DOING BUSINESS WITH WIND TURBINE MANUFACTURERS: BECOMING PART OF THEIR SUPPLY CHAIN

dti

Scottish Enterprise

A report to DTI and Scottish Enterprise by Douglas-Westwood Limited and BVG Associates, July 2006

About the Authors

Douglas-Westwood Limited is an independent company that carries out business research and market due-diligence for the international energy industries. Its market analysis, surveys and forecasts are used by many of the world's major energy companies, the leading industry contractors and manufacturing companies, financial institutions and government departments. In total, DWL has clients in 33 countries and to date over 400 projects have been completed in oil & gas, renewable energy, conventional and nuclear power generation.

BVG Associates is a technical consultancy providing expertise in the design and economics of fuel-less renewable electricity generation systems. Clients include the market leaders in the wind turbine and tidal turbine sectors. The objective of BVG Associates is to help establish fuel-less renewable electricity generation as a major, responsible and cost-effective partner in a balanced UK energy portfolio. BVG Associates partners each have almost 20 years of experience working in the wind turbine sector.

DOUGLAS-WESTWOOD

BVG Associates

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1 Introduction to Guide

1.1 Background

The UK is now experiencing substantial growth in the wind industry. In 2005, the UK joined only seven other countries worldwide in having over 1 GW of wind energy installed. The British Wind Energy Association state that the UK installed 446 MW in 2005, more than double its 2004 record total. Over the coming years this expansion is set to continue, especially within the high-potential offshore wind market.

Growth in demand globally is outstripping supply. In 2005, almost 12,000MW wind turbine projects were installed, with a value of almost £9bn. This was over 40% more MW of wind plant than in 2004 and growth would have been higher but for supply chain limitations, especially with regard to gearboxes and blade materials.

The growth the UK is currently experiencing took place in countries such as Denmark, Germany and Spain several years ago and these countries are now the centre of the wind industry and home to the major manufacturers and suppliers. The UK industry therefore has to compete with highly-established supply chains. Much of the value of projects being installed in the UK, both onshore and offshore, is going abroad to these suppliers. Opportunities do exist to enter the supply chain, however, particularly as UK wind installations increase.

The UK has a world-class level of relevant offerings throughout the supply chain, from manufacturing through operations and maintenance to decommissioning, including its oil and gas industry experience. In many cases, these skills are directly transferable to the wind industry. Many companies have already secured work in onshore & offshore wind through applying their existing expertise of other industries. Throughout this guide, examples of UK suppliers that have already been successful in working with wind turbine manufacturers are briefly profiled.

The UK currently has a very limited share of turbine & component manufacturing. Market leader Vestas are the only wind turbine manufacturer to have its own production facilities in the UK, with tower manufacturing and nacelle assembly in Scotland and blade design and manufacture on the English South Coast. With turbines accounting for up to 50% of project costs increasing the UK share of supply to turbine manufacturers is a key way to take advantage in the growth of the UK and global markets. UK companies have the opportunity to act as 1st and 2nd tier suppliers to turbine manufacturers by supplying component parts ranging from power converters through gear wheels to bolts.

1.2 Aims of Guide

The guide is aimed at the UK manufacturing and servicing sectors, giving clear and concise information needed to do business with wind turbine manufacturers. Beginning with a overview of the onshore and offshore wind industry which examines the past and future markets, the guide aims to inform the reader of the issues and technologies associated with the wind industry.

1.3 Methodology

This guide was produced from the results of face-to-face interviews with turbine manufacturers, telephone interviews and desk research utilising extensive in-house resources from the project consultants Douglas-Westwood Limited (DWL) and BVG Associates. From the outset the aim was to produce a highly structured document with a standardised approach that was easy to read by all businesses regardless of their previous knowledge of the wind industry. By gaining access to high-level individuals in the turbine manufacturers it has been possible to present valuable information to the end-user of the guide. The information on which the market forecasts presented in this guide are based is drawn from DWL's data sources. These project information databases were established by DWL in 2000 and are maintained as commercially available data sources for the industry.

1.4 How to use this Guide

For the benefit of all companies reading this guide, no previous knowledge of the wind industry is assumed. It can be used in different ways, for:

2 Summary of Market Opportunity

2.1 Onshore Wind Activity

Onshore wind power provides an increasingly economic source of energy, with significant worldwide growth for the last ten years. The industry has been made viable through economic subsidies which have enabled development to take place. For some countries, onshore wind power is both a key energy source and a major industry in its own right.

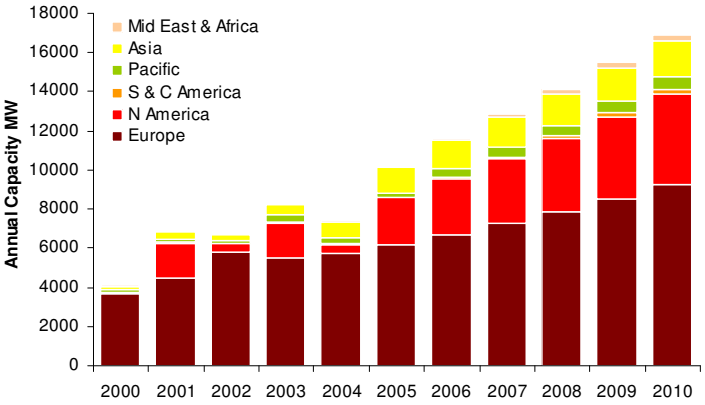


Figure 2-1: Onshore Wind – Annual Installed Capacity

The onshore wind industry has seen year-on-year growth for the past 15 years – there are very few industries where such a growth rate has been seen to be sustained for so long.

There is an average global market growth of approximately 10% annually. In 2005 a record-breaking 11.7 GW was installed which represents a growth of 35% compared to 2004.

For 2005, the largest markets were the US (2,400 MW), Germany (1,800 MW), Spain (1700 MW), India (1400 MW) and China (500 MW). The UK was the seventh largest and growth here is increasing, particularly in Scotland which has many large future projects planned.

The large US market is tied to the Production Tax Credit, and when it expired at the end of 2003 installations slumped in 2004. Following its renewal, 2005 was a very busy year in the US and high levels of activity are predicted here in the future. The strong market here is stretching turbine production in Europe as one major manufacturer stated:

- *"80% of our supply will be taken by the US market in 2006." – a leading wind turbine manufacturer.*

Some early leaders are now beginning to slow such as Germany; likewise Denmark has installed very little onshore capacity in recent years. To balance this, activity is strong in the massive Spanish market and significant new markets such as the UK are emerging. Together with rapid growth in Asia, prospects for overall high growth remain strong.

2.2 Offshore Wind Activity

The first offshore wind turbines were installed at Vindeby off the Danish island of Lolland in 1991. The first ten years of the industry saw small projects being built in shallow, near-shore locations. These 'demonstration' projects have paved the way for the more recent projects that are of a much larger size.

There are 20 operational offshore wind farms in the world today. The 357 installed turbines in these projects provide a total of 707 MW. At the present time, Denmark is the world leader in installed capacity with 426 MW (60% of the world total), but the UK is making fast progress and now has 214 MW operational. An additional 90 MW is under construction at the Barrow offshore wind farm which will be online this spring. From 2008/9 the UK market is expected to grow more rapidly.

Offshore wind is an extremely important sector. It involves the installation of very large wind farms (many planned projects are around 1 GW in size) in an environment with a better wind resource and where visual impact is minimal. Currently, however, due to high costs of offshore activities, economics are less attractive than for onshore wind in the UK. The sector is driving technological development and offers a considerable diversification opportunity for UK industry.

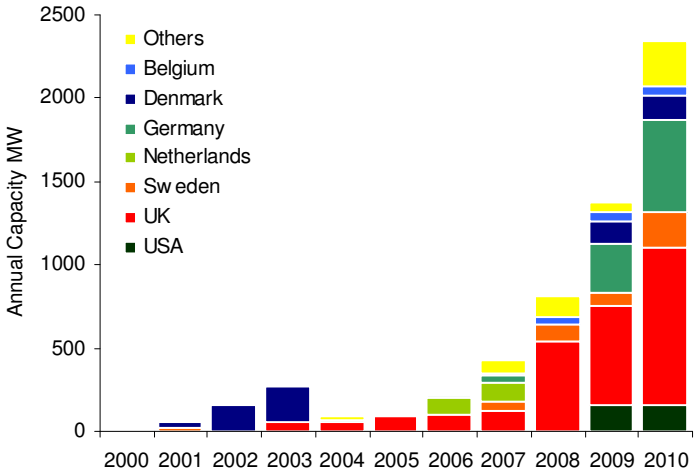


Figure 2-2: Offshore Wind – Annual Installed Capacity

A total of over 5 GW of offshore wind capacity is planned for the 2006-2010 period. The UK currently has four major offshore wind farms complete and a well-structured development programme which has resulted in a high number of projects due for construction in the future. The UK is forecast to be the world's largest offshore wind market this decade with up to 2.4 GW expected. The major growth will occur here from 2008 onwards. Germany is a high potential market but it is unlikely to develop significantly until the end of the decade. The US will become active at this same time. Asia is emerging as a long-term prospect with some very large projects planned.

2.3 Manufacturer Market Share

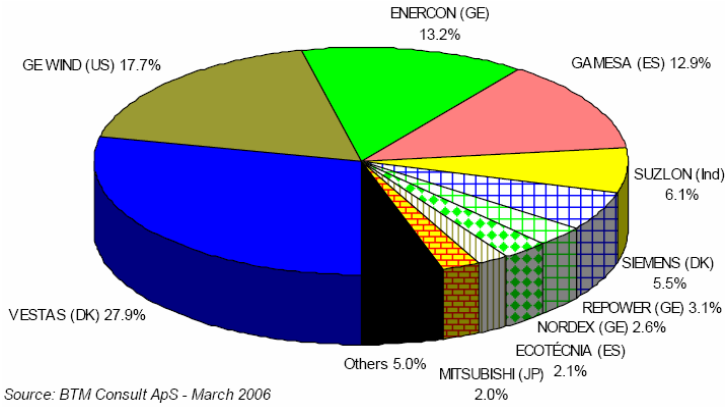


Figure 2-3: Turbine Manufacturers – Market Share (2005)

The four largest turbine manufacturers supplied over 71% of all capacity installed in 2005. The top 10 manufacturers supplied 93% of all capacity.

In 2004 Vestas merged with NEG Micon creating the world's largest manufacturer with a 28% market share.

Whilst there is fierce competition in some markets, in others a single turbine manufacturer can have a dominant share of all supplies.

Siemens currently has the largest market share of the UK wind energy market with 44% of all installed capacity. Vestas and GE Wind Energy are the other significant manufacturers with 30% and 18% of capacity respectively. Gamesa, Enercon and REpower each have a small number of turbines installed.

Manufacturer	UK Market Share
Siemens	44%
Vestas	30%
GE Wind Energy	18%
Gamesa	5%
Enercon	3%
REpower	0.5%

Table 2-1: Turbine Manufacturers - Market Share UK (2005)

The locations of the major turbine manufacturer's head offices are illustrated below. Most large manufacturers have production facilities and/or sales offices in other countries. For this guide manufacturers have been split into 'main players' and 'other players' based on turbine sales in 2005 (shown above).

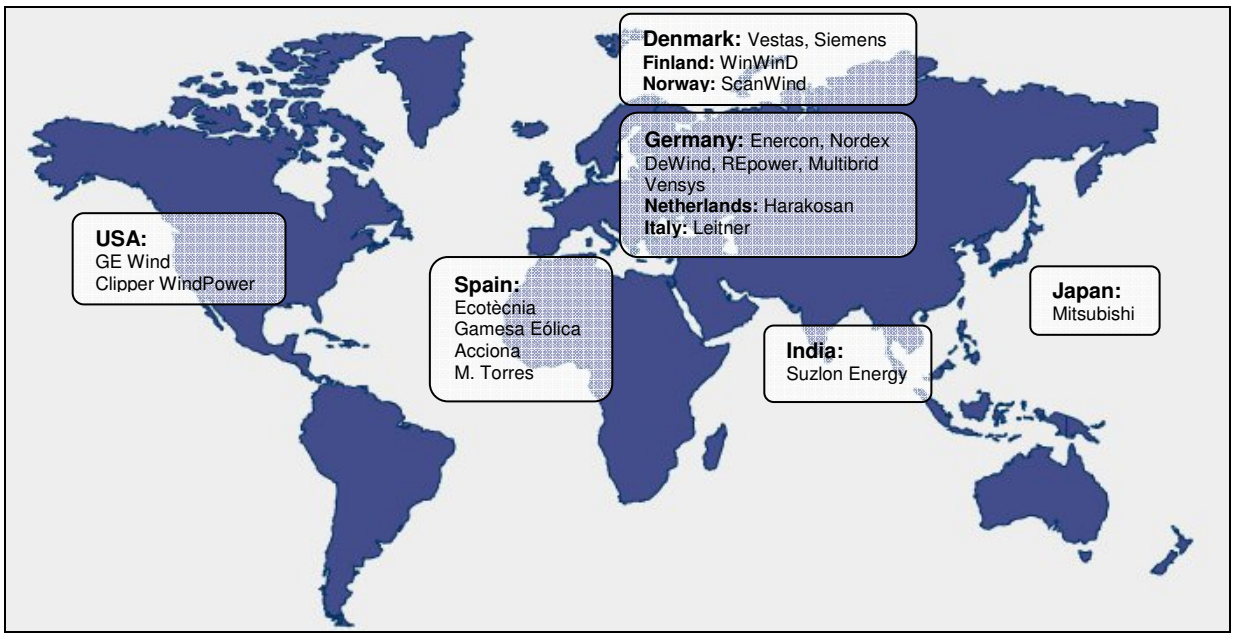
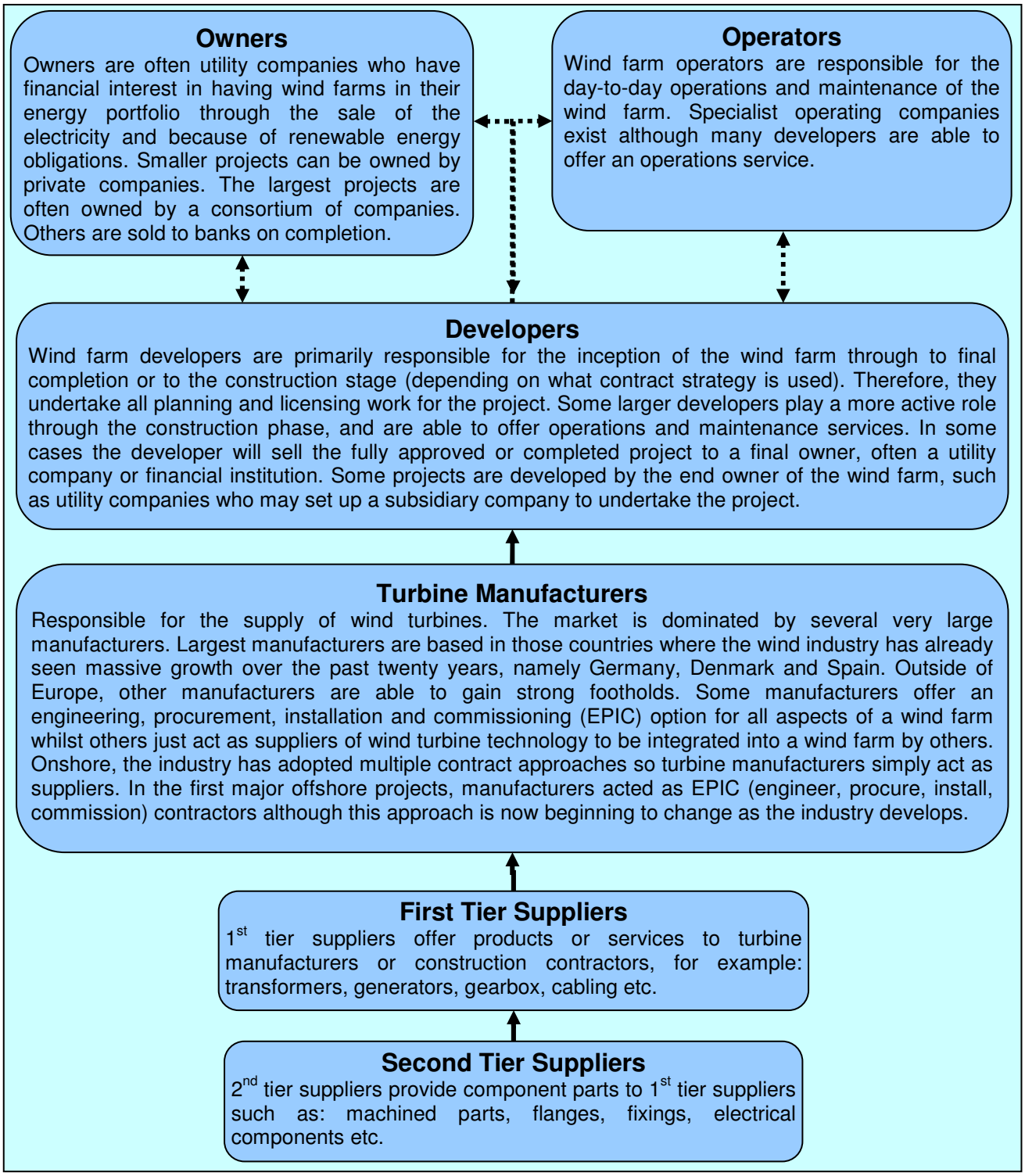


Figure 2-4: World Map of Turbine Manufacturer's Headquarters

2.4 Structure of the Wind Industry

An outline of the structure of the wind industry is presented below. Note that there can be a great deal of blurring at the top of the chain between developers, owners and operators because some companies are active in two or three of these roles.



These two factors can act as an advantage for companies looking to gain work with manufacturers. Due to the range of supply options available to customers, short lead times are common for manufacturers. Whilst larger turbine manufacturers are able to forecast likely demand for their products and build accordingly, this is not the case for smaller manufacturers who cannot always produce in advance of orders being placed. Turbine manufacturers face greatest demand towards the end of the year. Typical delivery patterns for wind turbines is 10% of annual production in Q1, 20% in Q2, 30% in Q3 and 40% in Q4.

2.5 Market Intelligence Sources

There are a number of free market data sources available for interested companies.

- **The DTI** has a large number of studies on the industry covering subjects from R&D through to future market forecasts. www.dti.gov.uk/energy/sources/renewables

- **Scottish Enterprise** offers publications on the industry targeted at Scottish companies. www.scottish-enterprise.com/sedotcom_home/sig/sig-energy/renewable-energy/renewable-energy-help/renewable-energy-research.htm

- **The British Wind Energy Association** holds significant data on existing and planned projects in the UK together with extensive planning information. www.bwea.com

- **Yes2Wind** is an initiative from Friends of the Earth, Greenpeace and WWF. Aimed at supporting the development of wind power in the UK, the website contains information on UK projects in operation and planning. www.yes2wind.com

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3 Summary of Wind Turbine Technology

The key components that make up a complete wind turbine are described below. Whilst most major items are common to all turbines, different manufacturers have different designs of turbine so some variation in components occurs and these are explained below. Where appropriate, suppliers of major components are given – in some cases there is opportunity for UK companies to supply to these companies as sub-suppliers.

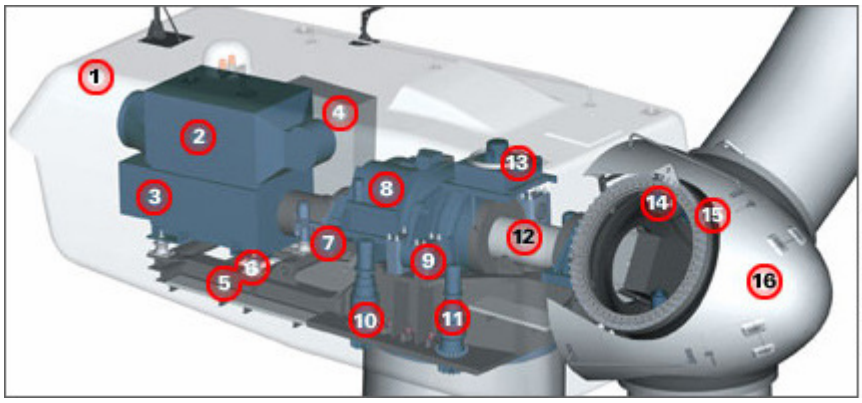


Figure 3-1: Turbine Schematic Diagram
Picture: GE Energy 3.6 MW Series Turbine – GE Energy

Nacelle – The nacelle is the main unit of the turbine which sits on top of the tower. It houses the main components within its fibreglass cover.

The yaw mechanism within the nacelle automatically turns the nacelle so that the rotor of the turbine is facing directly into the wind, allowing maximum power generation.

Components in the nacelle (in addition to those described below) include:

- Nacelle bed plate
- Main bearing (in most cases)
- Main shaft (in most cases)
- Brake calliper (typically spring-applied, hydraulic-release), gearbox slip rings
- High speed shaft
- Yaw bearing
- Yaw system (sensors, motors, gearboxes, pinions)
- Control and power panels
- Sensors, cabling
- Cooling systems
- Maintenance crane and tooling
- Nacelle cover

Blades – Modern commercial-sized turbines are three-bladed designs. Typically manufactured from fibreglass reinforced polyester- or epoxy resin, new materials such as carbon fibre are being introduced to provide the high strength to weight ratio needed for modern wind turbine blades. Rated power of the turbine varies roughly proportionally to the swept area of the rotor (square of the length of the blades). A typical 2 MW turbine would have blades of approximately 40m in length, whilst the largest turbines currently installed, 5 MW machines, feature blades in excess of 60m in length.

- Key 1st tier suppliers: A&R Rotec, Euros, Tecsis and market leader LM.
- A number of wind turbine manufacturers make their own blades in-house (eg. Enercon, Gamesa, Siemens, Vestas).

Formax UK Ltd
East Midlands – Composites

Formax are an SME (40 employees, £4.9m turnover) specialising in the manufacture of glass and carbon composite reinforcements. Formax supplies a number of wind turbine blade manufacturers with multiaxial reinforcements, both directly, and indirectly via manufacturers of pre-pregs. The main driver of the company's growth in this market has been a focus on both quality and flexibility.

Rotor Hub – The rotor and hub assembly of the turbine rotates in the region of 10-25 revolutions per minute depending on turbine size and design (constant or variable speed). The hub is generally attached to a low speed shaft which connects to the turbine's gearbox. Wind turbines will typically start operating at a wind speed of 3-4 metres per second and have a cut-out wind speed of 25m/s.

Most modern turbine hubs contain a pitch system to adjust the angle of the blades by rotation of a bearing at the root of each blade in order to control power and slow the rotor, as required. This pitch system may provide hydraulic or electric actuation (market is split approx. 50:50).

Control of the power output from the blades is done by one of 2 basic methods:

- Pitch Control, where the angle of attack of the blades is decreased to limit power – this requires almost constant adjustment of the pitch angle at above rated wind speed. This type of control can be coupled with variable speed generator technology to give superior power output quality, lower operational loads and greater operational flexibility (eg. to reduce noise levels during particular conditions).

- Active Stall Control, where the angle of attack of the blades is increased to limit power – this requires only occasional adjustment of the pitch angle at above rated wind speed and but has to be coupled with simpler fixed-speed generator technology, providing a simpler solution but with reduced functionality compared to Pitch Control coupled with variable speed.

Older turbines work via passive stall control. In this case, the blades do not pitch and power limiting is achieved through natural stalling of the aerofoils as the windspeed increases. Such blades have tips (last 15%, say) that can pitch quickly through 90 degrees to allow the rotor to be slowed.

Components on the rotor (in addition to the blades):

- Blade Bearings (key 1st tier suppliers: DRE/CON, Rothe Erde, IMO, Liebherr, Rollix).
- Hub casting
- Electric pitch system (communications, control and power panels, batteries, sensors, motors, gearboxes, pinions) or
- Hydraulic pitch system (communications, control and power panels, actuators, pumps, sensors, valves, hoses, filtration).
- Grease distribution system

Gearbox – The majority of turbine designs feature a gearbox, although some manufacturers produce 'direct drive designs' which do not require one. The gearbox (almost all fixed gear ratio) converts the low-speed high-torque rotation of the rotor to high-speed rotation at low torque for input to the generator. The gearbox drives a high speed shaft leading to the generator at typically 1,500 revolutions per minute. A mechanical disc brake is fitted for operation when the turbine is being serviced and as an emergency solution to stop the turbine if the aerodynamic brake fails. Gearboxes are currently identified as a supply chain shortage.

- Key 1st tier suppliers: Bosch Rexroth, Eickhoff, Hansen (owned by Suzlon), Jahnel-Kestermann, Moventas, Renk and market leader Winergy (owned by Siemens).

Auxiliary components (may be supplied with gearbox):

- Oil cooling
- Filtration
- Pumps
- Sensors
- Brake disk (on high speed side)

Converteam
(ex Alstom Power Conversion
Glasgow & East Midlands
Converters, generators, electrical equipment

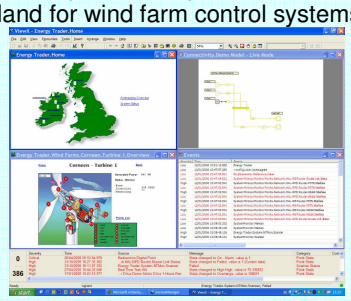
Converteam are specialists in advanced generators, controlled by intelligent power converters. Initial convertor order for £7 million received from a major OEM for an offshore project. APC are now active with 3 of the leading OEMs to develop '2nd generation' equipment for them, and are starting on a 3rd generation high tech UK solution.

Generator – The generator is housed in the nacelle and converts the mechanical energy from the rotor to electrical energy. Typically, generators operate at 690VAC (three-phase). The standard arrangement today uses doubly-fed induction generators, though permanent magnet and synchronous generators are also used,.

- Key 1st tier suppliers: Converteam, Elin, Hitachi, Leroy Somer, Loher, VEM, Winergy and market leader ABB.
- A number of turbine manufacturers make generators in-house (eg. Enercon, Gamesa, and Vestas).
- Auxiliary components (may be supplied with generator): Cooling, pumps, sensors, grease distribution

Serck Controls
West Midlands – SCADA control systems

SERCK Controls is a leading supplier of high technology data acquisition, control and safety systems. Two orders in excess of £1m just received from major developers in UK and Ireland for wind farm control systems.



Controller – The turbine's electronic controller monitors and controls the turbine and collects operational data. Effective implementation of control systems can have a significant impact on energy output and loading on a turbine and they are, therefore, becoming increasingly advanced. The controllers monitor, control or record a vast number of parameters from rotational speeds and temperatures of hydraulics through blade pitch and nacelle yaw angles to wind speed. The wind farm operator is therefore able to have full information and control of the turbines from a remote location.

Tower – the vast majority of commercial wind turbines use tubular steel towers, with lattice towers used in some circumstances (usually because of cost) on smaller capacity turbines. Tower heights depend on rotor diameter and the wind speed conditions of the site. Tower heights range from 50 metres for a 1 MW turbine to as high as 125m for the very largest turbines currently installed. Ladders (and frequently elevators in today's largest turbines) inside the towers allow access for service personnel to the nacelle.

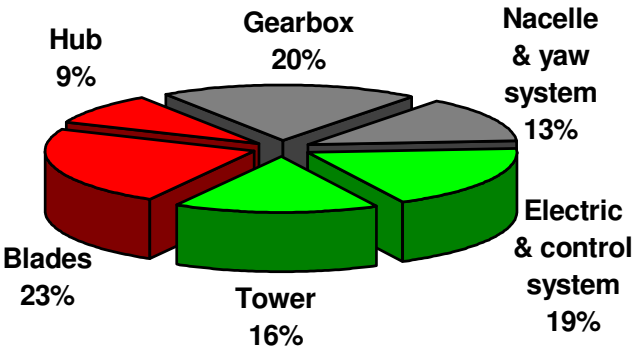
Transformer – The transformer is often housed inside the tower of the turbine. The medium-voltage output from the generator is stepped up by the transformer to between 10-35kV according to the local grid.

Camcal
Isle of Lewis - Towers and piles

Modern, purpose-built facility for manufacturing towers and foundations and other structures for the renewables industry, with on-site coating and direct export capabilities. Camcal has supplied towers for many UK wind farms and piles for one of the first-round offshore wind farms.

Component Value & Mass

Typical properties are presented below.



Rotor: 40 tonnes
(blades & hub)

Nacelle: 70 tonnes
(gearbox, generator & yaw system etc.)

Tower: 200 tonnes
(steel & electrics)

Figure 3-2: Component Value & Weight
Figures: BVG Associates

Turbine Power Output – A typical modern wind turbine has a rated power of up to 5 MW. At any time, output is dependent on the instantaneous wind speed, the relationship being represented by a power curve – see Figure. Different models of wind turbines may be designed for different average wind speeds and hence will have different power curves.

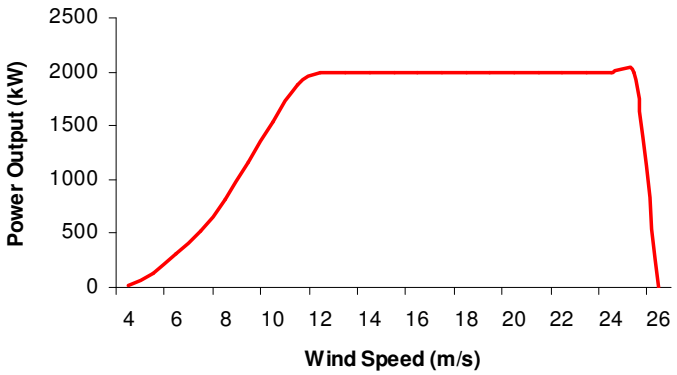


Figure 3-3: Typical Power Curve for 2 MW Rated Turbine

Over a year, average output from a wind turbine is approximately 25-30% of rated capacity for UK onshore sites and 35-40% for UK offshore sites where the wind resource is greater.

3.1 Typical Product Lifecycle

3.1.1 Design

The design process for a new turbine takes typically 1-3 years depending on extent of change from previous designs. Over the years, the wind industry has overcome significant barriers to the development of larger turbines by incorporating new technologies, for example the increased use of carbon fibre in blades has enabled a 30% increase in blade length whilst keeping blade mass relatively constant.

Design Drivers vary for different components, but in general, structural elements are fatigue-driven, with care being needed to avoid resonant frequencies. Careful design brings margins against failure under ultimate loads as close as possible to margins against failure under fatigue loads. Fatigue loads come from mainly from combination of gravity- and aerodynamic loads.

Systems are typically reliability-driven. A typical car goes 500 working hours between yearly service inspections. A typical wind turbine goes a good 12 x longer between inspections. Wind turbine technology, sold in '000's falls between aerospace and automotive technology in terms of quantities but far in excess of both in terms of hands-off reliability requirement.

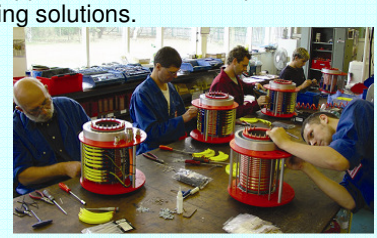
3.1.2 Certification

External design certification is necessary for turbine manufacturers to demonstrate that their turbine meets specified standards on a range of criteria. These usually include items such as:

- Control systems
- Structural loads, both stationary & operational
- Structural component specification (blades, hub, shaft, mainframe, yaw mechanism, tower, etc.)
- Mechanical component specification (transmission gears, bearings, cooling, filtering, seals, braking systems, yaw drive, pitch system, locking devices, etc.)
- Electrical component specification (converter, grid connection, generator system, contactors, grounding, lighting protection, etc.)
- Turbine characteristics (power performance, noise measurements, etc.)
- Operational plans
- Maintenance plans
- Safety plans (fire protection, climbing provision, warning signs, escape routes, emergency lighting, high-voltage equipment, etc.)

BGB Engineering
East Midlands – Electrical

BGB is a manufacturer of electrical slip rings that provide continual electrical contact through rotating machinery. BGB was the first slip ring manufacturer to design a dedicated wind turbine slip ring for hub control systems. Working closely with major wind turbine manufacturers, BGB remains at the forefront of turbine technology and is now a leading supplier in the development of slip ring solutions.



The certification is of value in assuring the purchasers of the turbine that their investment is secure by having been tested and evaluated by a recognised independent body, that it has met internationally agreed standards and has demonstrated safe operating characteristics. Certification is almost always a contract condition from project developers, investors and insurance companies. Certification includes a requirement for use of specified suppliers of key components.

3.1.3 Prototyping

Prototyping is undertaken by manufacturers as a natural step towards commercial series production of their new turbines. Prototype installations of new turbines demonstrates internal development work and shows the marketplace the new technology available. For example, several manufacturers are currently prototyping their new 5 MW class turbines. These huge turbines are extremely complex and expensive and the manufacturer, therefore, needs to have operational experience with the turbine to iron out any problems, tweak performance and give the turbine proven capability. By collecting extensive data from the prototype turbine, a full analysis can be made. The manufacturer can gain useful information regarding installation and the servicing of the turbine, two areas which are

especially critical offshore. If the turbine model passes through the prototyping phase successfully (often a one year period), the move towards series production of that model is then able to begin.

3.1.4 Series Production

Series production will often start a batch of limited size. Although prototyping gives detailed information to the turbine designers, the robustness and reliability of a turbine design is often only developed during a period of operation under a range of different climatic conditions. Successfully managed, acceleration of supply allows the turbine manufacturer to benefit from economies of scale in purchasing components and from repetition of the processes of assembly, installation, troubleshooting and routine maintenance.

3.1.5 Warranty

Warranty requirements made by manufacturers on their suppliers are typically in the region five years. Some manufacturers expect to see longer warranty requirements coming into place in the future. The current high demand being experienced for components has seen turbine manufacturers accepting shorter warranty terms.

- *"In the US, can set own warranty terms, as it is a sellers market. Elsewhere we have not gone over five years yet but expect that it will be required."*

Compensation for lost revenue due to resulting downtime from a faulty component is required by some manufacturers but not by others; specific major components such as generators are more likely to be subject to such a clause.

Warranties tend to be specifically negotiated but manufacturers typically expect component suppliers to provide between three and five years warranty which can include component exchange and transport costs. Some manufacturers expect cover for loss of revenue in the event of downtime caused by faulty components – this varies by manufacturers and component.

- *"Typical warranties are for 5 years. Standard supplier master agreement covers exchange and transport costs, but not lost generation. It is seen as important that a supplier stands behind their product by providing local spares and support as required."*

3.1.6 Maintenance

Modern wind turbines typically have a 20 year design life. Turbines are designed to have one or two planned maintenance checks per year. Increasingly, advanced control and monitoring systems allow the operator to gain a large amount of health-checking data from the turbine in operation which can pre-empt problems. Cost of operations and maintenance onshore is approximately 1-2% of the capital cost per year.

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

Hydratight
West Midlands – Bolt tensioning services and equipment

Wind energy business has accelerated over the past 4 years to a current annual turnover of £2 million, with service & sales provided to almost all major OEMs for wind farms in USA, Europe & increasingly in Asia.

There is a lot of effort being put in by wind turbine manufacturers to reduce maintenance work, due to the cost of such activity, especially offshore. The change is reflected in the use of the language of lifetime cost rather than simply CAPEX when considering design requirements. Operation of a wind farm is conducted by the owner of the project or an operations contractor.

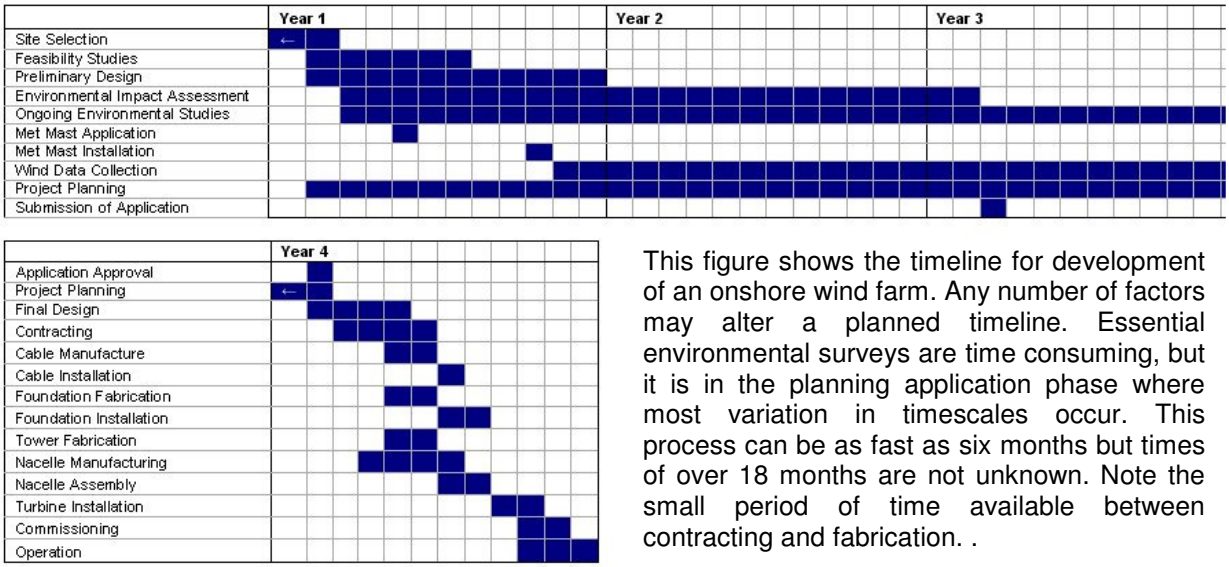
UK companies have a strong reputation for innovation and for working in the servicing industries. Companies that can produce reliable and serviceable components that fit into the lifecycle costs model that the wind industry follows have a definite advantage.

For component suppliers, unique opportunities are sometimes available through maintenance work where spare parts are needed. Within turbine manufacturers, the maintenance departments sometimes have their own purchasing powers and procedures, separate to the main purchasing department. For one large European supplier this was the case:

- *"Spares are purchased independently by the maintenance department, using suppliers & specs from main purchasing but paying higher prices due to lower quantities. Maintenance tools also purchased independently by the maintenance department."*

3.2 Wind Farm Project Development Timelines

3.2.1 Onshore Wind



This figure shows the timeline for development of an onshore wind farm. Any number of factors may alter a planned timeline. Essential environmental surveys are time consuming, but it is in the planning application phase where most variation in timescales occur. This process can be as fast as six months but times of over 18 months are not unknown. Note the small period of time available between contracting and fabrication. .

Figure 3-4: Typical Project Lifecycle for an Onshore Wind Farm

3.2.2 Offshore Wind

The timeline below is a guide to the project development schedule for a moderate sized (100 MW) offshore wind farm assuming that planning, financing, contracting and commissioning goes smoothly. In reality a lot of projects can face extended timescales due to objections, or delays in the financing or contracting stages.

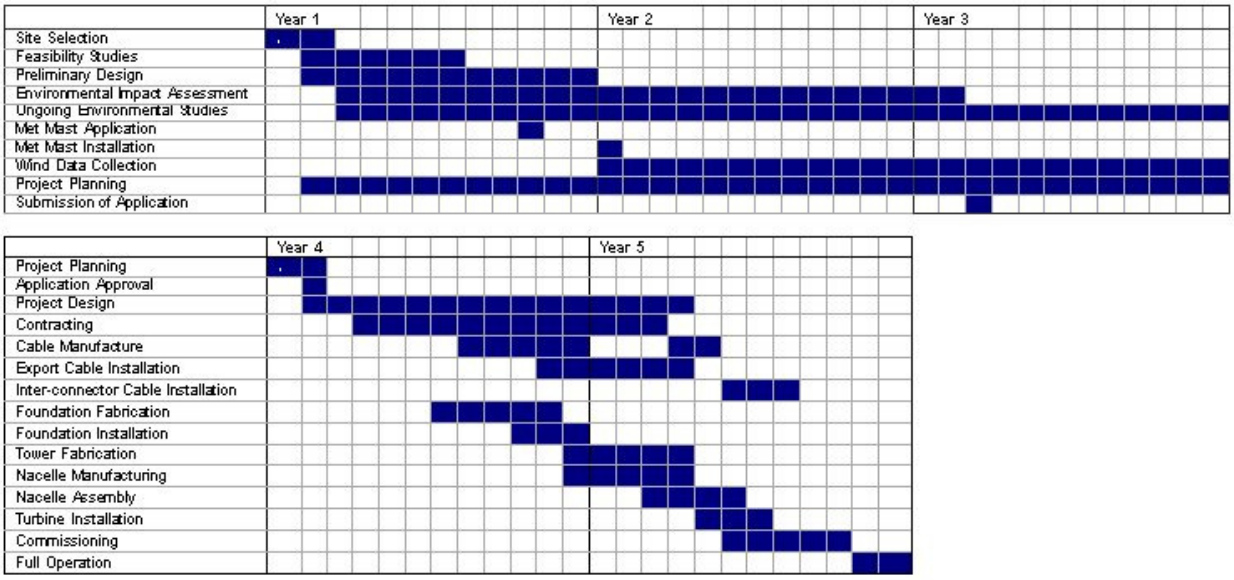


Figure 3-5: Typical Project Lifecycle for an Offshore Wind Farm

Beatrice Wind Farm Demonstration Project

An advanced offshore wind development in the North Sea with significant UK content levels.

The Beatrice offshore wind farm is one of the most technologically advanced offshore wind projects in the world. Under development by a joint venture of Talisman Energy and Scottish and Southern Energy (SSE), it is to be built 25 km from shore, in 45 m of water, in the Moray Firth off Scotland. When fully built, the wind farm could be up to 1 GW in size, and have 200 x 5 MW turbines. The demonstration project will have two REpower Systems 5 MW turbines.

Interestingly, the proposed wind farm will use some of the infrastructure from Talisman Energy's Beatrice Alpha platform and oilfield. The platform itself is planned to house the wind farm's substation. It would also be used as accommodation for offshore personnel for installation and operations and maintenance. When operational, the generated electricity will help pay for the decommissioning costs of the existing platforms.

This project is designed to show the potential of the site and to demonstrate structural design and installation techniques. The two turbines would allow operations and maintenance procedures to be developed, reducing future costs.

The project is a perfect example of how existing oil and gas technologies and experience can be transferred to the offshore wind sector.

UK successes (to date) on the Beatrice Wind Farm Demonstration project:

- REpower UK Ltd is the joint venture of REpower Systems AG and Peter Brotherhood, a British engineering company. Founded in September 2003, the company sells REpower Systems' multi-megawatt wind turbines in the United Kingdom and provides a full after market service.
- In February 2004, Kellogg Brown & Root was awarded a contract for an engineering design study of the project.
- AMEC was awarded a contract to design and manage delivery of the project.
- The £5m jacket foundation manufacturing was contracted to Burntisland Fabrications in Scotland. The 'jacket quattropod' is based on designs from Owec Tower, a Norwegian company. The contract will create around 60 jobs during this fabrication phase.
- Tower manufacturing for the two REpower turbines will be undertaken by Camcal, based in Scotland. The 60 metre towers will each weigh 200 tonnes.
- JDR Cable Systems won the contract to design, manufacture and test the two composite power cables required to control the turbines linked back to the Beatrice Platform. The 2 composite bundles (970m & 1,920m long) each comprise 3 phase 70mm² 33kV power cores, data cables, back up power cables and fibre optic communication cables.

Scroby Sands

Domestic successes on the UK's second large offshore wind farm.

The 60 MW Scroby Sands offshore wind farm, located an average of 3 km off Caister, was developed by E.ON Renewables Offshore Wind Ltd (EROWL). Scroby Sands was commercially complete on 31st December 2004 and was formally opened in March 2005. It is the second of the UK Round 1 offshore wind projects to be constructed.

The development, construction and initial five years operation of the Scroby Sands offshore wind farm resulted in a total expenditure of £80 million. Contracts to the value of £38.8m (48%) were sourced from UK companies.

The highest levels of UK content were realised within the development and operations phases of the project. The construction phase presented the highest value phase of the project and there were notable UK successes including foundation and cable manufacture, onshore cable installation, grid interface, and the installation of the export cable to shore. UK companies also provided all environmental monitoring, survey, insurance/legal and onshore installation related works.

UK successes on the Scroby Sands offshore wind farm:

- The first subcontract to be issued by EPI contractor Vestas was to Halliburton KBR to project manage the development on its behalf, while EROWL employed its own project manager, Offshore Design Engineering (ODE), on a 20-month contract valued at around £750,000.

- In May 2003 Cambrian Engineering were awarded the contract for the supply of 16 piles, with Isleburn Mackay and Macleod winning a contract to supply the remaining 14 piles and approximately 700 tonnes of additional steelwork.

- CNS Subsea installed the infield and export offshore cables, which were sourced from AEI Cables, while Nacap UK installed the onshore cables, supplied by Pirelli Cable Limited, over the period October 2003 to February 2004. EROWL also contracted EDF (formerly 24-7) for the onshore grid connection and have on ongoing consultancy contract with Econnect.

- Turbines were assembled at Vestas' factory at Campeltown. Seacore were contracted to install six of the turbines in the shallowest water locations. The turbines/blades were pre-assembled by Vestas Celtic at SLP Engineering's Lowestoft yard.

- In August 2004 the £500,000 operations centre was opened in Great Yarmouth, providing the service back-up for the wind farm.

Picture: E.ON UK

The *'Scroby Sands – Supply Chain Analysis'* report was published by the DTI in 2005

4 Future Trends

Whatever technology steps wind turbine manufacturers take, it is likely that these steps will be slower than in the past. In the last 15 years, huge steps have been taken to massively reduce cost of energy from wind farms, through technical innovation, up-scaling of commercial activity and increase in turbine size. Currently, in a sellers market and with costs of electricity generated by wind beating gas in windy areas, we are seeing a significant rise in turbine prices as wind turbine manufacturers reward shareholders with profits rather than simply high-risk growth and rapid product turnover..In time, this maturity should also flow through to the rest of the supply chain.

4.1 Turbine Concepts and Component Technology

5 MW+ turbines – We are already seeing prototype installations of the next generation of wind technology – the 4-5 MW class wind turbine. At present, the most standard series produced turbines are in the 1.5 MW – 3 MW classes. The 4-5 MW turbines are primarily designed for offshore use where it is more economical to have fewer larger turbines than more smaller ones. With less restrictions over visual impact, the offshore environment is the ideal home for this larger technology. This size of technology offers a new opportunity to work with manufacturers as they seek to develop their products. Most major offshore wind farms installed after the end of the decade will utilise these turbines. A 6 MW turbine is in operation in Germany, and efforts are already focused on increasing turbine size further still.

New concepts - Most of today's new turbines are following the basic design concepts proved over many years (let's call this 1st generation technology), with some specific components undergoing step changes to use 2nd generation technology (for example, the use of permanent magnet generators is becoming more widespread). It is anticipated that 3rd generation technology will eventually be implemented, involving significant rethinking, especially around the drive train and power take off and 'power-station' type operation of complete wind farms. Recently, a number of new players have entered the market, often offering gearless (direct-drive) turbines or arrangements with an intermediate gear ratio and medium-speed generators. With the large players focussed on their standard concepts, there are interesting times ahead for this new generation of companies and concepts.

Marinisation – To date, offshore wind farms have used standard onshore wind turbines, with some slight modification. Whilst this may be appropriate for nearshore projects, when future projects are built increasingly further from shore greater consideration needs to be given to the marinisation of turbines and their components. The expense of servicing turbines far offshore is considerable and greater R&D into ways to ensure reliable operation is required. New solutions are needed for the future for many turbine components, but especially installation and maintenance methods and the wind industry can gain great benefit from utilising the experience of both marine and oil & gas companies.

New materials – In recent years, carbon fibre has transformed the opportunities for increased blade length. Composites are likely to be used more in other areas of turbine design. Much work continues also on material properties and quality, in order especially to maximise fatigue strength.

ADI Treatments
West Midlands – Austempering

Orders now approaching £1 million. New capital investment equipment just commissioned. Whole strategy for market entry through investment aided by RDA and WindSupply, with funding help from RDA. Includes heat treatment of sub-assembly goods from Germany, and transported back to Germany for turbine assembly there.

4.2 Changes to the Industry Structure

Both onshore and offshore wind have highly competitive markets, but these are becoming increasingly open to companies who can offer innovative and cost effective solutions. The intense drive for bigger and better wind turbines utilising reliable and high quality component parts will increase as manufacturers seek to gain a market advantage. But it is not just the technology that is changing; the industry itself is constantly evolving.

Driven by the desire to diversify into expanding markets many companies are attempting to enter the wind industry. This is true for both very small and very large companies from small suppliers to international utility companies. At the current time there is a significant number of companies whose main business has been oil & gas that are increasingly making the effort to enter the offshore wind industry. This trend will continue in the future as companies seek to apply their years of experience, technology and skills to the challenges of offshore wind. There are many examples of this, one of which is the Beatrice wind farm off Scotland which is a showcase for innovation and cross-over technology. Whilst major utilities have been active in developing and owning offshore wind farms for many years, major oil and gas players are now entering the market.

The number of mergers and acquisitions is expected to rise with manufacturing and servicing companies seeking to consolidate market share and gain access to new markets. In addition to the major Vestas (world no. 1)/NEG Micon (world no. 3) merger in 2004, several small turbine manufacturers have been taken over in the last two years.

The onshore market is now mature and the way the industry works has become increasingly standardised, though there is still a mix of vertically integrated companies (such as Gamesa and Acciona) with single focus companies (such as Vestas). Some players are happy taking on EPIC contracts in distant markets, others will only supply wind turbine technology. Offshore, this is not the case and there are significant different approaches being adopted in the development of projects. Contracting is currently the area where greater consideration will be paid to how it is undertaken. The first large projects were mostly done under EPIC contracts with one company, usually the turbine manufacturer, being responsible for placing individual contracts for the construction of the project. One major disadvantage with this approach is that the lead contractor bears all the risk, which offshore is substantially high. With the experience from the first projects, EPIC prices have risen which in some cases is causing loggerheads between developers and contractors who cannot agree prices and terms.

Offshore, we are already seeing examples of major projects being undertaken using a multiple-contract approach whereby risk is split. This type of contracting is common for onshore projects and as offshore developments grow in size it will be adopted more and more in an effort to reduce costs. Another step forwards would be the emergence of alliance style contracting, with several companies grouping together to win major contracts. This creates a highly experienced team which could bid for work at extremely competitive prices.

4.3 Research and Development

The ongoing commercial need for technological improvement is pushing the importance of research and development in the wind industry as manufacturers seek to produce both more powerful, more reliable and more cost efficient turbines. There is, therefore, a need for manufacturers to work with existing and potential suppliers to further product development.

- *"Doing joint R&D with external companies from Germany, Denmark and Italy."*

A majority of manufacturers are extremely keen to engage in R&D activities with suitable suppliers. Some manufacturers are willing to co-fund R&D work, either through in-house funding or by using external funding such as EU support.

- *"Have done joint R&D activities with suppliers, but not yet externally funded. The right project with the right supplier is more important than the funding."*

- *"We gained provincial and EU support to help fund R&D."*

4.3.1 Sources of External R&D Support for Suppliers

DTI: Technology Programme – The former business support schemes, including the New and Renewable Energy R&D Programme have been replaced with the Technology Programme, a more focused programme that assists businesses with their technology development. The New and Renewable Energy R&D Programme is now being delivered through the Collaborative R&D Business Support Product.

The Technology Programme has the purpose of providing funding to facilitate investment in science, engineering and technology. UK-based firms and consortia may submit proposals to the DTI under this Programme for funding through two business support products: Collaborative R&D and Knowledge Transfer Networks. Knowledge Transfer Partnerships are part-funded by the Government and can enable your business to work with a university, college or research organisation that has expertise relevant to your business and can help you increase profitability.

Over the period 2005-2008, £320 million is available to businesses in the form of grants to support research and development in the technology areas identified by the Technology Strategy Board.
www.dti.gov.uk/technologyprogramme/

FP6/FP7 – The Framework Programmes are the EU's main source of support for leading edge research and technological development. FP6 has a budget of €19 billion, over the period 2002/6 with which to support organisations of all sizes throughout the EC. Funding for long-term R&D in wind energy under FP6 (2003 - 2006) has been extremely limited, with no long-term funding allocated, and at present amounts to only €24m, compared to €70m under FP5.

However, in its December 2004 call for proposals, the European Commission decided to reinstate long-term research in wind power. If approved, long-term funding in the range of €10-15 million would be included in FP6. This represents the sum total of long-term wind energy R&D for the period. The total budget for long-term research in "Sustainable Energy Systems" is €405 million.

Liquid Controls Ltd
East Midlands – Tooling

Liquid Control Ltd, part of the Graco world wide group of companies, design and manufacture standard and special purpose equipment for processing two-component and multi-component Resin and Adhesive systems.

Liquid Control is considered the market leader for resin mixing machines in many industries including the manufacture of wind turbine blades. Turnover in the turbine industry has doubled each year for the past three years.

There is currently a call for a separate budget for renewable energy and specifically, wind power, as other technologies fall under the same grouping at present. 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/

Research and Development Tax Credits – R&D tax credits are a company tax relief which can either reduce a company's tax bill or, for some small or medium sized companies, provide a cash sum. The aim of the tax credits is to encourage greater R&D spending in order to promote investment in innovation. The R&D tax credit works by allowing companies to deduct up to 150% of qualifying expenditure on R&D activities when calculating their profit for tax purposes.
www.hmrc.gov.uk

Scottish Enterprise: R&D Plus – SE has launched R&D Plus, designed to support large companies engaged in R&D activities in Scotland. The first scheme of its kind in the UK, R&D Plus aims to build on Scotland's reputation for technical excellence by actively supporting companies engaged in new and innovative research into products and processes which demonstrate real potential for global commercial success. R&D Plus is open to all large companies located within Scotland or planning to establish an R&D presence in Scotland, with the aim of encouraging R&D investment and job creation. The scheme aims to support companies by providing discretionary grants of up to 25% of eligible costs to undertake development of new products or processes to the pre-production prototype stage.
http://www.scottish-enterprise.com/sedotcom_home/services-to-business/ideas-and-innovation/innovation_funding_innovation.htm

Scottish Executive: The Scottish Executive has several relevant programmes available to assist Scottish companies R&D efforts:

SMART:Scotland – Successful applicants receive funding of 75% of the cost of carrying out a technical and commercial feasibility study lasting between 6 and 18 months. The maximum award is £50,000. SMART:Scotland winners who successfully complete their projects and who need more help to develop a pre-production prototype can get further support through the SPUR programme.

SPUR – SPUR grants help small to medium sized enterprises (SMEs) to develop new products and processes involving a significant technological advance for the UK industry or sector concerned, up to pre-production prototype stage. Awards can be made to independent businesses and groups with less than 250 employees.
http://www.scotland.gov.uk/Topics/Business-Industry/support/

EUREKA – EUREKA is a pan-European network for market-oriented, industrial R&D. Created as an intergovernmental Initiative in 1985, EUREKA aims to enhance European competitiveness through its support to businesses, research centres and universities who carry out pan-European projects to develop innovative products, processes and services. EUREKA offers project partners rapid access to its network of knowledge, skills and expertise across Europe and facilitates access to national public and private funding schemes.

The EUREKA label adds value to a project and gives participants a competitive edge in their dealings with financial, technical and commercial partners. Through a EUREKA project, partners develop new technologies for which they agree the Intellectual Property Rights and build partnerships to penetrate new markets. In the UK there are currently 80 running projects, 38 of which are energy-based.
www.eureka.be

Carbon Trust – The Carbon Trust is an independent company funded by Government. Its role is to help the UK move to a low carbon economy by helping business and the public sector reduce carbon emissions now and capture the commercial opportunities of low carbon technologies. The Carbon Trust aims to deliver best practice programmes to inform and influence behaviour, to build skills and resources and to inform policy makers in the low carbon debate. The Carbon Trust works to support the development of a UK industry sector that capitalises on the innovation and commercial value of low carbon technologies.

Applied Research Grants – The Carbon Trust's Applied Research Programme is open to UK businesses and research institutions and aims to support the development and commercialisation of technology with the potential to reduce UK carbon dioxide emissions. As such it endeavours to encourage and support the progress of low carbon technologies towards large scale deployment.

When a call-for-proposals is open companies can apply for a grant of up to £250K towards the cost of a project. A minimum 40% match funding is required, and, to be successful a project must demonstrate: genuine innovation and the potential to contribute to substantial reductions in UK greenhouse gas emissions; that the work is well planned and builds on previous work in the area; that the results of the work will allow a clear step forward on the path towards commercialisation; and that it represents good value for money.

Incubator Programme – The Carbon Trust launched its Low Carbon Incubator programme in April 2004. Incubators, sometimes known as Business Accelerators, provide a range of business skills to assist technology developers in commercialising their research work and in building their businesses. The incubators provide up to £60K of advisory support per qualified start-up company, and will use set entrance and exit criteria to screen for the most appropriate candidates and to manage the number of companies receiving support.

The Carbon Trust can refer potential candidates, who have real commercial and technical promise, into our co-funded incubators. The selection process is competitive and has both entrance and exit criteria; success is determined by meeting designated milestones over time. The incubators provide strategic and business development consultancy, advice on corporate

finance, mentoring for the management team, energy-related market research and guidance on technical support.

Venture Capital – The Carbon Trust is a co-investor of choice in the low carbon technology field. It specialises in identifying and investing in early stage technologies and credible management teams with the ability to create and deliver 'low carbon' businesses. The Venture Capital team is strongly supported by in-house technical and strategy groups as well as a wide network of specialists. For all venture capital deals the Carbon Trust works with other venture capital and private equity firms as co-investors. The Carbon Trust is interested in technologies with commercial potential, that can demonstrate feasibility and that have potential co-investors in place. Typically the Carbon Trust invests between £250k-£1.5m per deal as a minority stakeholder alongside private sector investors on the same terms.

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5 What to do Next? Creating Opportunities for Supply

5.1 Typical Process for New Supplier and Component Approval

An overview of the process for new component suppliers is given below. It is formed from detailed responses to a survey conducted with the major turbine manufacturers.

Potential suppliers require ISO 9000 compliance and for the largest manufacturers, need an international strategy. It may take 1-3 years from 1st contact to series production (if adopted), depending on component and success of relationship.

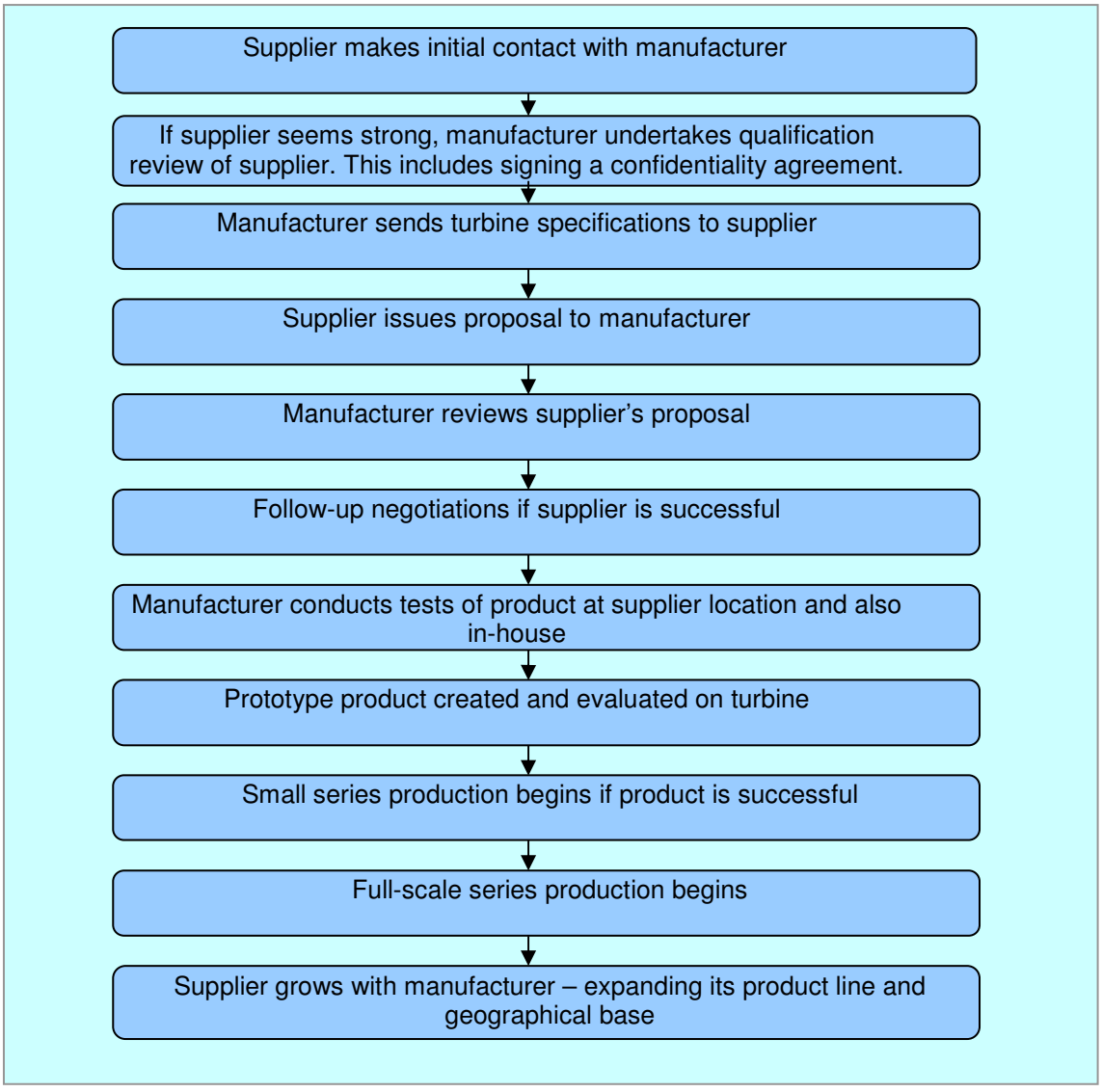

Figure 5-1: Process for Supplier Approval for supply of Significant Component

It is relevant to note that although gearboxes are regularly cited as a limiting feature of the supply chain, no wind turbine manufacturer stated gearboxes as a supply chain need. This relates partly to the political sensitivity of stating publicly such a key need but also to the recognition that no independent newcomer could address the shortfall within the next 3-4 years anyway, due to long learning curve and experience required in order to provide confidence in the delivery of reliable gearboxes to the industry.

5.2 The Potential for UK Suppliers – Key Factors

Turbine manufacturers are starting to view the UK supply chain with increased interest in light of the rapid growth of the UK market and the current global limitation on sales due to limitations on supply.

The UK is not traditionally seen as a wind-power nation as the number of wind farm installations has only recently grown significantly. Some manufacturers, especially the smaller ones, are currently unaware of the potential suppliers the UK has and what the key strengths of UK industry are. Recent changes to EU procurement policy regarding UK utilities may open up opportunities for the UK supply chain

Companies in the UK face a high level of competition from both continental Europe and worldwide. It cannot be assumed that supply for UK wind projects will naturally increase the chance of UK supplier success.

- *"Unless local content requirements are demanded, a global demand is satisfied from a global supply base."*

Several manufacturers interviewed specifically stated that they would like to start to purchase components in the UK where possible but factors of price, quality, deliverability and support are paramount. UK companies, therefore, must show a clear advantage to gain initial orders and maintain their position.

- *"Price, delivery & quality come before location, but the ideal would be to get these and be able to buy in UK."*

Key requirements made on potential suppliers include price, delivery timescales, product quality, long-term commitment to products and flexibility. Management capability and industry knowledge are further important values that turbine manufacturers judge to be especially important. These are examined below.

5.2.1 Price

Price is a sensitive factor especially because the wind industry has to date largely been built on the back of economic subsidies. The industry has done much over the years to reduce costs by technical and commercial innovation.

- *"UK companies have a tendency to have a traditionalist annual price increase mentality, whereas the wind industry generally works with annual price decrease, to be found by increasing quantities and efficiencies and changing product or process technologies. Advice to UK companies is to ditch the traditional mentality."*

With turbines representing the largest cost of wind farm development and the ongoing effort to reduce overall costs by manufacturers, there is pressure on component suppliers to focus on lowering their prices over time. This requirement will be felt by suppliers and sub-suppliers entering the industry.

- *"A component cost reduction push is currently underway."*

Cost reduction is an area where manufacturers often actively work with established suppliers to jointly achieve savings.

5.2.2 Quality Assurance & Reliability

Turbine manufacturers highly value suppliers who have invested in considerable R&D and testing to prove their products. With some high-profile and costly component problems in recent years, excellent quality control is essential. Suppliers that can demonstrate highly reliable components in this demanding application are, therefore, of considerable value and can rise to prominence in a manufacturer's supply chain.

We are moving into a period where higher prices can be justified if long-term reliability can be proved. Manufacturers are becoming more open to discussion on up-front and lifetime cost saving measures, but only with players who have some industry track-record. Companies that can demonstrate this are at an advantage.

- *"There are key areas where the lifetime cost viewpoint is changing the choice and specification of component."*

Component suppliers must additionally recognise the 'low-service reliability' nature of the market (e.g. turbine manufacturers aim for one turbine service visit per year). Suppliers need to offer superior process control and documented plans to enable proactive avoidance of problems rather than reactive repair.

- *"Reliability, flexibility and supply line independence (low-maintenance: avoiding the need to expedite and negotiate constantly) are key requirements of a good supplier."*

Turbine models destined for offshore installations have to have increased reliability. In the marine environment servicing costs are far greater than for onshore wind so manufacturers are keen to reduce scheduled and non-scheduled maintenance work in order to minimise downtime. UK companies have strong skills in offshore technology and the application of this to offshore wind is a high-value opportunity.

5.2.3 Industry Awareness

Whilst keen to engage with suitable UK suppliers, several manufacturers highlighted the fact that understanding the marketplace and business practices, that have mainly developed in continental Europe, is of great importance for potential suppliers. UK suppliers must accept the position that they are competing for work with an increasingly global supply chain.

UK companies have to demonstrate professionalism in both their product offerings and their business approach. Market knowledge and awareness of the current industry issues is essential as both impact on the potential for new suppliers.

5.2.4 International Development

The largest manufacturers are especially interested in companies with an international presence to suit their target markets. It was found that turbine manufacturers look to the potential for suppliers to grow alongside them in entering new markets, with an openness to establishing new offices/factories in these markets. Suppliers must have a global vision and commitment to the sector. Being able to offer international servicing and support is seen as a key value.

- *"We like to work with multi-nationals who can provide a range of components and systems from a range of sites."*

This international presence or development strategy is of greater benefit for working with the major turbine manufacturers that have a large international market for their turbines. Typically, the smaller the manufacturer the more localised their market is and the less they can demand from their suppliers,

5.2.5 International Competition

The above factors are especially relevant as potential UK (and established Western European) suppliers are increasingly facing supply competition from Eastern Europe and China where production costs are significantly lower.

- *"We see quality factories producing quality goods in China."*

Whilst some components will still be produced locally because of transport costs the emergence of wind industry suppliers in these countries is a threat to UK companies.

- *"In 2006, 10% of total nacelle components purchased by XX will be from China. In 2007, this will be 20%... Currently, all assembly and in-house manufacture is in our home market. In summer '06, assembly (and some manufacturing) will start in China."*

In order to compete UK companies need, therefore, to offer substantial quality and service in this increasingly global industry.

5.3 Making Contact with Manufacturers

Whilst manufacturers are pleased to welcome inquiries from potential suppliers there is a need for suppliers to use appropriate methods to seek interaction, especially with the major manufacturers. There are examples where manufacturers believe UK companies are not adopting the right approach.

One turbine manufacturer was concerned about being approached by UK companies and agencies who did not have sufficient understanding of the industry basics. The larger manufacturers especially can be overwhelmed with unqualified potential suppliers approaching them. Potential suppliers must be realistic about their products and capabilities, turbine manufacturers are not interested in companies that lack first-class products.

One manufacturer stated that some UK companies they had contact with were often complacent:

- *"…UK companies are not getting to grips with how to work with [other nationalities, not putting in R&D effort to really prove products and expecting purchasers to come and find them."*

Most large manufacturers have a presence at industry conferences and exhibitions and this can provide a good opportunity to open contact with them. Additionally, regional development agencies sometimes run 'meet the buyer' type events which offer a unique opportunity for suppliers to offer their capabilities directly to a purchaser.

- *"We like to receive supplier presentations/brochures electronically in PDF form, then we will be proactive when the right time comes. There are insufficient resources to dialogue with all companies that are interested in supplying."*

Suppliers need to ensure that they internally allocate one main contact person for dealing with individual manufacturers. This relation building is seen as important for efficiency and the establishment of trust.

- *"Our experience was that the company was slow, hard to contact and inefficient – we often got asked the same question 2-3 times by different people."*

It should be recognised that the wind industry remains in a period of significant growth, hence resources are stretched and focus is only on areas of greatest benefit, with recognition that other areas could also benefit from further activity.

Two manufacturers advised that they expected to grow their technical capability in the UK in 2006, with one of their tasks to investigate and grow UK supply chain possibilities.

5.4 Examples of Specific Supply Chain Needs

Each turbine manufacturer was asked what their current supply chain needs were and if any of these were UK-specific. Broken down by component, examples of key needs from individual manufacturers are shown below along with comments. These needs are highlighted because they have either been present within the industry for some time or were raised by a number of wind turbine manufacturers.

In general, there is a significant need to expand the supply chain, summed up by the following responses.

- *"Vestas requires more supply possibilities in order to continue to balance cost, capacity "and flexibility.*
- *"An increased supply chain requirement is anticipated in many areas.""*

Towers – From the interviews conducted with all the turbine manufacturers, the number one quoted need from UK suppliers was for towers. Local production of towers is of value in avoidance of transport costs and a number of manufacturers are actively looking for new potential tower suppliers in the UK.

- *"When Gamesa sells more into UK, they will look for local balance of plant content, especially towers. Gamesa always interested in local content if possible."*
- *"For UK market, towers are being shipped from Germany via the Cuxhaven ro-ro. Would very much like a UK alternative."*

Towers Internal Components – Closely linked with manufacture of towers is the supply of all internal components – ladders, platforms, lights etc. Towers manufactured in the UK today use kits of internal components imported from the continent.

Blades – Within the industry, there is a mix of in-house and external manufacture of blades. There are concerns in the industry over future blade supplies, with some manufacturers worried that independent blade producers may get bought out by their competitors. Supply opportunities for blade tooling and materials exist throughout the industry.

- *"Near-term growth is constrained by blade production (number of moulds and buildings), though really this comes down to the number of competent people rather than constraints due to raw materials."*

Additionally, carbon fibre is now being used more and more in large blades and there is a worldwide constraint on production capacity because of huge demand from both the wind industry and elsewhere.

- *"There are no UK suppliers of carbon fibre. It needs a fair amount of space and probably £30m investment to be cost effective. There are significant shortages now [late 2005], though new plant is being built elsewhere. There is a growing global demand for carbon fibre."*

SG iron castings – there has for a long time been insufficient supply chain for large SG iron castings.

- *"Castings required from 1.2 to 33T, though most interested in castings 8-10T and above. At the 10T size we need to be able to source 50/year at the start, rising to 200/year."*

Main shaft forgings – a need repeated by a handful of manufacturers.

Other items – the following other items were raised by at least one turbine manufacturer:

- Tower flanges (forged and in some cases welded rings)
- Transformers and power converters
- Electric pitch systems
- Main bearings (especially large diameter)
- Blade- and yaw bearings (slewing rings)
- Balance of plant

5.5 Where to go for Help – Key Organisations

DTI – The DTI drives its ambition of 'prosperity for all' by working to create the best environment for business success in the UK. It helps companies become more productive by promoting enterprise, innovation and creativity. The DTI champions UK business at home and abroad and invests heavily in world-class science and technology.

The DTI's Energy Group deals with a wide range of energy related matters, from its production or generation to its eventual supply to the customer. The Energy Group is committed to working with others to ensure competitive energy markets while achieving safe, secure and sustainable energy supplies. Its role is to set out a fair and effective framework in which competition can flourish for the benefit of customers, the industry and suppliers, and which will contribute to the achievement of the UK's environmental and social objectives.

Contact: Department of Trade and Industry, Response Centre, 1 Victoria Street, London SW1H 0ET
Tel: 020 7215 5000, Email: dti.enquiries@dti.gsi.gov.uk, Web: www.dti.gov.uk

DTI Trade Promotion Service – The TPS is part of the DTI's Business Development team and is committed to raising the international profile of the UK renewable energy industry and to help individual organisations develop their export potential. It organises events, gathers and disseminates market intelligence and provides assistance and support to identify and communicate opportunities for UK renewable energy companies.
Web: www.ukrenewables.com

DTI 2010 Target Team – The DTI's Business Development team's focuses on maximising the benefit for UK companies' success in the growing world renewables energy market.
E-mail: enquiries2010@dti.gsi.gov.uk

Regional Development Agencies – The eight Regional Development Agencies (RDAs) set up in the English Regions are non-departmental public bodies. Their primary role, along with a ninth RDA, the London Development Agency, is as strategic drivers of economic development in their region. The RDAs aim to co-ordinate regional economic development and regeneration, enable the regions to improve their relative competitiveness and reduce the imbalance that exists within and between regions.

The RDAs' agenda includes regional regeneration, taking forward regional competitiveness, taking the lead on regional inward investment and, working with regional partners, ensuring the development of a regional skills action plan to ensure that skills training matches the needs of the labour market.

The functions of the Welsh Development Agency, a former Assembly Sponsored Public Body, are now part of the Welsh Assembly Government's Department of Enterprise, Innovation and Networks

Figure 5-2: The English RDAs

Table 5-1: Regional Development Agencies

RDA	Tel/Fax	Email	Web
Advantage West Midlands	0121 380 3500 0121 380 3501	neilskitt@advantagewm.co.uk	www.advantagewm.co.uk
East of England Development Agency	01223 713900 01223 713940	knowledge@eeda.org.uk	www.eeda.org.uk
East Midlands Development Agency	0115 988 8300 0115 8533666	info@emd.org.uk	www.emda.org.uk
London Development Agency	020 7680 2000 020 7680 2040	info@lda.gov.uk	www.lda.gov.uk
North West Development Agency	01925 400100 01925 400400	webmaster@nwda.co.uk	www.nwda.co.uk
One North East	0191 229 6200 0191 229 6201	enquiries@onenortheast.co.uk	www.onenortheast.co.uk
South East England Development Agency	01483 484 200 01483 484 247	seeda@seeda.co.uk	www.seeda.co.uk
South West of England Development Agency	01392 214 747 01392 214 848	enquiries@southwestrda.org.uk	www.southwestrda.org.uk
Yorkshire Forward	0113 394 9600 0113 243 1088	theresa.lindsay@yorkshire-forward.com	www.yorkshire-forward.com
Welsh Assembly Department of Enterprise, Innovation and Networks	0845 010 3300	ein@wales.gsi.gov.uk	http://new.wales.gov.uk/topics/businessandeconomy

Scottish Enterprise – Scottish Enterprise is Scotland's main economic development agency, funded by the Scottish Executive. Its mission is to help the people and businesses of Scotland succeed and in doing so, build a world-class economy. The Scottish Enterprise Energy Team works with both private and public partners to stimulate key sectors within the energy industry, The Energy Team assist companies and academics to commercialise new technology. They also assist companies active in the energy sector to diversify their business portfolio to secure the long term future of the Scottish energy industry. In partnership with Scottish Development International the Energy Team promote and encourage both inward and outward international trade activity.

Contact: Scottish Enterprise Energy Team
10 Queens Road, Aberdeen, AB15 4ZT, Scotland
Tel: 01224 252000, Fax: 01224 627006, Email: energy.info@scotent.co.uk, Web: www.scottish-enterprise.com

Scottish Development International – SDI was formed in 2001 to attract direct foreign investment to Scotland. Scottish development International replaced the former inward investment group Locate in Scotland and the former export promotion group, Scottish Trade International. With its headquarters in Glasgow, SDI is funded entirely by the government, and is controlled by both the Scottish Executive and Scottish Enterprise. SDI has offices throughout the UK, mainland Europe, North America and Asia.

Contact: SDI Headquarters, Atlantic Quay, 150 Broomielaw, Glasgow, G2 8LU
Tel: 0141 2282828, Fax:0141 2282089, Email: investment@scotent.co.uk

Highlands & Islands Enterprise – The Highlands and Islands of Scotland has around 19,000 businesses, more than 435,000 individuals with skills and potential of their own - and more than 8,000 voluntary and community groups. The task of the Highlands and Islands Enterprise (HIE) network is to unlock that potential and help create a strong, diverse and sustainable economy. HIE's activities include: delivery of business support services, provision of training and learning programmes, assistance for community and cultural projects and measures for environmental renewal.

Contact: Cowan House, Inverness Retail and Business Park, INVERNESS IV2 7GF, Scotland
Tel: 01463 234171, Fax: 01463 244469, Email: hie.general@hient.co.uk, Web: www.hie.co.uk

Other Relevant Organisations:

BWEA – The British Wind Energy Association is the trade and professional body for the UK wind industry. Formed over 26 years ago, and with over 310 corporate members, BWEA is the largest renewable energy trade association in the UK. Its primary purpose is to promote the use of wind power in and around the UK, both onshore and offshore. It acts as a central point for information for its membership and as a lobbying group to promote wind energy to government. BWEA represents industry at home and abroad, to Government, regional bodies and local authorities throughout the UK, to the business community, the media and the public.

BWEA co-ordinates statistics and intelligence on every aspect of wind energy in the UK, working closely with experts in member companies to provide the highest levels of information.

Contact: BWEA, Renewable Energy House, 1 Aztec Row, Berners Road, London, N1 0PW
Tel: 020 7689 1960, Fax: 020 7689 1969, Email: info@bwea.com, Web: www.bwea.com

Renewable Energy Association – The Renewable Energy Association was established in 2001 to represent British renewable energy producers and promote the use of sustainable energy in the UK. The REA was originally called the Renewable Power Association until October 2005. A membership-based organisation, it represents a wide variety of organisations, including generators, project developers, fuel and power suppliers, equipment producers and service providers. Members range in size from major multinationals to sole traders. Its membership topped 400 in mid 2005, making it the largest renewable energy trade association in the UK.

Contact: Renewable Energy Association, 17 Waterloo Place, London SW1Y 4AR
Tel: 020 7747 1830, Fax: 020 7925 2715, Email:info@r-e-a.net

WindSupply – A project to encourage, support and promote UK businesses to enter the supply chain for wind energy components, systems and services through innovation, product development and partnership. WindSupply is supported by the DTI and various UK Regional Development Agencies.

The WindSupply website includes an interactive marketing database (WINDow) containing full details and contact with "member" UK companies and their products and services for the international wind energy market, and with other European and international companies involved with the wind energy market.

WINDow is targeted at international purchasers, developers and designers needing further suppliers for existing components or wanting to develop innovative new components and sub-assemblies. It is designed to assist UK and/or international businesses to develop partnerships.

WindSupply provides a filtering / supplier search and introduction service to wind turbine manufacturers looking for new sources of supply of specific components, as well as facilitating educational workshops, mission visits, product innovation groupings and focussed coaching to companies new to the sector.

Contact: The Arch, 48-52 Floodgate Street, Birmingham, B5 5SL
Tel: 0121 693 8338, Fax: 0121 693 8448, Email: info@windsupply.co.uk, Web: www.windsupply.co.uk

Scottish Renewables Forum – Scottish Renewables has represented the renewable energy industry in Scotland since 1996. Scottish Renewables Forum is a Company Limited by Guarantee, registered in Scotland, with a Board of Directors appointed as representatives of each renewable energy technology in Scotland. Its membership comprises a cluster of key players with a common interest in the development of renewables in Scotland.

Scottish Renewables supports the development and provision of a sustainable energy future for Scotland. Sustainable energy comes from sources that are safe, clean and renewable, and which should also be secure, diverse and competitive. Scottish Renewables therefore promotes the effective use of Scotland's abundant biomass, geothermal, hydro, landfill gas, tidal, wave and wind resources to generate social, economic and environmental benefits for all.

Contact: Scottish Renewables Forum, Central Chambers, 93 Hope Street, Glasgow, G2 6LD
Tel: 0141 222 7920, Fax: 0141 222 7929, Email: info@scottishrenewables.com, Web: ww.scottishrenewables.com

UKERC – The UK Energy Research Centre is a publicly funded organisation charged with integrating energy research in the UK, while establishing itself as a centre of research excellence in its own right. The Centre was established in 2004 following a recommendation from the 2002 review of energy initiated by Sir David King, the UK Government's Chief Scientific Advisor. It is a central part of the £28 million cross-Research Councils programme Towards a Sustainable Energy Economy (TSEC).By taking a co-ordinated and collaborative approach to national and international energy research, and through its own interdisciplinary research activities, UKERC aims to provide the knowledge needed to work towards a sustainable energy system and realise UK energy policy goals.

Contact: UK Energy Research Centre, 58 Prince's Gate, Exhibition Road, London SW7 2PG
Tel: 0207 594 1574, Fax: 0207 594 1576, Email: admin@ukerc.ac.uk, Web: www.ukerc.ac.uk

Other Notable Regional Renewables Organisations:

- **Aberdeen Renewable Energy Group** (AREG) is an innovative private-public partnership set up in 2001 to help identify and promote new energy opportunities in North East Scotland. AREG is an incorporated company with an independent board, and its wide-ranging projects and activities are supported by Aberdeen's City Growth Fund.

  Contact: Balgownie 1, Conference Way, Bridge of Don, Aberdeen, AB23 8AQ
  Tel: 01224 814620, Fax: 01224 814590, Email: info@aberdeenrenewables.com,
  Web: www.aberdeenrenewables.com

- **The Highland Renewable Energy Group** (HiREG) aims to highlight to wind farm developers and operators the outstanding calibre of skills and facilities available in the Highlands and Islands region (shown to the right) in order to encourage and facilitate greater local content in wind power. It also acts as a forum for Highland firms, encouraging information share and joint ventures and liaises with developers. It aims to promote the industry in the Highlands to regional, national & UK government and to seek a more strategic approach to development.

  Contact: Email: info@highlandrenewableenergygroup.com, Web: highlandrenewableenergygroup.com

- **Regen SW** is the renewable energy agency for the South West of England. It's objectives are to increase the amount of high quality renewable energy projects on the ground, to secure short-term growth by supporting business in the renewable energy sector & to position the region for long term economic growth by developing early leadership in renewable energy technologies

  Contact**:** Regen SW, Sterling House, Dix's Field, Exeter, Devon, EX1 1QA
  Tel: 01392 229 394, Fax: 01392 229 395, Email: admin@regensw.co.uk, Web: www.regensw.co.uk

- **Renewables East** (RE) is the agency for renewable energy in Norfolk, Suffolk, Essex, Hertfordshire, Bedfordshire and Cambridgeshire - the East of England. Renewables East aims to drive forward the deployment and development of a full range of low carbon energy solutions into the East of England economy whilst ensuring the region exploits the best economic benefit and delivers jobs in an emerging and exciting global market.

  Contact: ZICER Building, School of Environmental Sciences, University of East Anglia, Norwich, NR4 7TJ
  Tel: 01603 591 415, Email: info@renewableseast.org.uk, Web: www.renewableseast.org.uk

- **Envirolink Northwest** is the sector support body for renewable energy companies in England's Northwest, which covers the counties of Cheshire, Cumbria, Lancashire, and Merseyside and Greater Manchester. Envirolink Northwest exists to promote, strengthen and support the renewable energy sector in the region by helping Northwest companies supply parts, components and services into the renewable energy sector through a range of regional, national and international projects and programmes.

  Contact: Spencer House, 91 Dewhurst Road, Birchwood, Warrington, WA3 7PG
  Email: h.seagrave@envirolinknorthwest.co.uk, Web www.envirolinknorthwest.co.uk

5.6 Key Issues & Recommendations for UK Success

From interviews held with wind turbine manufacturers, the following conclusions and recommendations are presented.

Single point of contact for manufacturers needed

- Need to have a UK contact that works with turbine manufacturers
- No existing single point of contact exists today within either DTI or BWEA
- Conduit for communicating supply needs from manufactures to UK companies and ideas and areas of excellence from UK to manufacturers
- This role requires outstanding industry knowledge – needs to be seen as valuable, trustworthy partner to wind turbine manufactuers
- Benefit versus cost is very high
- One contact also needed within each region (some manufacturers have been overwhelmed by numbers of approaches from regions)
- Greater coordination between central contact and regional activities
- Regional competition is unhelpful for manufacturers – regional bodies should be clear on their role. No one region can offer everything
- Would benefit from a central coaching / advice centre to help UK companies hone their proposition and understand their potential customers.
- Contacts by unprepared companies has been harmful to the UK's image with manufacturers

Little industry awareness of UK capability

- Many manufactures do not even consider the UK suppliers
- UK strengths and successes must be better communicated
- UK industry needs unique selling points publicised – what is being targeted?
- Importance of UK service industries – operations, financing, law: all high-value
- UK traditionally seen as innovative but expensive, though has one of the most flexible labour markets
- Lifetime cost model of wind supports expenditure R&D and reliability – key UK skills
- Need development of realistic and positive strategy for maximising UK content
- Look at different timescales – eg. fully-dedicated offshore turbines – the UK can apply core skills here.

Realism & professionalism

- Potential suppliers must be realistic about their products and capabilities
- Turbine manufacturers are not interested in companies that lack first-class products
- Suppliers must be able to demonstrate excellence
- Cases of poor business practice – must realise that this is an established international market and supply chain. UK companies have to demonstrate professionalism in both their product offerings and their business approach.

UK supply chain database

- UK Wind industry equivalent of First Point/Achilles needed
- This central information source would:
    - Demonstrate the strength of the UK supply chain – encouraging UK content
    - Allow suppliers to identify early-stage opportunities and for manufacturers to identify potential suppliers
    - Be sufficiently detailed to support sourcing, pre-qualification and selection
    - Offer independent benchmarking and analysis of supplier capabilities
    - Be a feedback system for buyers and sellers
- Potential for this extends to all renewables sectors – not just wind
- Reliable and trusted qualification needed to ensure high-quality content.

Learn from success

- UK must examine supply chains in other countries to identify reasons for success
- Established markets such as Denmark are not hugely different on cost base, but frequently offer significantly lower prices
- Emerging markets similar to the UK, eg. Italy and Greece – what is being done here? Are such markets a threat or an opportunity?

Oil and gas experience

- Original UK oil & gas success was built on set UK content requirement
- If local content cannot be enforced for wind how else can UK advantage be gained?
    - Openness from manufacturers on project costs?
    - Supplying wind farm performance information to central system eg. WindStats?
- Enables manufacturers to see supplier performance information
- Pushes message of the reliability advantage of UK suppliers

Monitoring UK supply chain progress

- Quantitatively examine UK content on wind projects past and present
- Establish system to monitor levels of UK content and the changes occurring
- Create UK content 'targets'
- System would allow examination of UK content by manufacturer and by region – helps target potential improvements and gaps requiring intervention
- Making information system available to local planners would enable it to become a useful tool to weigh up real local benefits of proposed projects and focus the minds of developers and manufacturers attempting to gain planning permission.

Studying other supply chain entry points

- Service sector is high-value and a key UK strength – the oil & gas example
- How can UK development activities be expanded?
- What is the export potential of UK skills?
- Supply of key components to 1st tier suppliers and balance of plant services to the industry. This guide focuses on supply to wind turbine manufactierers. Today, the global supply chain limitations relate to sub-supply of components to 1st tier suppliers and more work could be done to open UK supply opportunities in this area.

Supporting Quality of Early Sales in UK

- A key risk for a wind turbine manufacturer adopting a new supplier is quality. It is expensive and time consuming for members of non-UK based quality departments to make regular visits to UK companies. It is suggested that a UK capability be made available to support such activity.

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6 Manufacturer Profiles

The turbine manufacturers below were contacted for inclusion in this guide with each having equal opportunity to provide a standard set of information for use by UK companies, containing company profile, level of UK involvement, current turbines, key markets, major in-house manufacturing locations, purchasing function and supplier strategy.

Due to the variation in size of the manufacturers, from the very large multinationals to the very small companies the scale of potential for UK suppliers varies considerably form one manufacturer to another. The current market share of each manufacturer is provided for reference earlier in this guide in the *Summary of Market Opportunity* chapter. Whilst the scale of demand of a major manufacturer may be far in excess of that of a smaller manufacturer, it is often the case that the smaller manufacturers are more open to new suppliers as their supply chains are less well developed.

Major manufacturers are listed in order of market share – see Figure 2-3: Turbine Manufacturers – Market Share (2005) on page 8. Smaller manufacturers are then listed in alphabetical order under them.

Manufacturers have different policies on sharing corporate details, with some less willing to release information, hence some profiles are more detailed in places than others. In this highly competitive market, we are very grateful to all the turbine manufacturers concerned for sharing information with us.

It is recognised that especially detailed information, though approved for use by each manufacturer at the time, may become out of date. The Authors would value feedback to be incorporated in any future updates to this guide.

Major Turbine Manufacturers

6.1 Vestas Wind Systems A/S, Denmark

Company Profile

- Vestas Wind Systems is the world leader in wind technology and a driving force in the development of the wind power industry. It has grown from a small Danish company manufacturing cranes. It started selling wind turbines in 1979 and to date has installed a total of 18,000MW in over 50 countries, worldwide. It currently employs around 10,000 people. Vestas acts solely as a manufacturer of wind turbine hardware, associated SCADA systems and as an EPC contractor. See www.vestas.com

UK Involvement

- Vestas has design, manufacturing, service and sales locations in the UK.
- With installations totalling 290 MW onshore and 304 MW offshore, Vestas is dominant in the UK.

Top Selling Turbines

- Current products are V80-2MW (1.8MW in US) (transitioning to V90-3MW), V82-1.65MW and V52-850kW turbines.
- Next products are V100-2.75MW (small quantity production in 2006) and V120-4.5MW (prototype in 2006/7).

Markets

- Global.

Key Relevant In-House Manufacturing Locations

- Rinkobing, DK (nacelles)
- Skagen, DK (hubs)
- Lem, DK (blades)
- Varde, DK (towers)
- Isle of Wight, UK (blades)
- Campbeltown, UK (nacelles, towers)

Purchasing Function

- Vestas has a number of Production Business Units (PBUs) covering nacelles (inc. hubs), blades, towers & control systems. Each PBU has a Purchase and Logistics function. Individual local production units within each PBU also have purchasing capability.

Strategy

- Typically, key supplier selection and price/quantity negotiation is by the PBU, with local purchasing placing call-off orders for these components.
- Strategy is to work with as few large, global suppliers as possible, whilst keeping sufficient capability and flexibility.
- The Technology Business Unit is involved in key supplier and component approval, often involving an introduction plan, testing and first article inspections.

6.1.1 Vestas Nacelles (UK)

Company Profile

- The nacelle assembly facility on the Campbeltown site assembles nacelles from kits of parts maily brought in from Denmark. It can produce approx. 1 nacelle every 2 days, for UK or EU sites.

Key Relevant In-House Manufacturing Locations

- Campbeltown, UK (nacelles, towers)

6.1.2 Vestas Towers (UK)

Company Profile

- The tower manufacturing factory on the Campbeltown site supplies towers for Vestas projects in the UK and overseas., typically producing 100-170 towers a year and employing approx. 100 people.

Key Relevant In-House Manufacturing Locations

- Campbeltown, UK (nacelles, towers)

6.1.3 Vestas Blades (UK)

Company Profile

- The UK's only wind turbine blade manufacturing plant, Vestas Blades (UK) Ltd is a subsidiary of Vestas and manufactures mainly 40m blades from its purpose-built waterside facilities on the South Coast, employing 4-500 people.

Key Relevant In-House Manufacturing Locations

- Newport, Isle of Wight, UK (blades)

6.2 GE Wind Energy, US

Company Profile

- GE Energy (www.ge.com/energy) is one of the world's leading suppliers of power generation and energy delivery technologies, with 2005 revenue of $16.5 billion. Based in Atlanta, Georgia, GE Energy works in all areas of the energy industry including coal, oil, natural gas and nuclear energy; renewable resources such as water, wind, solar and biogas; and other alternative fuels. Numerous GE Energy products are certified under ecomagination, GE's corporate-wide initiative to aggressively bring to market new technologies that will help customers meet pressing environmental challenges.

- With wind turbine design, manufacturing and assembly facilities in Germany, Spain and the United States, GE Energy is among the leading providers of wind energy products and support services ranging from commercial wind turbines and grid integration products to project development assistance and operation and maintenance. The company's knowledge base includes the development and/or installation of more than 8,500 wind turbines with a total rated capacity of 7,600 megawatts.

UK Involvement

- GE Energy currently has 65 turbines installed onshore in the UK, generating 52 MW.
- Recent tendering is expected to lead to a considerable growth in activity in the UK.

Top Selling Turbines

- Current products are variants of GE 1.5, the Multi-MW range and GE3.6sl for offshore use.

Markets

- GE is a global provider of wind turbines

Key Relevant In-House Manufacturing Locations

- Salzbergen, DE (nacelles & hubs)
- Noblejas, Spain (nacelles & hubs)
- USA, Canada and China

6.3 Enercon GmbH, Germany

Company Profile

- Enercon is Germany's leading manufacturer of wind turbines. Established in 1984, and headquartered in Aurich, Niedersachsen, it pioneered the development of the gearless wind turbine in 1991. Large-scale manufacturing of its gearless systems began in 1993, and to date Enercon has over 8,200 wind turbines installed worldwide, with rated capacity over 7.9 GW. Enercon manufactures most of its own key components in-house. See www.enercon.de

UK Involvement

- Enercon currently has 27 onshore turbines in the UK, with installed capacity 37 MW.

Top Selling Turbines

- Current products are E-112 (4.5 MW), E-70 (2 and 2.3MW), E-48 (800 kW), E-33 (330 kW)
- Next product: E-82 (2 MW)

Markets

- Key market is Europe
- Projects in over 30 countries (worldwide)

Key Relevant In-House Manufacturing Locations

- Germany (Aurich, Magdeburg)
- Sweden
- Brazil
- India
- Turkey

6.4 Gamesa Eólica S.A, Spain

Company Profile

- Gamesa Eólica is one of the world's largest wind turbine manufacturers. In 2004, it ranked second worldwide. Gamesa Eólica produces a range of turbines from 850 kW to 2 MW. In 2003, Gamesa acquired the turbine manufacturer Made. Gamesa Eólica has its own extensive design and technological development capability. Through 21 manufacturing facilities it has a huge integral production capacity, comprising of the manufacturing of blades, gearboxes, generators, converters and towers. Gamesa is also active as a project developer and offers turnkey installation services. A large proportion of all Gamesa turbines are used directly in projects developed by the company. See www.gamesa.es

UK Involvement

- The Tir Mostyn and Foel Goch wind farm, the first UK project to use Gamesa Eólica turbines (also developed by Gamesa) went on line in 2005.
- Have sales office in Newport.

Top Selling Turbines

- Current products are 850 kW (G52, G58), 2 MW (G80, G83, G87 & G90).
- Next product 4-5MW due in 2007.

Markets

- Spain, Germany, Italy, France, Ireland and UK,
- US and China

Key Relevant In-House Manufacturing Locations

- 6 locations in Spain (nacelles and hubs)
- 7 locations in Spain (blades, blade parts and blade tooling)
- 2 locations in Spain (generators and converters)
- 2 locations in Spain (gearboxes)
- 2 locations in Spain (towers)
- US and China in 2006

Purchasing Function

- Central purchasing split nacelle/blades/tower. Nacelle group split mechanical / electrical / miscellaneous.
- Local purchasers in US and China fit into the above structure.

Strategy

- Vertical integration, enabling control of quality, cost, delivery time and technical feedback.
- Global purchasing, with long-term partners setting up manufacture where customers are.

6.5 Suzlon Energy, India

Company Profile

- Suzlon Energy is Asia's strongest growing fully integrated wind power company. Suzlon integrates consultancy, design, manufacturing, operation and maintenance services. Suzlon has a subsidiary in Germany for technology development, an R&D facility in the Netherlands for rotor blade design and tooling, and wind turbine and rotor blade manufacturing facilities in India. See www.suzlon.com

UK Involvement

- Suzlon Energy has no turbines installed in the UK.

Top Selling Turbines

- Current products are 1.25 MW and 2.1 MW turbines.
- Next products are: 1.5 MW and 2.3 MW, due for small-scale production in 2006/07.

Markets

- India, China, USA, Australia and selected EU countries.

Key Relevant In-House Manufacturing Locations

- Pondicherry, India (blades & nacelle covers)
- Vadodara, India (tooling)
- Daman, India (nacelle covers & warehouse)
- Nandurbar, India (blades)
- Mandvi, India (blades)
- Hyderabad, India (towers)
- Dhulia, India (towers)

Purchasing Function

- Mainly in Pune, with project-specific purchasing led by relevant project office (eg. in Aarhus, Denmark for the EU market).

Strategy

- Where relevant, to set up JVs to take high technology to low cost base greenfield sites in industrial South of India.
- Share purchasing decisions regarding towers and balance of plant with project management teams located in specific markets.

6.6 Siemens Wind Power A/S, Denmark

Company Profile

- In October 2003, Siemens Power Generation signed a deal to buy Bonus Energy. Bonus Energy was the fifth largest turbine manufacturer in the world with annual sales of over $350m and a workforce of 750. Siemens PG is an international heavyweight with annual sales of over US$9 billion and a workforce of over 30,000. See www.siemens.com/powergeneration/windpower

- The activities of Bonus form the core of the Siemens PG Wind Power Division, which is headquartered in Brande, Denmark. In total, Siemens have over 5,400 wind turbines in operation worldwide with over 3.2 GW of rated capacity.

UK Involvement

- Siemens Wind Power is one of the main suppliers to the UK wind industry, with over 400 turbines currently installed onshore.
- Siemens are expected to become prominent in the UK offshore market, having recently won their first project of 25 x 3.6MW turbines.

Top Selling Turbines

- Current products are: 2.3MW, 2.0MW, 1.3MW and the 600kW turbines. The 2.3MW turbine has CombiStall (active stall) and a variable speed versions.
- Next products are: 3.6MW, due for small-scale production in 2006 and a 5-6MW turbine.

Markets

- Key markets are Denmark (especially offshore), Germany, UK, Norway, USA, India & China

Key Relevant In-House Manufacturing Locations

- Brande, DK (nacelles and hubs)
- Aalborg, DK (blades)

Purchasing Function

- Groups with global responsibility covering main components, auxiliary components, electrical, steel and blades. Local purchasers are located in these groups as necessary. Matrix links with Siemens PG purchasing and quality departments providing global coverage.
- Purchase for spares is central.

Strategy

- Turbine supply for EU will continue from Denmark. US facilities will be set up.
- Except for blades, all components bought-in and assembled in-house.

6.7 REpower Systems AG, Germany

Company Profile

- REpower Systems is a German turbine manufacturer, founded in 2001 and listed on the stock exchange one year later. Its product range comprises several types of turbines with rated outputs of between 600kW and 5MW. Over 1,000 installations have been completed to date. REpower is active in project development.

  Internationally, REpower adopts various strategies for establishing itself in foreign markets including joint ventures, licensing and subsidiaries. See www.repower.de

UK Involvement

- REpower UK Ltd is a joint venture between REpower Systems AG and Peter Brotherhood, a British engineering company. Founded in September 2003, the company sells REpower Systems' multi-megawatt wind turbines in the United Kingdom and provides a full after market sales service. REpower UK has its headquarters in Edinburgh and a second office in Peterborough at Peter Brotherhoods headquarters in East Anglia. See www.repower-uk.co.uk
- Since the establishment of the joint venture in September 2003, the company has received orders for 47 wind turbines at 6 different locations in the UK, including for 2 5MW turbines offshore in deep water.

Top Selling Turbines

- Current products are MD70 (1.5 MW), MD77 (1.5 MW), MM70 (2 MW) and MM82 (2 MW).
- Future products are MM92 (2 MW), due for production release in 2006 and 5M (5 MW), starting small-scale production in 2007.

Markets

- Key markets are Germany, India, China, UK and France.

Key Relevant In-House Manufacturing Locations

- Husum, Germany *(nacelles & hubs)*

Purchasing Function

- All purchasing happens centrally in Husum.

Strategy

- As well as usual questions of cost and quality, flexibility and fast delivery times are key.

6.8 Nordex, Germany

Company Profile

- Nordex has over 2,500 turbines installed worldwide, with a total generation capacity of over 2,400 megawatts. Nordex was established in 1985 and is based in Norderstedt, near Hamburg, Germany. The company has offices and subsidiaries in 18 countries. In addition to manufacturing, Nordex is active as a turnkey installer. It designs its key components in-house. See www.nordex.de

UK Involvement

- Nordex has 57 turbines operational in the UK with an installed capacity of 92.7 MW

Top Selling Turbines

- Current products are: Nordex N60 (1.3 MW), Nordex S70 (1.5 MW), Nordex S77 (1.5 MW), Nordex N80(2.5 MW), Nordex N90 (2.3 MW), Nordex N90 Offshore (2.5 MW)
- Future products are: 5 MW Offshore

Markets

- Europe, US, India, China.

Key Relevant In-House Manufacturing Locations

- Rostock, DE (nacelle and blades)

Purchasing Function

- Strategic purchasing based in Hamburg with call-off ordering from assembly plant in Rostock.

Strategy

- Opening up to far-east supply.

6.9 Ecotècnia, Spain

Company Profile

- Ecotècnia is a cooperative which was established in 1981 and played a large role in helping develop the Spanish wind energy market. Spain is its main market, but recently the company has installed turbines in countries worldwide. Whilst not a major role, the company has been active as a developer. Ecotècnia only manufacture their own control systems and towers. All other components are bought in from European suppliers. See www.ecotecnia.com

UK Involvement

- Ecotècnia currently has no turbines installed in the UK.

Top Selling Turbines

- Current products are: Ecotècnia 48 (750 kW), Ecotècnia 62 (1.3 MW), Ecotècnia 74/80 (1.67 MW), Ecotècnia 100 (3 MW).
- Next product is Ecotècnia 80 2.0 (2 MW).

Markets

- Key market to date is Spain. Others targeted.

Key Relevant In-House Manufacturing Locations

- Galicia, Spain (nacelle and hub)
- Navarra, Spain (nacelle and hub)
- Castilla y Leon, Spain (tower)

Purchasing Function

- Supply Chain Management (20 person) integrated in Production Department

6.10 Mitsubishi, Japan

Company Profile

- Mitsubishi Heavy Industries has produced wind turbines since the 1980's and to date, over 1,800 have been installed worldwide. Mitsubishi maintains an integrated design and production capability for key wind turbine components, including blades, gearbox, generator and controls. See www.mpshq.com/products_wind.html

UK Involvement

- In 1993, Mitsubishi installed the then largest wind farm in Europe, 103 x 300kW turbines in mid-Wales.
- Mitsubishi has sales office in London but not installed any other wind farms since 1993.

Top Selling Turbines

- Current top selling turbines are MWT-57 and MWT-61 (both 1MW).
- Next product is MWT-92 (2.4MW), recently released for sale.

Markets

- US, China, Japan, Europe.

Key Relevant In-House Manufacturing Locations

- Nagasaki, Japan (nacelles, towers and blades)
- Juarez, Mexico (blades)

Purchasing Function

- For European projects, local balance of plant purchasing and service is led by MHI's London office.

Strategy

- Have Japanese supply chain for most components.

Other Turbine Manufacturers

6.11 Acciona, Spain

Company Profile

- Acciona is one of the most active wind farm development companies in the world, with over 2 GW of projects completed. Through its fully-owned subsidiary company Ingetur, it produces a 1.5 MW wind turbine using in-house technology.
  See www.acciona-energia.com/site_i/actividad/aerogeneradores.asp.

UK Involvement

- Acciona is not currently active in the UK market.

Top Selling Turbines

- Current products are IT 70/1500 and IT77/1500 (1.5 MW)

Markets

- Spain, France, China

Key Relevant In-House Manufacturing Locations

- Barasoin, Spain (nacelles and hubs)
- Valencia, Spain (nacelles and hubs)
- Nantong, China (JV)

6.12 Clipper WindPower, USA

Company Profile

- Clipper Windpower Inc was formed in 2001 and is a wind energy technology company which has designed the 2.5 MW Liberty wind turbine based on a gearbox with 4 output shafts. It also actively develops and builds wind power generating projects in the Americas and Europe. Clipper has a UK office, Clipper Windpower Europe Ltd. See www.clipperwind.com

UK Involvement

- Clipper Windpower listed on the London Stock Exchange's AIM in September 2005.
- No Clipper turbines are currently installed in the UK.

Top Selling Turbines

- Current product is the 2.5 MW Liberty wind turbine, with rotor diameters 90, 93 and 96.
- Next product will be a marinised version for offshore use (released for sale 2007), followed by a larger turbine specifically optimised for the offshore market, to be released for sale 2009.

Markets

- US, Europe

Key Relevant In-House Manufacturing Locations

- Cedar Rapids, Iowa, US (nacelles and hubs)

Purchasing Function

- Central purchasing from US.

Strategy

- Worldwide multiple-source supply chain, ideally taking assembly close to where the markets are.
- Benefit from suppliers' development skills and worldwide presence.
- Aim is for Liberty to be a truly 'low cost of energy' machine.

6.13 EU Energy, Germany

Company Profile

- DeWind was founded in Lübeck in 1995 and installed its first turbine the following year. By mid-2002, over 400 turbines had been supplied. To date, 513 turbines have been installed with a total generating capacity of 450 MW. The company, which employs some 300 people, now offers three product lines and also acts as a turnkey contractor.

- In July 2005, DeWind was acquired by by EU Energy Limited from FKI plc (who acquired DeWind in 2002). EU Energy are active developing JV relationships in various key markets. See www.eunrg.com.

UK Involvement

- Turbine production was established at FKI's Loughborough facilities in December 2002.
- DeWind currently has no turbines installed in the UK.
- EU Energy, a UK based alternative energy group acquired DeWind in 2005 as part of a joint-venture.

Top Selling Turbines

- Current products are: D4 (600 kW), D6 (1 MW/1.25 MW), D8 (2 MW)
- Future product is US version of D8.

Markets

- India, China, USA, Germany

6.14 Harakosan BV, Netherlands

Company Profile

- In January 2005, a subsidiary of the Japanese Harakosan group took on the technology of Zephyros BV, a Dutch developer and manufacturer of multi-megawatt gearless wind turbines. Harakosan expects to franchise technology and support outside 'home market' of Benelux, France and UK. In their wind business, Harakosan share close cooperation with Japan Steel Works (JSW). See www.harakosan.nl .

UK Involvement

- None to date.

Top Selling Turbines

- Current product is Z72, 2MW (72m diameter).
- Next product is Z82, 2MW (82m diameter), followed by larger turbine suitable for offshore use.

Markets

- Taiwan and Japan. Benelux, France and the UK targeted.

Key Relevant In-House Manufacturing Locations

- Den Helder , Netherlands (nacelle)

Purchasing Function

- Depending on the project, purchasing is split between the team in Holland and team at JSW in Japan.

Strategy

- Dual source as much as possible. Local partners and suppliers where possible. Best quality for lowest price.

6.15 Leitner AG, Italy

Company Profile

- Founded in 1888, Leitner has always been at the forefront of technological developments of ski lifts and ski-field products. In the last financial year the Leitner-Group achieved a turnover of approx. €500m.
  In 2001, Leitner started the design of a wind turbine. The basis of the "LEITWIND" turbine is the gear-less technology originally created for ski lifts. LEITNER expects wind power to reach 30% of its yearly turnover within the next four years.

UK Involvement

- None to date.

Top Selling Turbines

- Current product is Leitwind 1,2 (1.2MW; 62m diameter).
- Next products are 1.35MW 77m diameter and 1.5MW 70m diameter.

Markets

- Italy.

Key Relevant In-House Manufacturing Locations

- Vipiteno, Italy

Purchasing Function

- Central function for Leitner Group in Vipiteno, Italy.

Strategy

- Leverage across Leitner Group. Minimum 2 suppliers for key components; aim for 3.

6.16 M. Torres, Spain

Company Profile

- MTorres started life in 1975 as a small family-owned company supplying process automation to the paper industry. The company developed into a group of companies employing almost 400 people. In addition to its wind turbine design and manufacturing which it began in 1999, it is an innovative player in the fields of civil and military aircraft construction. Favouring direct-drive turbines, MTorres bases its designs on a multipolar synchronous generator. See www.mtorres.es

UK Involvement

- MTorres is not currently active in the UK market. No turbines are installed in the UK, though hoping for a demonstration project in 2006.

Top Selling Turbines

- Current products are TWT 1650/70 and TWT 1650/78. 12 turbines have been installed to date, starting in 2001.

Markets

- Spain (UK market is targeted)

Key Relevant In-House Manufacturing Locations

- Torrez de Elorz, Navarra, Spain
- Ólvega, Soria, Spain

Purchasing Function

- Purchasing is shared with the other M.Torres Group activities.

Purchasing Strategy

- Global aspirations, with in-house blade manufacture and assembly of components.

6.17 Multibrid Entwicklungsgesellschaft mbH, Germany

Company Profile

- Multibrid is a small German wind turbine manufacturer owned by renewable energy company Prokon Nord. They acquired rights to use the compact Multibrid turbine technology developed in 1990's by Aerodyn which incorporates a single-stage gearbox and mid-speed generator. Their technology is aimed at the offshore market.. See www.multibrid.de.

UK Involvement

- No Multibrid turbines are installed in the UK.
- Enertrag UK (part-owned by Prokon Nord group) is a developer active onshore.

Top Selling Turbines

- Current product is M5000 (5MW).

Markets

- Germany, Europe, offshore

Key Relevant In-House Manufacturing Locations

- Bremerhaven, Germany

Purchasing Function

- Based in Bremerhaven.

Strategy

- Best quality for an acceptable price

6.18 ScanWind Group, Norway

Company Profile
- ScanWind Group AS is a small Norwegian/Swedish wind turbine manufacturer, basing its large turbine designs on needs for the harsh Nordic wind climate.

UK Involvement
- None to date.

Top Selling Turbines
- ScanWind 3500DL (3.5MW; 90m diameter) will be commercially available in 2006.

Markets
- Nordic countries.

Key Relevant In-House Manufacturing Locations
- Verdal, Norway

Purchasing Function
- Based at head office in Trondheim, Norway.

6.19 Vensys GmbH, Germany

Company Profile
- Vensys are a small German turbine manufacturer developing direct-drive wind turbine technology. Previously related to Permapower, in 2005, Vensys installed their first turbine in China through partner company Goldwind. See www.vensys.de

UK Involvement
- No Vensys turbines are installed in the UK at present. UK is seen as a target market.

Top Selling Turbines
- Current products are Vensys 62/64 (1.2 MW).
- Next products are Vensys 77 (1.5MW), for small-series production in 2006/7 and Vensys 92 (2.5MW), for small-series production in 2007/8.

Markets
- China (under licence), Japan, Germany, Western Europe, Spain (under licence).

Key Relevant In-House Manufacturing Locations
- No in-house manufacturing
- Partner in Saarbrücken, Germany (nacelles and hubs)

Purchasing Function
- Based in Saarbrücken.

Strategy
- No in-house manufacturing.

6.20 WinWinD, Finland

Company Profile

- WinWinD is a small Finnish wind turbine manufacturer. They acquired rights to use the Multibrid turbine technology, originally developed in 1990's by Aerodyn which incorporates a single-stage gearbox and mid-speed generator. Activity has mainly focused on Finland and Sweden to date but the company is keen to expand in China and elsewhere. See www.winwind.fi

UK Involvement

- No WinWinD turbines are installed in the UK.

Top Selling Turbines

- Current products are WWD-1 (1 MW) and WWD-3 (3 MW).

Markets

- Finland, Sweden, Portugal, China

Key Relevant In-House Manufacturing Locations

- Raasakka, Finland

Purchasing Function

- Central purchasing.

Strategy

- Networked business approach with maximised local content.