a multitude of online, control and management possibilities.

Special ships will most likely be used for continuous maintenance and small repairs. All required work must be planned in detail, since wind farms may only be easily accessible in the summer months. Complex repairs are also only possible during this time and require the usage of floating cranes or other special equipment, which may not always be available at short notice at the height of the season.

Locating a central position in relation to the offshore wind farms will be an important decision criterion for maintenance operations. The port has to provide sufficient quaysides and adequate covered storage to handle and to store spare parts.

In order to narrow down the sites under consideration, port requirements can be summarised as follows:

- direct connection to water deep enough for seagoing vessels
- berthing, dispatch and manoeuvring facilities for large floating cranes and special ships
- loading abilities for all turbine modules
- quaysides for final assembly and load-out of turbines with waters deep enough for seagoing vessels
- quaysides for simultaneous ship dispatch, related to the installation and to module delivery via inland waterways or short-sea-shipping,
- areas used for interim storage and pre-assembly of turbines and turbine modules
- reliable and easy transport connections on the onshore and offshore side
- good shipping possibilities to other European countries (liners and charted ships),
- sector expertise and project management experience of local port and logistic service providers
- qualified local staff
- (if required) sufficient industrial areas, with direct connection to the water for the construction of production lines for final assembly.

Ports planning expansion should take the following recommendations into account:

- planning based on a view of long-term business and a secured quantity structure
- upgrading step by step and in line with demand
- minimal investment within the infra- and superstructure
- identifying measures aimed at minimising investment risks, e.g. multi-purpose port development
- evidence of third party usability of the port’s proposed new infrastructure.

Note: third party usability should be taken into consideration in case of investment or development plans. Upgrading to a so-called multi-purpose terminal would secure the development possibilities within traditional commodities, such as container, high & heavy loads, automotive, steel and other project cargos and minimise utilization risks.

5.2.5 Operations and Maintenance Services

Whilst offshore wind construction has very specific requirements which limits the number of suitable ports in the POWER region, there are further services that other ports can provide once an offshore wind project has been built. There is a continuous need for servicing turbines, both as part of standard maintenance visits and for unplanned problems. Spatial requirements for ports to undertake O&M work are much lower than for construction and the main factors for port choice are location and flexibility. A number of ports in the POWER region are strategically suitable for such work.

O&M Port Example: Husum, Germany – Husum lacks the capability to manage and/or assemble turbines and foundations but it will be a good location for O&M. Potential activities include spare parts supply with handling and storage capacities with added value logistics, a good production location for components like rotor blades and nacelles, handling and storage capacities for large modules. The wind turbine manufacturer Repower is situated at the quayside of the port of Husum. Because of the long distance to all offshore wind farms, planned in Germany, there is a special concept under construction, which involves a special platform near the wind farms in the logistic of the assembling- and the service- and maintenance-process. The platform should be supplied from the port of Husum. The advantages of Husum are the location in a central position in relation to the offshore wind farms and the existing wind cluster (i.e. Vestas and REpower).

5.2.6 Isolating Current Specific Requirements

In order to evaluate the current situation of the ports in the POWER regions, reference data from the typical transport and installation ships has been used. Based upon this, the possibilities of the ports can be described and qualitatively analysed.

Table 5-1: Reference Data from Selected Transport and Installation Ships

Name	Giant 2 -4	Bolle 8	Eide	Barge	Eide	Barge
LOA (m)	140.00	70.00	60.00		91.50	
BOA (m)	36.14	20.00	19.00		27.43	
Draft (m)	8.55	4.40	3.60		4.84	

Name	Sea Installer	MW- Resolution	JU Odin	JU Jumping Jack	JU Vagant
LOA (m)	140.57	130.50	46.10	91.0	43.50
BOA (m)	29.60	38.00	30.00	33.0	22.50
Draft (m)	4.88	2.25	3.25		4.20
Operational WD (m)	45.00	30.00	45.00	37.00	app. 40.00

Hence, the following technical requirements can be listed:

- Water depth at the quayside and passage to the sea: 5-10 m (at low tide).
- Berth length: 80-160 m.
- Locks: width between fenders 25-40 m.
- Number of berths: it must be assumed that at least two berths are required, to allow simultaneous dispatch of installation and maintenance ships and incoming ships delivering modules.
- Quay loading – heavy lattice boom cranes with floor loading of 30 tons/square metre (LR 1350, 350 tons / 6 metre throat depth) up to 80 tons/square metre (e.g. Demag 8800, 442 tons/29 metre throat depth) may have to be used.
- The area required for the final assembly at quayside depends mainly on the turbine design and module assembly sequence. In case of consolidation for transporting on an installation vessel and interim storage possibilities of 10-15 units, the area required amounts to some 60,000 square metres for handling, storage and assembly:
  - This area decreases if the modules are shipped from several ports or directly from the production site.
  - This area increases if the assembled cannot be shipped out, e.g. due to the weather, and the inflow cannot be controlled.
  - It is unlikely that all units (e.g. 80 turbines) will be stored simultaneously.

5.3 Analysis of Available Ports

In order to evaluate the current situation of the ports each feature has been evaluated in terms of four categories.

Table 5-2: Key Coding for Port Capability Mapping

Key Colour	Description
	Facility currently available
	Facility currently planned
	Facility currently available & further development planned
	Gap – a development need/possibility

Table 5-3: Established Ports in The UK's Offshore Wind Farm Area (North to South)

Attributes	Immingham (UK)	Great Yarmouth (UK)	Lowestoft (UK)	Ipswich (UK)	Felixstowe/ Harwich (UK)	Tilbury (UK)
Water depth at the quayside and the connection to sea 5-10m (at low water)	Available	Available	Available	Available	Available	Available
In case of locks, dimensions (width between fenders) 25–40m						Available
Available dedicated berth >300m	Dedicated for general cargo	Available & further development planned	Available & further development planned	Available	Dedicated for general cargo	Dedicated for general cargo
Operation area at quayside available for assembling/handling of:						
• turbines & transformers	Available	Available & further development planned	Available	Available	Available	Available
• foundations >monopile	Gap	Gap	Gap	Gap	Gap	Gap
• cables	Available	Available	Available	Available	Gap	Available
Own heavy lift crane and ground equipment	Available	Available	Available	Gap	Gap	Gap
Available port operator with offshore focus	Gap	Available	Available	Gap	Available	Gap
Management and staff with wind energy experience	Gap	Available	Available	Gap	Available	Gap

Table 5-4: Established Ports in The Netherlands' Offshore Wind Farm Area (South to North)

Attributes	Rotterdam (NL)	Amsterdam (NL)	Den Helder (NL)
Water depth at the quayside and the connection to sea 5-10m (at low water)	Available	Available	Available
In case of locks, dimensions (width between fenders) 25-40m			
Available dedicated berth >300 m	Available	Dedicated for general cargo	Dedicated for offshore services
Operation area at quayside available for assembling/handling of:			
• turbines & transformers	Available	Available	Available
• foundations >monopile	Available	Available	Gap
• cables	Available	Available	Available
Own heavy lift crane and ground equipment	Available	Available	Gap
Available port operator with offshore focus	Available	Available	Available
Management and staff with wind energy experience	Available	Available	Available

Table 5-5: Established Ports in the German and Danish Offshore Wind Farm Area (West to East)

Attributes	Emshaven (NL)	Emden (DE)	Wilhelmshaven (DE)	Brake (DE)	Bremerhaven (DE)	Cuxhaven (DE)	Bruns-büttel (DE)	Esbjerg (DK)
Water depth at the quayside and the connection to sea - 5-10m (at low water)	Available	Available	Available	Available	Available	Available	Available	Available
In case of locks, dimensions (width between fenders) 25-40m	n/a	Available	Available	n/a	Available	n/a	n/a	n/a
Available dedicated berth >300 m	Available	Available	Available	Dedicated to general cargo	Available & further development planned	Available & further development planned	Dedicated to general cargo	Available
Operation area at quayside available for assembling/ handling								
• turbines & transformers	Available	Available	Available	Available	Available	Planned	Available	Available
• foundations monopile	Gap	Gap	Gap	Gap	Planned	Planned	Gap	Gap
• cables	Gap	Gap	Gap	Gap	Planned	Planned	Gap	Gap
Own heavy lift crane and ground equipment	Special solutions necessary, rental equipment is available, but depends on market constraints							
Available port operator with offshore focus	Gap	Available	Planned	Available	Available & further development planned	Planned	Available	Available
Management and staff with wind energy experience	Gap	Available	Gap	Available	Available	Gap	Available	Available

5.4 Summary & Recommended Actions

Demands on an optimally functioning logistic and transport organisation for offshore windpower projects are very high. The associated costs can reach 10-15% of the total offshore wind farm expenditure.

Therefore, the complete logistic chain must be analysed – starting with the first supplier, moving on to ports and ending with the final installation. This is of special importance for port design.

Economic project implementation depends significantly on supply chain management and then on the port, including the production and assembly site. Logistic networks are project specific but are very important, particularly within the planning phase.

Should the usage of offshore wind energy grow as planned, developments would be necessary of several central ports.

Involvement of local maritime businesses is important in order to increase the local content, and/or the establishment of new specialised companies. The majority of planned ports for the wind energy sector are initiated by local business development organisations.

Port authorities and operators must address the following crucial questions in regards to offshore orientation and the development of ports:

- At what point can the development of additional port infrastructure be justified solely by offshore wind projects?
- Which of the project business tasks can be taken over by the port and how large is the competition in this field, in other words which market share can be achieved?
- How can the ports' utilisation risks for wind offshore projects be handled?
- What consequences will result for the existing port business by integrating offshore wind operations – for example, how can dedicated berths / terminals / assembly and storage areas be utilised between the projects?

Future concepts aim at assembling complete turbines onshore and transporting them with special ships to the installation site. These concepts make new demands on a port's infrastructure and superstructure which is not currently included in ports' long-term strategies.

The fact that all the ports considered are established in certain load sectors (e.g. container, ro-ro-breakbulk, automotive) is an important to consider how serving offshore wind projects would compete with these other established cargo sectors. The outcome of this competition would be determined purely by economic and operational factors.

The key ports would first take over the trans-shipment function, especially for the early pilot projects. Modules would be delivered from their production site or from other ports, consolidated and stored for installation. For this reason, vacant or older terminals or smaller ports would be used, which could possibly make the project more complicated or more expensive.

Therefore, the provision of existing capacities in multipurpose ports is directly connected with the sustainability of this business – it must be recognised that investments in ports are always tied to an operating phase of at least 30 years.

Present port development is focused on wind energy turbines. The use of ports in wider roles, for example, the complete building of foundation structures from materials purchasing to assembly to shipment remain unknown.

The further development of a port – from the first idea, through the approval process and ending with implementation and start-up – is a long process in which some cases has taken up to 10 years. If terminal operators can assure business, port facilities designed for the wind industry will be built on strategically located sites.

Today, facilities for assembly of wind farm modules and their shipment systems are not considered to be established as independent operations. Seen from the position of ports, they are in the range of ‘project loads’ of which the total turnover is minimal, when compared with container-based loads, general cargo, etc.

A fundamental problem is that even though a high load potential is associated with the planned wind offshore projects, continuous utilisation of the ports is not assured. Therefore port enlargement due to offshore business has to be organised in consideration of the potential of other commodities which can secure utilisation between or after the wind farm projects. This means that other available cargo streams for the particular port is a primary consideration.

Port operators need detailed information about market potential in order to be able to safely estimate to what extent offshore wind farms could be a sustainable business. Should a decision be made to investigate a port becoming involved in the wind energy sector, a comparison with investment in gaining more traditional port traffic must be expected. The alternative is to resort to use of vacant / older (and less ideal) terminals which would than be run only sporadically within single projects.

Of particular importance is that the economic results of serving future offshore wind projects ports remain unknown or non-transparent. For this reason, it remains difficult for port operators to estimate if the wind offshore business provides a sustainable market in comparison to other business activities.

Having decided in favour of the wind energy sector the port operators must prepare the company’s superstructure, such as management, staff, equipment and IT systems for the new requirements and, in this way, minimise the degree of improvisation. While the requirements for the port infrastructure can, to large extent, be estimated, the general requirements for the port superstructure must also be clearly described.

Furthermore, at this stage there is the possibility of forming co-operation agreements between ports and the division of tasks and functions. In the case of traditional commodities such as container or break bulk, this task and function sharing was first established through economic competition, which has been very cost-effective.

With these co-operations in place, package deals can be offered. The ordering party obtains a single package offer, even if the project needs to be realised using several ports. This means that single modules / project phases are handled in the most suitable of the cooperating ports. Such ventures could also be created beyond the regional level, if, for example, a German or Danish port could be used as a transhipment port for modules to a local port in the East of England. All resources of an established supply chain could be used and managed as a single operation with the customer offered the significant cost advantages of dealing with a single supplier of port/logistics services.

East England – Over 20 offshore projects planed (2 projects per annum on average) involving 1,700 turbines are under consideration for installation. Within range of the wind farms are seven ports with capabilities for the installation projects.

The aforementioned questions, and estimating which ports and in what sectors supplementary investments would be necessary, could be answered through development of an overall logistic concept, which neutrally compares the available resources with the demands of the wind energy sector. A framework plan to conduct the 19 projects could be developed and combined with a detailed listing of port development measures.

In case of the ports of Yarmouth and Lowestoft, development of a master plan conceived as a process oriented flow plan appears to be necessary. Based upon this experience, requirements for an economically successful port enterprise can be defined. Task sharing between the bordering ports on the one hand, plus knowledge for a targeted port development, can result from this. This would certainly be advisable in the context of future consistent positioning when competing to get new projects.

The Netherlands – planned wind farms are probably going to come into being without any firm port enlargement plans. This is due to the ports of Rotterdam, Amsterdam and Den Helder already being established in the heavy load or offshore market via existing service providers operating in the ports.

Den Helder is strongly committed to developing as a maintanence port for offshore wind farm servicing.

German Bay – this area has prospects for the installation of the largest number of turbines (up to 6,500) within the next 25 years. This is a cargo amount of 6.5 million tonnes, however, the ports will physically handle this amount several times due to the sequence of supply, processing, mounting, shipment.

Due to the deep water there are requirements for more complex foundations, the assembly and shipping of these structures will take place utilising the ports which are also involved in providing major units such as foundations and towers.

The land area or quay capacities of the ports in the German and Netherlands area should not be seen as forming a bottleneck in the logistics chain, the more significant issues are those of transport and installation capacities. All transportation capacity in the offshore industry is subject to global demand, which means that the market price determines the availability.

6 Supply Chain Development

There are a number of significant issues faced by supply chain companies and would-be suppliers. Of these the most fundamental is the need for an assured market which at present is fundamentally a function of government's policies towards the promotion of offshore windpower.

Although this study is primarily concerned with activity and markets within the POWER regions, there is considerable potential for a global market to develop over the next decade and this raises issues of funding and support of export marketing activities. It is important that the POWER regions companies are able to gain early entry to markets.

There are many European, national and local bodies involved in promotion and development to the offshore windpower sector – some may say too many. However, if the POWER regions are to harness the business potential of offshore wind it is vital that activity proceeds in an increasingly proactive and cohesive manner.

For individual companies there still remains a high level of risk in entering the industry and margins are presently low. Companies must take a long-term approach when looking at market entry. There is, therefore, a need for companies to maintain their fundamental base of business at this point and make informed steps to diversify into offshore wind.

6.1 Nations' Commitment to Offshore Windpower

The main risk faced by a would-be supplier to the offshore wind sector is of making a significant investment in a new market that does then not develop or where projects suffer from delays to the point where suppliers loose interest in the sector.

The development of the offshore wind sector has been much slower than many expected and this has seriously dissuaded many SMEs from actively pursuing the opportunities.

To fully exploit the considerable potential for offshore windpower demands that governments take a long-term view that enables operators to make development plans and the supply chain to invest in the appropriate resources. 'Stop-start' policies will only serve to dissuade the development of the supply chain.

What would be of great advantage would be an overall European initiative for the development of the offshore wind industries as part of its overall strategy for growing sustainable energy supplies.

6.1.1 Planning and Approval Barriers

At both a national and local level, mechanisms need putting into place to remove/smooth many of the planning and approval barriers that exist and greatly slow project development and as a result the industry's overall progress. Much of the delay is a result of objections from a very small but vocal minority.

A very real part of the above problem is the public misconceptions that exist regarding offshore windpower and its environmental impact. Examples include the ideas that wind turbines "generate excessive noise", "kill birds", "are an eyesore" – when in reality they are relatively quiet, have very little impact on bird populations and offshore farms have very little visual impact. It is of note that some wind farms have become a local tourist attraction; an example is the Kentish Flats farm which has resulted in new boats being deployed to facilitate tourist trips. It seems a public education programme is needed focused on the benefits offshore windpower delivers.

6.2 Market Intelligence

The lack of readily available and continually updated market intelligence is a subject that was raised by companies a number of times in the national studies.

Projects – it is believed that one of the reasons that port operators are not making the necessary long-term decisions is their lack of public domain information on the market opportunities.

It is ironic that to a great extent this information is in fact available for purchase (an example is the database of projects used in the compilation of this report). However, it must be remembered that much of this need comes from companies outside the offshore wind sector. Port operators for example, need detailed market information to estimate sustainability / continuity of the offshore wind sector. Therefore seems that what is necessary is to make market information available in the public domain and ideally internet accessible.

Companies – there is a need to make an internet 'directory' of suppliers available of at present there is no single comprehensive source of information of the companies that make up the existing supply chain within the POWER regions. The absence of this increases the amount of research that would-be suppliers have to do in order to decide whether to pursue market entry. In the oil & gas industry the First Point/Achilles system is used to identify opportunities and to match suppliers and purchasers. It offers independent benchmarking and analysis of companies and provides a feedback system for buyers and sellers. The establishment of a directory listing offshore wind companies in the greater POWER region would serve as an excellent tool for regional companies and as promotion for the region to the wider market.

Market research – it would be useful to have in place a specific scheme that offers part or complete funding of companies wishing to research the potential market for their products and services. An example of a similar non-specific scheme is whereby UK Trade & Investment provides support to companies to undertake export marketing research through the Export Marketing Research Scheme, managed by The British Chambers of Commerce. Hundreds of companies each year access free, professional and independent advice about researching export markets and receive financial subsidies of up to 50% towards marketing research costs.2

6.3 Business to Business Linkage

We firmly believe that considerable benefits can be gained from putting in place mechanisms that allow companies to identify business partners both locally within their own regions and in the other POWER countries. There are many possible mechanisms and tools that could aid this process of interfacing with both peers and potential customers including:

- The on-line directory proposed above
- Funding and support packages for individual companies exhibiting at trade shows
- A POWER stand at international trade shows allowing SMEs to showcase their products & services at a subsidised rate.
- A specific opportunity exists to encourage the working together of ports in manufacturing and end-user locations to offer a complete logistics package for offshore wind farm installation and maintenance.
- Transnational Business Forums/inward missions

[2] www.uktradeinvest.gov.uk

6.4 Funding and Support for SMEs

Our work has shown that suppliers particularly need:

Ongoing Funding & Support Mechanisms – continued government support of SME's R&D and business development activities is essential to nurture what is in reality a very new industrial sector. The benefits of such mechanisms to companies are evident in the case of Denmark's support of the development of its wind turbine manufacturing industry. In Germany, the national drive towards renewable energy and onshore wind power has fostered development of a strong manufacturing capability now being applied to the offshore wind sector. Support mechanisms must be appropriate to a developing industry have a long lifetime, say 5-10 years.

Coordinated Business Support – the fragmented approach of national, regional and local support agencies is not conducive to most efficient delivery of services to SMEs. In additional to a European Centre of Excellence it would be logical to have one organisation and/or offshore windpower champion within each POWER region that could work within a transnational cooperation agreement and be responsible for:

- coordinating delivery of support services
- raising SME's awareness of the available R&D and marketing schemes
- building / facilitating supply chain relationships
- development of trans-national business to business linkages.

Coordinating Operational Experience – the industry would benefit from coordinating information on safety issues and near misses.

Market Intelligence – would-be suppliers' lack of knowledge of the market, the client base and future projects has been a recurring theme. For example, major turbine manufacturers complain about the considerable number of approaches they receive from would-be suppliers who lack knowledge about the existing supply chain. Port operators have difficulties making investments due to their lack of knowledge of future offshore windfarm projects. Easy access to such information would enable existing supply chain companies to analyse opportunities and would-be suppliers to evaluate the prospects for their services. This service, essentially projects and companies databases are to an extent already commercially available but need funding for further development and to make centrally accessible via the POWER website.

Export Marketing Support – the prospects for exporting POWER regions products and services to third countries will grow considerably in future as offshore windfarms are developed internationally. Mechanisms often in place for support of SME suppliers' international marketing in other sectors need applying to offshore wind, for example:

- trade shows / conferences – a POWER stand / group presence specifically geared to building the profile of SME's by offering exhibition facilities at an affordable price. (It is important that any subsidies are not absorbed by charges imposed by the organisers.)
- trade missions – organising groups of companies visits to specific markets / conferences and other events outside their home market.

6.5 Funding for Research & Development and Innovation

R&D – an ongoing level of funding is needed. Despite onshore wind having a long history the transition to offshore has presented a number of technical challenges that need addressing, including:

- Lowering overall cost

- Increasing turbine capacity
- New foundation designs for operation in greater water depths
- Installation methods for increased distances from the shore
- Improving system reliability
- Improving power output characteristics

The International Energy Agency estimates that some 40% of wind energy technology cost reductions can be attributed to R&D.

- **FP6/FP7 –** The Framework Programmes are the EU's main source of support for leading edge research and technological development. Support for wind energy R&D under the current EU research programme - FP6 - has been severely restricted and at present amounts to only €24million, compared to €70 million under FP5." Increased, consistent and above all transparent funding for wind energy research is needed under the 7th Framework Programme (FP7), to run from 2007-2013 which is currently under preparation. A specific budget line for renewable energy R&D, including a chapter for wind energy, must be established. Under FP6, renewables are included in the wide-ranging "Sustainable Energy" budget line. A separate budget line for genuinely renewable technologies is essential. Failure to increase wind energy R&D funding under FP7 will endanger European research and industrial leadership. The establishment of such a 'European Technology Platform for Wind Energy' is important to gain sufficient R&D funding.
  http://europa.eu.int/comm/research/

Innovation – ongoing support is needed not only in R&D where there are technological challenges to address, but also for SME commercial development / innovation without which the R&D will not generate a return on investment.

6.6 Electricity Storage

A recurring theme of both onshore and offshore windpower generation is the need for a cost-effective means of storing excess production at periods of low demand. Present designs of batteries are not adequate and perhaps other means such as conversion of water to hydrogen, pumped water storage, etc may hold the answer. There are some concept plans for hydrogen/wind test sites which is encouraging although commerciality of such systems are certainly a long way off realisation.

6.7 Inward Investment and Public Sector Infrastructure

The development of infrastructure to enable offshore windpower is a key need:

Grid access – many of the areas of high wind resource lack good grid access. Considering the initial high costs and potentially long-term benefits that can arise, facilitating grid access for individual wind developers or and/or perhaps regions would seem an important issue to look into, and explore how this could be financed. Where major work is needed this is beyond the capability of individual developers and needs tackling at a national level. Timing is critical, if this issue is not addressed quickly, then it could cause serious delays to the development of offshore windpower.

Ports – the need for the development of ports as supply bases was highlighted in the national studies. This is an area which requires major short-term investments to be made where returns will be forthcoming over the long-term. It is important to note that the complete logistics supply chain must be addressed and this probably presents the most significant opportunity.

Ports have a strong capability to act as supply chain hubs where offshore wind companies will naturally concentrate. The crucial factor is for the port itself to adopt a long-term commitment to the industry and develop the services it is able to offer and that it promotes itself strongly. Wind farm developers are known to be looking throughout the region for suitable ports for offshore construction – there is considerable potential for several ports to strongly target the industry and gain tremendous benefit. Chapter 5 of this report, Ports & Logistics, covers the issues in depth.

Centre of Excellence – international markets for offshore windpower are likely to grow dramatically in future years and it is vital that the companies within POWER regions maintain their share against the competition that will undoubtedly develop. Moreover, there is potential for companies in the POWER partner countries to bid together for global contracts.

There could be a case for a single body or centre of excellence that can act as a point of focus and represent the interests of the POWER regions in global markets. We note the planned OREC facility in Lowestoft (UK) – perhaps the management of this or a similar organisation could be used to develop a central coordinating role for the POWER regions.

In addition, there are other central services such a facility could offer, for example;

- as the POWER regions are originators of the global offshore windpower industry it would be possible for a regional centre to set standards for other countries to follow
- there is a need for a central pre-qualification system for suppliers to the industry (similar to the Achilles / First Point system used in the oil industry)
- a centre for bringing together academia and commerce throughout the regions
- embrace and develop the Classification System as a tool to develop a better understanding of the POWER regions companies capabilities and to identify existing capabilities in the offshore oil & gas industry that could be applied to offshore wind.

6.8 Use of Offshore Oil & Gas Industry Development Expertise

The POWER regions, in particular Denmark, East of England and The Netherlands, have developed a considerable expertise in the oil & gas industry. In doing so they have amassed experience in many of the areas likely to prove problematic to the newly developing offshore windpower sector, including design, installation and operations of major offshore and subsea installations. In some instances this expertise has already successfully employed to good effect (e.g. the project management of the Scroby Sands wind farm.)

Examples where offshore oil & gas expertise can (and in some cases is) being deployed includes:

- project management
- procurement
- logistics
- safety management & safe access
- site survey
- installation techniques
- subsea cables (manufacturing and installation)
- marinisation of electrical systems
- corrosion prevention & surface coatings
- lightweight structures
- legal, insurance and financial expertise
- decommissioning.

Cost Problems – it important for would-be players recognise that although there is considerable potential for transferring skills into offshore windpower, it has a very different economic basis which may not be able to accept oil & gas sector costs. It is likely that in some past work carried out on offshore windfarm projects has been done on a marginal cost basis after companies' primary activity (such as offshore oil & gas) has absorbed the main corporate overhead.

Skills Shortages – lack of skilled labour will increasingly be a problem, particularly with the booming offshore oil & gas industry able to pay more for the same skills. There is a case for developing common competences, skills, standards and certification across the various offshore energy sectors.

6.9 Globalisation – Threats & Opportunities

The Danish study in particular raised the subject of globalisation which can be viewed both as a threat and an opportunity. As discussed above, the immediate market is set to develop in Western Europe; however, the longer term and arguably much larger opportunity lies in other parts of the world.

This could result in foreign markets having considerable export potential for the POWER regions companies. If the export markets do grow very strongly then it is inevitable that the issue of achieving local content will materialise as it has with the offshore oil & gas and other industries. The logical result is a requirement to assemble and/or manufacture in foreign markets.

This can however open the opportunities for POWER companies to develop low-cost manufacturing faculties and export to third country markets.

The great risk of not addressing the emerging markets is that of countries such as China developing their own designs and manufacturing capability and with the benefits of a large local market then sell wind turbines to world markets at considerably below European makers costs.

6.10 Should POWER be Further Developed?

If continued in its present form there needs to be a minimum of a five year funding commitment in order to carry it through the forthcoming high growth period of the market when maximum efforts will be needed to assure development of a supply chain.

Another alternative would be to identify individual centres of excellence in each country and work together under a cooperation agreement, with perhaps one having a coordinating role.

7 Major Issues & Risk Factors

7.1.1 Cost

The single largest current barrier to offshore wind development is cost. Douglas-Westwood estimate that current and upcoming projects are between 15-30% more expensive than targeted costs. Many industry commentators and players fully expected costs to have begun to fall by this stage in the development in offshore wind but the opposite is true – costs are in fact rising.

From the handful of full-scale projects that have been built this decade lots of experience has been gained and throughout the supply chain, companies have realised the true difficulties that offshore wind development brings.

Taking a common viewpoint held as little as two years ago, the offshore wind industry should have progressed from its early stages and a large number of projects should be vying for construction this year in European waters. Contracts should be progressing on larger wind farms and costs falling. None of this is the case. Only two full projects will be completed in 2006 and five in 2007 (excluding prototype sites), contract negotiations on future projects are in difficulty and underpinning all these failures is the most crucial issue, the rising costs of offshore wind development.

The target costs of €1.5 million per MW are often beyond reach, with some projects now trying to progress with costs of up to €2.5m/MW. In such a short time period why have costs increased so dramatically from this initially envisaged?

The answer lies in lessons learnt from recently built offshore projects, an imbalance between risk and cost, contracting systems that are unworkable, rising turbine prices and insufficient competition in the marketplace.

The market for wind turbines is currently very much a seller's market and the costs of wind turbines is increasing accordingly. The strength of onshore markets, particularly in the USA, is driving costs upward with turbine manufacturers focusing on supplying this more predictable and quantifiable opportunity. Many recent faults with turbines offshore is not helping turbine supply quotes. Some manufacturers are now treading cautiously, believing the offshore market is not worthwhile pursuing at present. Turbine prices are set to increase further when the first commercial 5 MW class machines enter the market as a significant supply and demand mismatch is forecast.

The main price rise centres on the twin issues of contracting and risk. The Engineering Procurement and Construction (EPC) contracting methodology which was expected to be the most common style of contracting for the current type of project is failing to deliver. With one contractor having to bear the majority of risk the costs these EPC contractors are submitting are increasing to the point where project developers are unwilling to progress. Some EPC contracted projects have also left subcontractors short-changed and unhappy with the lack of consultation between parties.

In the second half of 2005 several UK projects abandoned their EPC tendering process to switch to a multiple-contract approach in an attempt to receive lower costs from contractors. So far this methodology appears more promising and allows a better sharing of risk and overall savings of approximately 10% could eventually be possible.

In terms of overall project costs this alone is not sufficient and further savings are needed throughout the supply chain. For offshore wind to really grow to its potential in the coming years cost savings of up to 20% must be found to build the essential momentum in the industry which it currently lacks. It must be remembered that large scale development will require installations in waters deeper and further offshore than previously tackled – in these environments costs are greater than at present.

These cost savings are required across the board and industry must come together to find the solutions. Some may emerge through economies of scale if the industry is strong enough to push projects through to completion at current costs, but other savings must be strived for through greater interaction and communication throughout the supply chain.

Feedback from contractors suggests that they feel they are having to take on high levels of risk because developers are not always fully providing detailed enough site information or not listening to the recommendations of the contractors who in many cases are extremely experienced in working offshore (e.g. on cable burial) and can give real-world advice. In a similar vein, there is a case for earlier integration of intended contractors into the development cycle, something which is being done on some European projects such as Thorntonbank under development by C-Power off Belgium. By actively working with a project developer final costs can be reduced.

Contractors need to be confident in a stream of upcoming projects in order to justify their involvement in investing to enter the industry. With just seven full scale projects in the next two years this is a critical time for the industry. These projects need to run smoothly to stimulate confidence, and the projects currently at a tendering stage must display initiative and realism.

7.1.2 Contracting

Contracting is a very relevant topic at present as it is currently undergoing a shake-up and moving away from standard EPC/EPIC contracts.

The situation is changing as a greater sense of realism is now present in the marketplace. High profile problems, such as those at Horns Rev where turbine manufacturer Vestas suffered massive financial costs for the component failures that required replacement and reinstallation of the turbines (and also additional loss of production payments to Elsam), make the issue of risk and who should bear it more relevant.

For the forthcoming larger projects, higher bids are being submitted for supply and construction tenders than developers often expect. This is because EPC contractors are increasingly cautious of the risk they have to adopt under such contracts and have a greater sense of realism of the true costs of offshore wind construction which were not always fully recognised for the first major projects.

In the UK in 2005, several major projects encountered substantial contracting problems that caused projects due for construction in 2006 to be delayed. EPC contractors are unwilling to bear the majority of the risk without appropriate financial reward. The financial losses and technical challenges faced by many sub-contractors on the first major projects are also keeping prices high.

Future projects are of a far greater scale than any that have yet been built or contracted. New contracting methodology is needed to reduce the burden of risk that would otherwise be placed on the main contractor. This period’s large developments, far offshore in deep water, using the very latest technology are high-risk projects. Without a major step change in contracting strategy it will be hard for any contractors to willingly tender at the price point developers are looking for. Even the specialist offshore wind contractors are, in most cases, only small to medium sized companies at present. It would take some of the largest offshore contractors from the oil & gas and marine sectors to be able to take on the large offshore wind developments under current procedures.

It has, therefore, become apparent that risk is being improperly managed under standard EPC contracts and that an associated cost increase has occurred because of this. For the industry to lower its costs, a multiple contracting approach needs to be adopted by developers.

Turbine manufacturers have been awarded the main EPC contract in the past which is an in-efficient way of running a project. With little experience or indeed no experience working offshore these companies are not best-placed for running high-risk projects where others would be more experienced in doing so. EPC approaches have tended to be taken because although such a strategy may be more expensive for the developer it is better for them in terms of risk.

In hindsight, contractors on the first large-scale projects in some cases underbid themselves to developers, losing money as a result. The high-risk strategy that contractors have had to adopt has had particular impact.

Development teams have been unrealistic about the true costs of development. The offshore contractors hold the experience and knowledge of working offshore, and working to a constrained budget that sets the maximum outlay in one area, e.g. foundation installation is unwise especially for developers/EPC contractors who often have very limited offshore experience themselves.

Over the last year the industry has woken up to the fact that for many projects, a multiple-contract approach is more suitable for getting projects built for the lowest overall cost.

Turbine supply will, therefore, most often become a single contract placed by a developer along with ones for foundation supply, cable supply, topsides installation, cable installation etc. By splitting contracts in such a way developers are effectively cutting out the profit that would otherwise go to an EPC contractor. This model, however, places increased risk on the project developer who must have measures in place to be financially capable of bearing this risk.

Further consolidation and takeovers are expected in the 2005-2009 period as leading developers and contractors look to gain market advantage. The increased entry of major oil & gas contractors is highly likely, with buyouts of some offshore wind contractors a certainty as the true potential of the offshore wind market, and the value of the contracts on offer, is realised.

7.1.3 Financial Support

Investment Support – Despite the growing offshore wind capacity and its excellent market prospects, the industry is still judged as a high-risk investment. Whilst the onshore wind market is well understood by investors, offshore wind is less well established and despite strong forecasts is a somewhat uncertain market because of changing market subsides which affect long term views of it. The high-risk nature of the investment needs appropriate high returns, but with project costs rising this is not necessarily the case. Whilst some projects are financed entirely through the owner’s balance external investment is a key element for others.

Investment is sometimes held back because risks are difficult to quantify at present because of the lack of installed capacity on which to judge individual projects. Risks must be quantified from operational projects, and as all major offshore developments are only several years old at most this is problematic. There is little long-term information on operations and maintenance costs for example. There have been a number of high-profile, costly and embarrassing failures with some key offshore wind farms in the last three years which do not inspire confidence.

Financers can be attracted to the industry as experience is gained within the industry and the solutions communicated effectively to stakeholders. Ultimately the industry has a level of risk that will always be associated with it. What needs to occur is that the financial community needs assuring that that risk is quantifiable, sufficiently managed and insured.

Governmental Support – The aim of financial support from government is to develop sustainable capability in the industry for the future. With the majority of offshore wind farms only judged to be economically viable with government grants, subsidies or feed-in tariffs, the continuation of these financial schemes is crucial. Ten-year feed-in tariffs are common, which ensure a subsidy will be paid for each kWh generated for the first ten years of operation.

Whilst it is the case for each of the POWER Project countries, German offshore wind farms will be particularly reliant on assured long-term feed-in tariffs because the technically difficult projects here will be more expensive than projects being built in Denmark, the UK and the Netherlands. Failure to commit will harm the industry.

Frequently changing support mechanisms indicate a lack of foresight and cause additional paperwork for developers looking for investment as it alters feasibility studies and can even completely de-rail projects. This has been seen in Europe this decade with The Netherlands being an example where offshore wind development policy has seen fluctuation which has lead to market uncertainty.

Government-set renewable energy targets are equally important for attracting investment, as they indicate long term commitment to the sector. With offshore wind project lifecycles at 20-25 years it is important for investors to be able to foresee future support for as much of this period as possible.

Long-term commitment to offshore wind energy from governments is of great importance. A recommended first step is for individual countries to commit to renewable energy targets for 2020. This gives a strong signal to the investment community and to the industry. The UK for example, despite arguably having the strongest offshore wind sector in the world has still not committed to a renewable energy target for 2020.

7.1.4 Planning

A structured, fair, efficient and measurable planning system is one thing that could significantly speed up the growth of the industry. The approval process for offshore wind developments is often extremely slow and does not always fit logically with government driven targets that are trying to push the deployment of offshore wind only for it to be constrained by the planning system. There must be a shared agenda throughout government departments that can work to implement successful policy.

If an application runs smoothly then a processing time of approximately one year is common, but there are a great deal of projects which have become stalled in planning for a number of years because there is no precedent for such developments and managing the different interest groups involved is not done effectively.

Greater government-led direction on offshore wind development areas is one example of potential for smoothing the process. Ideally, such areas would have fast-track planning processes for developers aided by centralised and shared information systems which would enable greater collaboration on planning issues such as environmental surveys and grid connection.

7.1.5 Grid Connection

Grid connection and availability has long been one of the offshore wind industry’s most recognised issues and will become increasingly prominent as the industry develops. The issues include the availability of grid connection points, the availability of grid capacity, the necessary costs for improvements to the grid and who is responsible for paying to improve the grid. Developers may have to apply and pay for a grid-connection before a project gains approval, just to ensure capacity is available.

Additional large-scale capacity requires the development of new power transportation and distribution. Unless the installation of new capacity takes place at the same pace, at the same time and with the same power output characteristic, significant investment to enable network integration will have to be made. Given the average five to ten year negotiation time-scale to secure access this is a major issue for offshore wind.

Moreover, as the energy demand is not fully predictable (peak load) and generation capacity is sometimes unreliable (breakdown) or intermittent (wind), base generation must be supported by standby sources. This is an additional cost inherent to the fundamental operation of a power network since in the event demand would not be met for a few seconds, frequency on the network would suddenly drop, the entire system experiencing a domino-type crash as in New York in 2003.

In 2005, Econnect completed a major report on grid connection issues commissioned by the UK Government's Department of Trade and Industry (DTI). Entitled *The Development of the Offshore Grid for Connection of the Round Two Wind Farms*, it assess the costs of connecting the 7.2GW of Round Two offshore wind farms to the national grid. Whilst this is a UK study it's findings are suggested solutions are applicable across the POWER regions.

The results showed:

- The individual project connection cost estimates ranged from £117k/MW installed capacity to £254k/MW installed capacity with an average of £185k/MW.
- The joint connection options were found to be cost-effective for about half the projects considered, although some of these options rely on obtaining permits for new or rebuilt overhead lines.
- The average cost for the best mix of connections is £167k/MW.
- For the majority of the Round Two wind farms, connections using 132kV subsea cable were the most cost-effective solution
- The use of High Voltage Direct Current technology only became cost-effective where the project is a significant distance from the connection point and where large amounts of power are to be transferred.
- A number of the joint connection solutions identified for some projects were more cost-effective than their individual connection costs. This was generally a rule where the joint connection solution involved two projects that are near each other, and where interconnection between projects removes the need for one or more of the wind farm array to shore cables specified for the individual connection design.
- The modularity of offshore wind farm connection has advantages in that it allows the phased construction of larger projects without the necessity to invest in the full costs of the final grid connection solution up front.
- All the connection solutions allowed for the full capacity of the wind farm, or wind farms, to be transmitted to shore. However, installing sufficient assets to enable the capacities currently specified for the Round Two wind farms to be transmitted to shore may not be the most economic solution once the available subsea cable ratings are taken into account.

7.1.6 Installation Capacity

There is a potential shortage of capable vessels for the installation of offshore wind farm foundations and turbines. Current demand can be met by the leading contractors utilising their unique and efficient installation vessels but as the number of projects increases questions of demand and supply will begin to be seen. The issue is more complicated because Scenario 2 type projects in deep waters and using large turbines are beyond the reach of many existing installation vessels. The market leaders are already planning vessels with a greater capability but if the rate of installation is as forecast there will be a shortage of specialist vessels, perhaps as soon as 2008/9.

7.1.7 Steel Prices

The price of steel is particularly important to the offshore wind industry, being the principal raw material used in the manufacture of steel towers, monopile and tripod foundations and transition pieces. Any change in steel prices therefore has a considerable impact on manufacturing costs and as such project economics.

As the offshore wind sector really begins to take off, it will have a strong effect on the steel market. As an example, one project developer anticipates that its 1 GW project is expected to use over 250,000 tonnes of steel for the fabrication of the towers and foundations. 5 MW turbines and tripod (and even jacket style) foundations will in time become common. The factor of steel price (and perhaps more importantly, steel supply) will be extremely relevant to the industry.

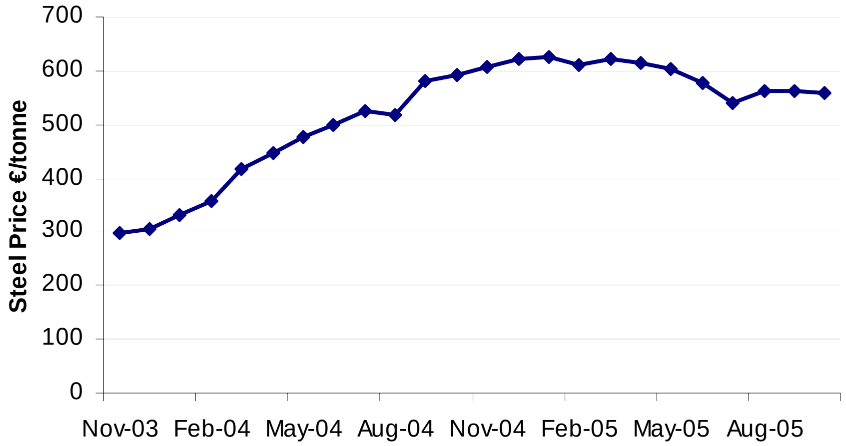

Figure 7-1: Hot-Rolled Steel Prices
Source: MEPS (www.meps.co.uk) January 2006

At the time of writing, steel prices are at approximately €560 per tonne, almost double the price two years ago. The gradual price rises steepened at the start of 2004 and grew at an increased rate throughout the year peaking in January 2005 at €625 per tonne. Many construction companies and manufacturers have seen a measurable impact with the increased prices of their primary raw material affecting balance sheets significantly.

Current price rises follow a period of cheap steel supplies with steel famously having been quoted as being cheaper than potatoes in the past. Indeed the price of steel had risen slower than the rate of inflation since the 1980s. Current trends are a result of growing steel demand from Southeast Asia, in particular China, where huge increases for the last few years are driving the high prices. China is seeing annual economic growth of around 9% and the surging demand for steel will continue.

There are few signs that demand for steel has slowed in light of the recent higher prices. For example, UK structural steel fabrications are at their highest levels of output since 1990. Availability of steel rather than its cost is the prime concern of manufacturers.

7.1.8 Insurance

The factor of risk mentioned above is relevant to insurance. Insurance must be available to cover the investment against the risks. There is a need for insurance policies which protect offshore wind equipment during transportation, construction, commissioning and operation as well as for the loss of revenue if downtime occurs and the relevant liability risks. The growing number of operational projects means it is easier for insurers to accurately assess risk through performance indicators and claims history. The installation and operation of demonstration turbines and small first phase developments help aid risk assessment.

For onshore wind, insurance costs are in the range of 2-3% of annual operations and maintenance spend. Offshore the risks of turbine and project downtime and the associated production loss need to be taken more closely into account. Turbines maintenance and possible replacement is far more costly and time consuming offshore than onshore and every part of the development process is more costly and risky. This must be balanced against the increase in production that offshore projects can offer over onshore ones because of their superior wind resource. External factors such as shipping collisions, potential damage to seabed cables, etc. all need to be factored in. More stringent industry-specific safety guidelines will also have a direct impact on offshore wind insurance.

7.1.9 Environmental Issues

Environmental issues are a key factor in offshore wind development. Developers are required to thoroughly demonstrate that their project will have a minimal and acceptable consequence on the environment and wildlife (resident and migratory birds and sea life). Visual impact of the wind farm is also an issue. The Environmental Impact Assessment (EIA), or Statement – EIS, is a report that must be filed and approved resulting from between one and two years of environmental studies at a proposed site.

There would be great benefit to increased dissemination of environmental studies that have been conducted in POWER Project regions and there is a definite case for studies to be undertaken specifically for the region, perhaps with EU funding. Such information is of high value to development.

Birds

Birds being killed by the spinning blades of wind turbines is one highly-publicised concern and is a prominent issue partly because of a number of high profile cases where birds have been killed in large numbers at onshore wind farms.

One example is the Altamont Pass Wind Resource Area (APWRA) in California, USA. This massive wind installation is known for high rates of bird mortality. Its 5400 (approximately) wind turbines are in most cases old, (construction began in 1982) low capacity machines, with smaller and therefore, faster spinning, blades which are more dangerous than the slower moving blades of modern turbines.

According to the Center for Biological Diversity, the turbines at APWRA kill more birds of prey than any other wind facility in North America, due to their location on a major bird migratory route in an area with high concentrations of raptors, including the highest density of breeding golden eagles in the world. Research by raptor experts for the California Energy Commission (CEC) indicates that each year, Altamont Pass wind turbines kill an estimated 881 to 1,300 birds of prey, including more than 75 golden eagles, several hundred red-tailed hawks, several hundred burrowing owls, and hundreds of additional raptors including American kestrels, great horned owls, ferruginous hawks and barn owls.

It has been shown that the onshore and offshore environments are very different, and that data can not be straight forwardly applied from an existing onshore wind farm to an offshore one, as is often the case. The main difference is the lack of landscape offshore which affect flight paths onshore.

An overview of results from some operating offshore wind farms is given below:

- **Horns Rev and Nysted, Denmark** – results of bird studies from the two largest operating offshore wind farms in the world were announced in November 2004. Horns Rev (80 turbines, 160 MW) and Nysted (72 turbines, 165.6 MW) came into operation in 2002 and 2003 respectively. An ecologist from Energi E2 showed that birds were simply flying over or around the huge packs of turbines rather than through them.

The ongoing environmental surveys also showed an increase in the diversity and numbers of sea life at the two wind farm sites. The foundations of the turbines have acted as artificial reefs, attracting new species and providing a sanctuary for fish in the trawler-free vicinity.

- **Lely, the Netherlands** – two diving duck species were studied to investigate flight behaviour. Radar tracking techniques were used, and showed that the birds were able to adjust flight patterns. The vast majority of birds passed around the outer turbines rather than between turbines, the rows effectively working as barriers (hence why very long lines of turbines are not favoured because of potential flight disruption). The birds were able to safely fly around the turbines at night time. In poor light conditions the birds would pass the turbines from a greater distance.

- **Tunø Knob, Denmark** – the area surrounding the wind farm is home to large numbers of sea duck. The study looked at the potential disturbance effect of the wind farm on the birds. The only distribution changes found were shown to be due to changes in food supply and not attributable to the wind farm. The highest bird numbers were recorded after the construction of the wind farm. It was found that birds avoided flying and landing within 100m of the wind turbines. The Tunø Knob survey showed fewer bird flights within 1500m of the turbines when light conditions were low.

All studies conducted show minor or negligible effect on bird life. Construction activities can temporarily displace some species of birds, which return after work is complete. There has been no real evidence of high levels of bird mortality. Careful wind farm planning and thorough environmental surveys can minimise impact.

8 Recommendations

The North Sea POWER regions contain the world's leading suppliers to the offshore wind industry and together with their supply chain they have the ability to present an unequalled offering in European and global markets. At present the POWER regions are clearly 'ahead of the game' and have major advantages when seeking business in seeking export business.

The challenge is now how to use this position to maximum long-term advantage. We believe that the way ahead is on two fronts;

- To realise the considerable offshore wind potential of the southern North Sea
- To capture and defend future export markets.

In order to do this demands policies for development of windpower as a part of European and national power supply strategy which will enable long-term planning, together with investments in infrastructure, R&D and commercial development of the SMEs that form the majority of the supply chain. We therefore recommend the actions listed in the following table.

Table 8-1: Recommendations

Industry Need	Why?	Recommended Action	Timeframe	Who?
National commitment to offshore wind as part of the energy mix	In order to achieve a flow of projects without which companies will not commit to the sector	EU policy to encourage implementation of offshore wind projects	Long-term programme	EU
Speedup of the planning process	Objections from a small vocal minority can cause major delays to projects	Begin a process of public education on the benefits of offshore wind power	Long-term programme	Government Industry bodies
	Lack of co-ordination between government bodies slows or halts development	Lobby for development of new planning guidelines inline with official government targets	1 year	Government
Market information	Lack of easily accessible information dissuades companies from considering market entry	Offer a free market intelligence service (via the POWER website?) to companies including: • Future projects database • Supply chain companies database • Tendering opportunities database	 1 month 3 months 3 months	POWER
Market research	Companies need research to justify business plans	Market research scheme	1 year	POWER (via intro to existing schemes?)
Business to business linkage	Considerable benefits to new entry companies	'Speed dating' (introductory service) via POWER website and real business speed dating meetings	3 months	POWER
Offshore wind R&D	Continuing need	Trans-national programme. Must be easy to access and low-bureaucracy	1 year	EU
Electricity storage R&D	Major enabler	Trans-national programme. Must be easy to access and low-bureaucracy	1 year	EU
Coordinated policies & agencies	Competing publicly funded organisations duplicate work and generate confusion	Initiate a series of workshops to bring together public bodies involved in offshore windpower	1 year	POWER
Best practice guidelines	For POWER region to grow quickly, strongly and safely	Key stakeholders for offshore wind development and construction. Particularly with regard to health & safety	1 year	POWER
Offshore oil & gas expertise	This considerable experience has not been fully utilised	Seminars / share fairs Participate in O&G trade shows Articles in O&G magazines	3 months	POWER
Address globalisation	Threat and opportunity	Learn from other industries (such as O&G) and disseminate	1 year	POWER