Vestas Case Study Collection

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Vestas®

Preface

This collection contains 15 case studies divided into five sets. The first set discusses Vestas' corporate strategy, and the other four build on this to create a common understanding of the business issues facing Vestas. Before tackling any of the case studies it is a good idea to read the associated introductory chapter, which provides background about the company and the wind power industry in which it operates.

Each collection of case studies is accompanied by challenges for students to solve. Facilitators and teachers can add their own challenges to bring depth and variety to classroom discussions.

We hope you enjoy these case studies and find them challenging.

Vestas Wind Systems A/S

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Introduction

Vestas: No. 1 in Modern Energy

With a 23% market share and 35,000 wind turbines installed, Vestas is the world's leading supplier of wind power solutions. The company's core activities are the development, manufacture, sales, marketing and maintenance of systems that use wind energy to generate electricity. Vestas supplies a full range of products, from individual turbines to turnkey wind power systems. As an independent partner, Vestas can guide customers on the development, financing and ownership of wind turbine projects. However, Vestas never participates directly in these activities, but remains an independent system supplier.

Vestas in brief: company history

Vestas installed its first wind turbine in 1979 and ever since has played an active role in the fast-moving wind power industry. From its pioneer beginnings, with a staff of approximately 60 in 1987, Vestas today is a global group with over 15,000 employees.

Vestas was founded in 1945, with origins extending back to a blacksmith's shop in Lem, Denmark, in 1898. The company began producing wind turbines in 1980. In 1983 Vestas opened its first subsidiary in the US, which at the time provided incentives in the form of subsidised loans and tax credits to stimulate growth in the wind market. The US venture was initially successful. In 1985, for example, Zond Systems in California bought 1,200 units from Vestas.

But in 1986 much of the legislation that provided incentives for alternative energy in the US expired—a development that

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brought Vestas to the edge of collapse. The company declared receivership, downsized dramatically, and at one point reduced its payroll to just 60 employees. However, Vestas continued to lead the industry technologically. The Group soon reorganised, and by the end of 1986 had established a new company, Vestas Wind Systems A/S, which focused exclusively on wind power. From that moment Vestas lessened its reliance on the American market, and looked to expand globally. At the time, European countries generally provided more stable and consistent financial incentives for renewable energy, so over the next few years the company opened successful new subsidiaries in Australia, India, Germany, Sweden, the UK and the US.

In 2002, Vestas supplied and installed turbines for the world's first large offshore wind power plant, at Horns Reef in the North Sea. In 2004, Vestas merged with another Danish manufacturer of wind power systems, NEG Micon. To date, Vestas has installed over 35,000 turbines in more than 60 countries. As of December 2007, Europe accounted for 46% of the company's sales, followed by the US and Asia. Vestas has 12 Business Units, with manufacturing plants in China, Denmark, Germany, India, Italy, Norway, Scotland, Spain, Sweden, the UK and the US.

Side thoughts

In 2005 Vestas presented a new vision: *Wind, Oil and Gas*. With the prospect of electricity consumption doubling from 2002 to 2030, it makes perfect sense to consider wind power as a source of energy that in the future will be as important as oil and gas. There are many good reasons why politicians and energy utilities in Europe and the rest of the world are now looking long and hard at wind power:

- Wind is an inexhaustible resource.
- Wind power can compete with conventional sources of energy if the comparison is made on equal terms.
- Wind power increases energy independence.
- Wind power makes it possible to establish a lot of generating capacity in a short time.
- Wind power is CO_2-neutral and therefore makes a positive contribution to cutting greenhouse gas (GHG) emissions, for example in relation to the Kyoto Protocol.

Strong international political support for renewables

For nearly a decade renewable energy has been on the political agenda in the European Union. In 2002 the EU and other large nations signed the Kyoto Protocol, an international treaty on climate change that assigns mandatory reductions for the GHG emissions of its signatory nations. Current EU projections suggest that by 2008 the EU's GHG emissions will be 4.7% below 1990 levels. In March 2007 the EU announced further plans to move to greener energy, in the form of a new energy policy that includes a unilateral 20% reduction in GHG emissions by 2020.

The EU member states have set their own national GHG targets, installed support measures for renewable energy, and created incentives to meet these targets. These initiatives include direct production subsidies (fixed prices for electricity from renewable sources that are higher than those from conventional sources), tax credits, and a new market for tradable certificates granted to producers of renewable energy. Vestas' home country of Denmark has an ambitious long-term energy plan under which renewables will provide 30% of all energy by 2025. The Danish government is also intent on privatising

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the state oil and gas company DONG Energy to create a fully liberalised energy market.

The US Department of Energy (DOE) hopes that at least 6% of US energy will be wind-generated by 2020. The federal government has approved the extension of a production tax credit for new wind generating capacity through 2007. While this increases the market's stability in the short term, it is not a permanent position on wind energy. However, the government has said that further measures are to be introduced to reduce US reliance on imported gas and oil. This may result in wind energy gaining more sustainable political support in the future.

Fuel cost increases in the years around 2005 have boosted the growth of alternative energy sources. Government-sponsored initiatives surfaced around the world, including China, whose Renewable Energy Promotional Act states that by 2020, 10% of all electricity generation will be from renewable sources. Vietnam is conducting research into household wind turbines, biogas systems, solar panels and cells, solar energy heaters, and small hydropower stations, with the goal of providing electric power to all homes by 2010. India is suffering from a shortage of energy, and the Indian government is favourably disposed towards renewable energy, so there is appreciable growth potential here. The Australian market is currently driven by legislation known as the Mandatory Renewable Energy Target (MRET); current government policy is to continue this unchanged, making the long-term market potential for wind power in Australia particularly uncertain. The Japanese market is marked by fluctuations from one year to the next, although the trend is towards more renewables. In Canada, in March 2005 Ontario's Ministry of Natural Resources announced that it would accept applications for new wind power developments and make 18 sites available for hydopower.

Wind industry outlook: threat of new entrants

In 2003 the wind power industry was valued at approximately $8 bn and was expected to hit $16 bn by 2007. Wind power was the fastest-growing industry sector at that time, and is now expected to grow at 20% annually through 2008. Continued growth in the renewables market, in conjunction with national incentives, is creating favourable conditions for new entrants. The wind industry is characterised by excess demand, showing that there is room for additional players throughout the supply chain.

In recent years new companies have appeared, especially in the high-growth markets, as people realise the business potential of securing future energy supplies through alternative energy sources. Thanks to deregulation, entry to US and EU markets does not seem to be difficult. This is not always the case in developing countries, many of which have regulations that can restrict market entry. The low quality and restricted extent of the electricity grids in these countries may also impose entry barriers. Many governments in developing countries are supporting renewable energy plans with incentives such as favourable tax schemes, however, and so markets such as Vietnam and India have seen a higher overall percentage of new entrants.

Traditional energy companies, notably the oil giants Shell and BP, are also increasing their spending on renewable energy

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R&D and diversifying their product portfolios. Both Shell and BP are focusing on solar energy, but they have also stepped up their research on wind.

In the past few years a number of new and very large firms have become active in wind power. These include some of the world's biggest industrial conglomerates, such as Siemens, General Electric and Mitsubishi, which are characterised by massive financial strength and a tradition of strong political ties. Through their size and market reach, these companies have been used to servicing some of the largest energy producers in the world, and these customers are in turn becoming the buyers of the largest wind power plants. Companies such as Siemens and GE have already gained large shares of the primary wind power markets, and are among Vestas' main competitors.

Bargaining power of suppliers

The growth in the market for wind power is putting pressure on the supply chains of many companies. Many suppliers are having trouble meeting demand, and a shortage of components and skills has affected the entire industry. With continuously increasing demand and potential overheating of the industry, it is expected that the current long and expensive lead times for important components will continue into the future. An important reason for this is the limited number of suppliers of key components, none of which can meet demand, thus further increasing the switching costs of their customers. Some of these suppliers are owned by direct competitors, such as Siemens and GE, so their bargaining power is high. For generic components the situation is easier; there are many suppliers, making it easier and cheaper for wind turbine manufacturers to switch sources.

Disintegration among suppliers would increase market competitiveness, but the trend seems to be in the opposite direction: towards vertical integration and industry consolidation, which will increase the bargaining power of suppliers. Supplier relationship management and long-term contracts with important suppliers will become key. Technological pressures, including the need to resist earthquakes and more-frequent storms, are also increasing product complexity and hence the need for joint product development. With improved management of intellectual property rights (IPR), companies are expected to enter into more advanced product development contracts with strategic suppliers. These improved relationships will, if handled correctly, resemble vertical integration, and so will level the bargaining power of the respective parties.

Side thoughts

"We at Vestas are convinced that the future for wind power is very bright—side by side with oil and gas. The fact that we are not alone in this belief is highlighted by the decision by a number of big players from the conventional energy sector to enter the renewable energy market. As a result, a completely new market situation is emerging: one distinguished not only by customers becoming bigger, more professional and more farsighted in their investments, but also by established developers and energy utilities being joined by some of the world's largest players in fossil fuels." — Ditlev Engel, Vestas President and CEO.

Bargaining power of buyers

Client characteristics have also changed. Buyers are today primarily professional investors—such as large electric utili-

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ties and generating plant owners—looking for the best return on investment, and requiring products and projects that are increasingly large and complex. Their buying behaviour has also changed; it is now characterised by forward purchase of turbine capacity, with clients more willing to take development risk, and a focus on reliability. Reliability, in terms of delivery dates, product lifetime, electricity output and operating and maintenance (O&M) costs, has become the key measure of competitiveness in the industry. This has important implications for the service and maintenance requirements set out by customers, and puts greater pressure on supplier competence. As the entry of competitors becomes an increasing threat, existing manufacturers must improve reliability if they are to thrive.

As demand for larger and more complex products increases, many wind turbine suppliers are in a position to reject projects; despite increasing service requirements, this improves their bargaining position. The issue, however, becomes more complicated when we consider market characteristics. In developed countries, where energy markets are primarily liberalised, market forces rule, and the bargaining power of buyers is in some respects directly linked to market growth and the strategic potential each market has for a given manufacturer. In some emerging markets, on the other hand, the energy sector is still under government control; this increases the bargaining power of the governments concerned, for instance by forcing suppliers to cut prices if they wish to enter the market. Growth in energy consumption, and the strategic importance these markets are expected to have in the future, allows buyers to put further pressure on suppliers despite the shortage of turbines. Finally, as these governments continue to promote the growth of renewable energy, the threat of backward integration increases. As mentioned previously, this has already occurred in markets such as India and Vietnam.

Threat of substitution

As economic development in Asia continues, we can expect a surge in demand for energy. The world thus needs all the energy sources it can get. The rising price of oil and gas will become less important as environmental, social and political developments continue to support the development of renewable energy.

Most renewable energy sources cannot yet be stored effectively, so consumption is limited to what nature is able to supply at the time. This brings the need for alternative energy sources to satisfy demand, and means that wind does not operate in an "either-or" environment. Wind is, however, expected to substitute for some of our traditional energy sources, and to compete with other non-traditional sources. Of the latter, solar and hydro are the most widely-used renewables today, and so pose the biggest threat of substitution. Solar energy has long been the darling of renewable energy supporters, and with production costs inching downward and efficiencies improving rapidly, it may become a preferred energy form. Hydro is the leading renewable energy source in many countries, including the US. If governments increase their support for solar and hydro power, this will have a direct impact on the wind sector.

Substitution, though a significant possibility, is not necessarily a major threat to the wind industry, because it is expected and can be allowed for. Moreover, wind power is becoming

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increasingly cost-competitive compared to traditional sources of energy. Technological improvements have improved the reliability and reduced the O&M costs of wind power plants, while manufacturing, assembly and transport costs have also fallen. Wind power is thus a competitive form of energy. This economic viability is the critical factor for customers, who are looking beyond the green credentials of wind. The cost issue relates directly to buyers' increasing focus on product reliability and longevity.

Competitive rivalry

The wind power industry is maturing, which implies that competition is intensifying. As the turbine industry has become increasingly international and the threat of new entrants has intensified, so competition for market share has increased. Competitors are aware of the gap between supply and demand, and are acting on it. In the past decade, major American and European manufacturers have strengthened their presence in each other's back yards. Competitors are expanding their businesses into new markets and countries, especially in Asia, in an attempt to secure a strong portfolio of customers and profitable projects. Companies are also reducing prices to enter these new markets, with the expectation of future growth. Vestas' main competitors, GE and Siemens, are not only well diversified, but have the financial strength to defend their positions and challenge existing businesses. As customers increasingly demand sound returns from larger and more complex projects, service and product reliability have become key to competitiveness. This goes some way to explaining why more wind turbine manufacturers are integrating backwards into their supply chains, increasing control and maybe even reducing supplier bargaining power. This trend to consolidation suggests possible takeovers in the future.

Side thoughts
Wind power projects–from planning to production

(Extract from the 2005 Annual Report)

Developing and building wind turbines is only part of Vestas' business. Today Vestas is involved in projects whose scope of work ranges from "simple" supply and commissioning projects to turnkey projects involving the supply, installation and commissioning of turbines, access roads, foundations, cabling, electrical substations, communications systems and more. It is a complex world that depends on a skilled and committed workforce.

Choosing a site

The customer identifies a likely site for a wind power plant and checks that land, construction permits and grid connections will be available.

Collecting wind data

Wind measuring equipment is installed to make detailed measurements of the actual wind conditions at the site. Accuracy is vital, so the measurements take at least a year.

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Vestas wind turbines typically start to generate power at wind speeds of around 4 m/s, and cut out automatically at a speed of 25 m/s.

Tendering, negotiations and contracts

Once the customer is confident that the site is suitable, contractors are invited to bid for the job. Negotiations between the parties fix the scope of work—including the type, number and exact location of the turbines—and contracts are signed.

It can take 18–36 months from first contact between the parties to the signing of a contract.

Project planning and detailed design

Having won the contract, Vestas begins detailed project planning. In the case of a turnkey contract, Vestas makes agreements with the subcontractors who will build the access roads, prepare the foundations and install the cabling.

Manufacturing

Manufacturing of nacelles, hubs and blades takes place in Vestas' factories worldwide. The sectional steel towers are manufactured by Vestas' own factories or ordered from local suppliers to minimise transport costs.

A V90-3.0 MW wind turbine has more than 5,600 components.

Site preparation

The site is surveyed, and locations for turbines, electrical substations and other buildings such as workshops are marked out. For onshore sites, access roads are planned and built. Offshore sites require a nearby deep-water port and careful measurements of water depth, bottom type, currents and tidal conditions.

Foundations and cabling

The turbine foundations are installed: typically concrete slabs for onshore turbines and tubular steel "monopiles" for offshore sites. A single monopile is around four metres in diameter and may be hammered 20 to 30 metres into the sea bed. Trenches are dug for cables to carry power from the turbines to the substation.

The Horns Reef offshore project in Denmark has around 100 km of cables under the sea and on land.

Transport to the site

The main turbine components are transported to the site by ship, barge, train or truck. With a V90-3.0 MW turbine having a nacelle that weighs around 70 tonnes and blades 44 me-

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tres long, this means serious logistics. Offshore turbines are carried from the harbour to the site by special-purpose ships equipped with cranes.

In 2005, Vestas used more than 5,000 trucks and nearly 40 ships to transport wind turbine parts to and within North America.

Installing the tower

Towers for large turbines such as the V90-3.0 MW are delivered in three pieces, each nearly 30 metres long. The sections are lifted into place on top of the foundation and bolted together. For offshore turbines, a tubular "transition piece" connects the monopile to the bottom tower section.

The tower of a V90-3.0 MW wind turbine weighs between 100 and 285 tonnes, depending on the wind conditions.

Installing the nacelle and rotor

Once a tower is complete, the nacelle—the main body of the turbine—is lifted into place on top. The hub is attached to the nacelle, and the blades are mounted one by one. All three blades may also be attached to the hub before it is mounted on the nacelle. For offshore installation, the hub and two of the blades are attached to the nacelle beforehand, creating a configuration known as the "bunny ears". With the nacelle in place on top of the tower and the "ears" pointing upward, the third blade is lifted into the bottom position and bolted up.

A V90-3.0 MW wind turbine with its 44-metre blades has a rotor diameter of 90 metres—larger than the 80-metre wingspan of the giant Airbus 380 aircraft.

Testing, commissioning and handover

As soon as each turbine is physically complete, Vestas technicians run careful checks to confirm that everything has been installed correctly. They then connect the turbine to the power grid and start it up. Commissioning takes one or two days per turbine. Once all the turbines are running, further tests confirm that the complete plant is performing as it should. If everything is satisfactory, the customer takes over the plant.

Vestas has installed wind turbines in temperatures from –30°C to 45°C.

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Service

Following handover, Vestas technicians return for regular service visits during the warranty period. After this, the customer may choose to sign a long-term service agreement.

Turbines can transmit operating information to control centres run by the customer or by Vestas, allowing their performance and operational condition to be monitored at all times.

Energy production

A V90-3.0 MW turbine needs to run for just two to three hours to generate the amount of electricity consumed by a Danish household in one year. This means that a single V90-3.0 MW turbine can supply around 3,400 Danish homes with electricity.

A V90-3.0 MW turbine takes less than seven months to generate the amount of energy used to build, install, operate and dispose of it, including the extraction of raw materials. No other electricity generating technology can match this figure.

Strategy

Vestas: No. 1 in Modern Energy

Case Study 1: External positioning
Case Study 2: Changing market conditions
Case Study 3: Operationalising strategy through performance measurement

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Vestas:
No. 1 in Modern Energy

Learning objectives

- Understand how strategies are created and changed
- Understand how financial and strategic goals can be translated and supported by organisational and operational changes

These case studies also address

- External positioning within a changing market structure
- The challenge of changing customer profiles and decreased customer satisfaction
- Operationalisation of strategy through goal-setting and performance measurement

Keywords

- Strategic goals, market change, performance measurement

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The Vestas strategy

Preparing to present Vestas' 2007 third-quarter performance to a meeting of press and analysts in London, Ditlev Engel, Vestas President and CEO, looked back over the many strategic and organisational changes the company had undergone during his three years at the helm. It had been a tough journey but an exciting one, and the many initiatives had shown their worth. The company was now about to reach the targets set by the 2005–2008 "Will to Win" strategic plan, and a new strategy was on the way starting from 2008: "Vestas: No. 1 in Modern Energy".

Ditlev became CEO on 1 May 2005, 15 months after the merger of Vestas and NEG Micon, which positioned Vestas as the undisputed world leader in wind power, with a market share of approximately 35%. Even though the basis for the merger was the desire to create a group large enough to exploit growth opportunities in the wind power market, however, the financial results at the end of 2004 were less than satisfactory.

Despite a 43% increase in revenue in 2004, Vestas recorded an operating loss of €49m—the company's first negative result in many years. Moreover, the annual customer survey showed that the proportion of satisfied customers had dropped from 90% in 2000 to a mere 60% at the end of 2004. This figure in itself was unacceptable.

Figure 1: Revenue (mEUR)

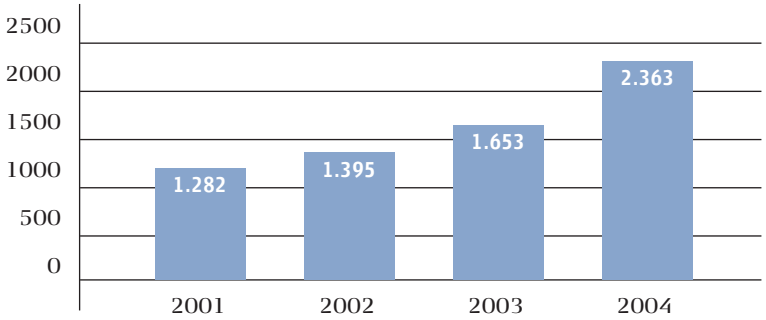
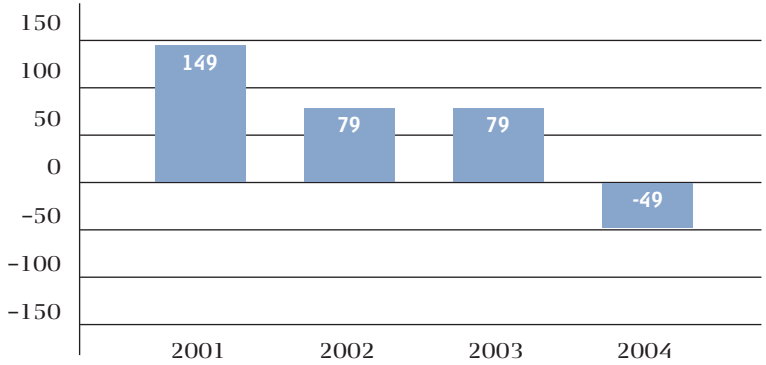


Figure 2: Operating profit/loss (EBIT) (mEUR)



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The company was also facing some new, and very challenging, competitors, following the market entry of major players including GE, Siemens and Motorola. The nature of its customers was changing too: more and more of them were large energy utilities demanding wind power plants whose reliability matched that of their conventional generating equipment.

Vision and strategic goals in 2004

In 2004, the company's vision was: "with quality and care to use the wind to generate competitive, clean and renewable energy. In future, wind energy will cover a substantial part of the global energy supply and contribute to substantial development for the benefit of future generations. Vestas is to be the international market leader in wind power solutions—valued by customers, shareholders, employees and other stakeholders."

The strategy communicated by the company at that time was "to supply customised wind power systems based on standard wind turbines, and standardised options that can generate electricity of optimal quality at the most competitive price".

In a growing market, Vestas is distinguished by a high degree of vertical integration, manufacturing all the components that cannot be purchased from external suppliers in standard or slightly modified forms. By manufacturing the principal parts of the turbine itself, Vestas increases the flexibility of its product development, reduces its dependence on suppliers, and maintains its high level of manufacturing know-how. At the same time, Vestas' strategy involves ensuring that production and sourcing are carried out as closely to the market as possible, which will similarly reduce dependence on exchange rates.

Vestas' strategic goal, as stated in the 2004 Annual Report, was "to be an international leader and to ensure sufficient financial strength to continue internationalisation."

To achieve this strategic goal, the Group planned to strive for:

- A global market share of at least 35%, measured in installed capacity.
- Earnings before interest and tax (EBIT) margin of at least 10%.
- Net working capital (NWC) at year end to be a maximum of 25–30% of turnover.

Organisational structure after the merger

Following the combination of Vestas and NEG Micon, a new organisational and corporate structure was laid down, dividing the organisation into four global production units and six regional sales and service units (see Figure 3). In addition, the central technology, finance and staff function was established at the group's headquarters in Randers, Denmark.

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Figure 3: Organisation of Vestas Wind Systems A/S in 2004

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May 2005: The start of the turnaround

In May 2005, Ditlev Engel, as newly appointed CEO, presented The Will to Win, the group's strategy plan for the period up to the end of 2008. The overall objective of the strategy, built on Vestas' core values—trustworthiness, care, the power to act, and development—was to move Vestas past the current earnings crisis and exploit the vast potential that the company held through its products, employees and know-how. Accordingly, enhanced profitability was the goal for the comprehensive changes the strategy involved.

A new vision: Wind, Oil and Gas

The Will to Win emphasises that Vestas' customers should perceive wind as an energy source on par with oil and gas. To reinforce this, Vestas presented a new vision: Wind, Oil and Gas. With these words Vestas signalled its intention, as the market leader, to assume leadership in making wind a source of energy that is on a par with conventional energy sources. This vision would contribute to making Vestas stand out, both at the time and in the future, as the best and most trustworthy provider of wind energy in the world.

A number of industry and social factors support progress towards Vestas' vision, as wind power offers several clear benefits over other energy sources. The five most important benefits are: Wind is an inexhaustible, free source of energy. Wind power can compete with conventional sources of energy in terms of costs. Wind power reduces dependence on imported energy. Wind power facilitates fast ramp-up of extensive production capacity. Wind power contributes to reducing CO_2 and other greenhouse gas emissions.

To achieve the bold vision of putting wind on par with oil and gas, Ditlev Engel also presented the company's new mission statement: "At Vestas, failure is not an option". In other words, Vestas should no longer apply the concept of "good enough". The company must always be perceived as a reliable collaboration partner, supplier and employer—at technical, financial, environmental and personal levels.

New strategic goals

Earnings ahead of growth represented the cornerstone of Vestas' new strategy. Moreover, competing with some of the world's largest corporations, Vestas needed to intensify its already strong global presence at that time and strengthen its global corporate culture. The aim of the plan was to improve the company's financial results and long-term development opportunities considerably. To take advantage of the appreciable growth potential in wind power, in both the short and the long term, the company needed to improve its ability to carry out increasingly larger projects for increasingly larger and more professional customers. In Ditlev's own words, the purpose of this strategic plan was "to ensure that in three years' time Vestas is still the world's leading manufacturer of wind

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power systems—both technologically and market-wise. We must prepare for the fact that future customers for our wind power systems will be international energy companies. They have high demands for us and for our products."

At the overall level, The Will to Win defined three benchmarks for the Group's results at the end of 2008.

Figure 4: The Will to Win benchmarks

Priority	Benchmark	Objective
1	EBIT margin	At least 10%
2	Net working capital	20–25%
3	Market share	At least 35%

The order of priority for these three benchmarks was important. Previously, Vestas had been to a great extent driven by a target of constant growth in megawatts, in other words market share. Under The Will to Win, this was no longer the case. Instead, the top priority was for the Group to generate a profit again; it was unacceptable that earnings had dropped in recent years in spite of substantial sales growth. The unsatisfactory financial performance, declining customer satisfaction and the fact that a number of external stakeholders had gradually reduced their perception of Vestas to an unacceptably low level made it clear to the Board of Directors and the Executive Management that it was necessary to re-focus the company's direction.

As a result, starting from 2005 the Group's strategic and commercial development would be planned with the primary target of an EBIT margin of at least 10% for the 2008 financial year. This target consisted of the following elements (not including possible marginal improvements related to higher sales prices):

Figure 5:

Expected EBIT margin, 2005:	approximately 4%
Reduction of costs related to component failures:	2%
Reduction of fixed costs:	4%
Total	10%

"During the coming three years, we will primarily focus on the improvement of the profit margin—no doubt about that. This does not imply that we have rejected growth; it just has to be profitable. If the growth is profitable, we certainly wish to grow on an ongoing basis," Ditlev Engel emphasised at the launch of the new strategy.

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Initiatives for improved profitability

To secure the long-term financial targets, a number of initiatives were designed to improve Vestas' operational profitability. The most important of these were:

- Direct production costs had to be reduced by improving the Group's production processes, production organisation and supplier structure.
- Indirect production costs and capacity costs had to be reduced by making the Group's organisation simpler and more efficient, delegating authority and clarifying business responsibilities.
- These cost savings would reduce the number of staff in those administrative functions that had doubled up as a consequence of the merger.
- A considerable increase in technology development was needed to strengthen Vestas' international competitiveness and re-establish the previous very high level of customer satisfaction.
- The strengthened development activities would also reduce the costs of warranty repairs, among other things, by strengthening strategic partnerships with sub-suppliers who share Vestas' quality perception.
- The sales units' competences in the sale and delivery of large wind power projects would be strengthened, leading to—among other things—a more even distribution of sales during the year.
- Higher prices for Vestas' products and services.
- Rejection of wind power projects that are deemed not to be sufficiently profitable.
- Plans for establishing local manufacture in North America were put on hold.
- An incentive programme for all employees was set up to stimulate employees' commitment to the Group's business development.
- Improved dialogue with the Group's stakeholders via strengthened communications.
- An appreciable upgrade of investor relations activities.

"These initiatives aim to increase effectiveness in all areas of Vestas' business. We will professionalise our dialogue with customers, we will improve the quality of our products and we will be much more effective in all that we do. By implementing 'The Will to Win' we are creating a new global Vestas," explained Ditlev Engel.

The constitution

Another new concept that Ditlev introduced to ensure the success of the new strategy was the "Vestas Constitution"—a foundation on which the Group would build its development and which would direct the company's every move. The Will to Win stipulates that decisions should be made on the basis of what serves Vestas best, and this became the key issue in the job description of every employee.

The Vestas Constitution was designed as the Group's future decision-making platform, indicating what Vestas stands for, which policies to pursue and which business procedures to follow. It comprised a declaration about the way in which Vestas is to act, as well as 13 corporate projects, each pivotal in enhancing Vestas' efficiency and product quality. The 13 projects address all the focus areas identified in The Will to Win, paying

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special attention to business understanding, product quality, service and maintenance.

The Vestas Constitution was a script written to drive the cultural change that Ditlev Engel aimed to achieve through The Will to Win. The fact that both customers and competitors had changed placed substantially more stringent demands on Vestas and its products. To live up to these demands, the entire Vestas organisation had to adopt a corporate culture based on unambiguous responsibility, clearly defined reporting procedures, close follow-up and attention to consequences.

The philosophy behind the Vestas Constitution was that the 13 projects would bridge the Group's external communication with customers and the in-house follow-up procedures, thus ensuring that the strategic goals were reached. This was to be achieved through new, detailed and, most importantly, timely reporting.

New management, new organisation

Another important part of The Will to Win was the significant changes it brought to the organisation and management structure of the company. The Vestas Executive Management shrank from five members to two. In return, a new Government was set up, comprising not only the Executive Management but also the Presidents of all 13 Vestas business units—of which three were new additions to the organisation. The term Government was used deliberately. Having accepted a seat in the Government, by definition, a member opted not to be part of the opposition.

Figure 6: Constitution enabling projects

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Explaining the reason for the new management structure, Ditlev said: "Previously, it was said that the big prey on the small. We at Vestas are convinced that in a world distinguished by globalisation and competition, it is rather a matter of the quick preying on the slow." For that reason, it was essential to create a management structure with the shortest possible routes from idea to action, so as to achieve the goals of the new strategic plan. "The various business units within the Vestas organisation depend on each other because everything is inextricably linked. Moreover, as both political and competitive conditions in the wind power market change almost from one hour to the next, it was important to bring the people who have the everyday responsibility for—and thus a keen understanding of the actual circumstances of—the various business units as close as possible to the Executive Management". The result was the new Vestas Government. To ensure maximum power to act in all areas of the Group, the Vestas Government holds telephone conferences once a week, and meets physically 8–10 times a year.

Another factor that carried a lot of weight in the planning of the new structure was the desire to divide responsibility more clearly and unambiguously between the business units. Previously, there were a number of areas of overlap in decision-making. Even though it was impossible to eliminate "grey areas" completely, the new structure at Vestas made it much easier to define precisely who is responsible for what.

The implementation of the new structure saw the appearance of no fewer than three new business units on the Vestas organisation chart. The three new business units—Vestas People and Culture, Vestas Technology R&D and Vestas Offshore—were all previously either staff functions or skill centres under a different business unit. By turning these into independent units with representation in top management—the Government—Ditlev made it clear that in future these areas were to have much greater importance within the company. The new structure was also meant to increase transparency, and to transfer responsibility and skills to the relevant parts of the organisation. Within the new structure, the management of each business unit reports to the Executive Management, for example through the weekly telephone conferences held by the Vestas Government.

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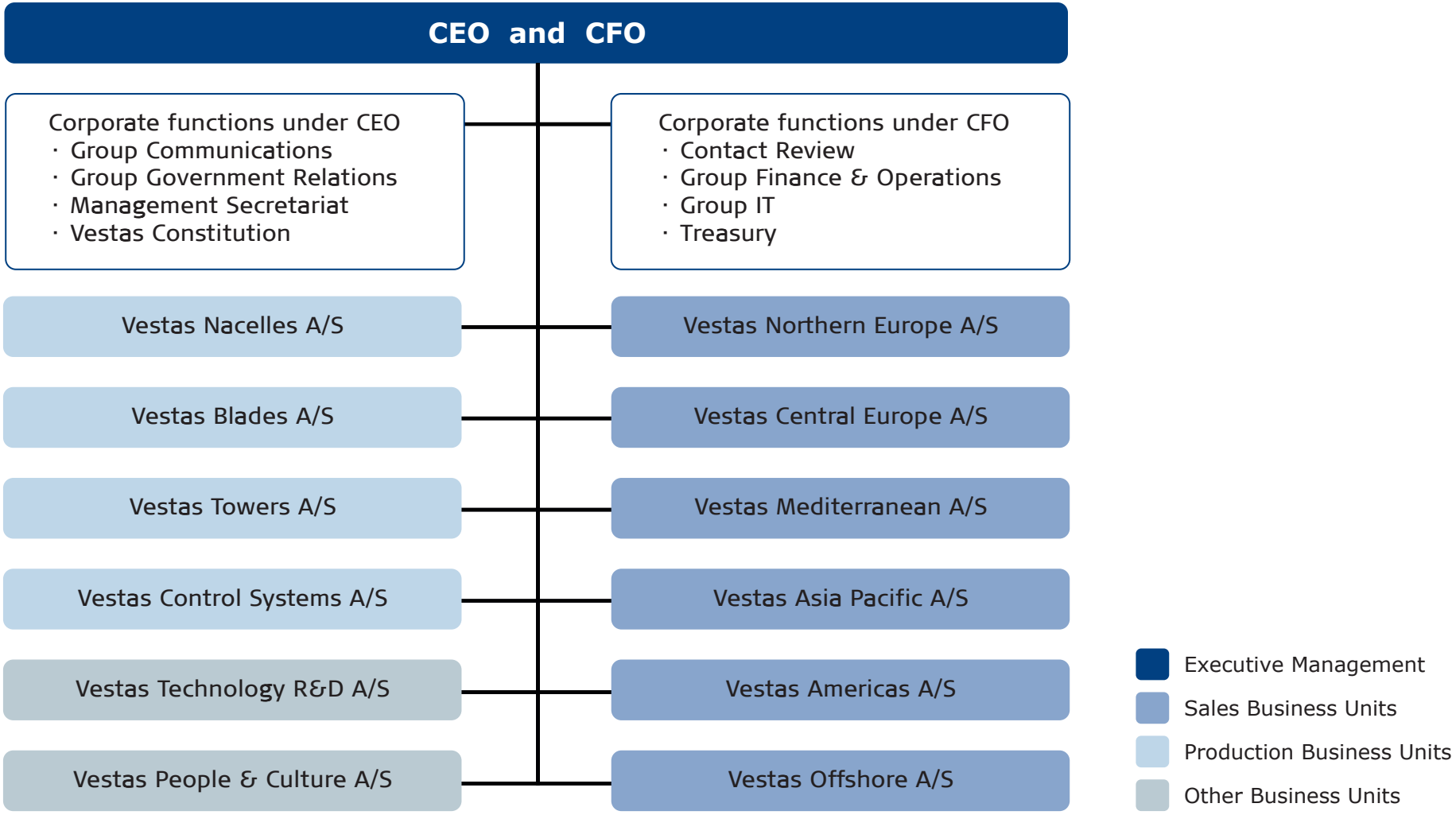
Figure 7: New organisational and corporate structure (Vestas Mediterranean West and Vestas Mediterranean East were joined into one business unit in 2006)



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Time to measure up

It was now the end of the third quarter of 2007, only five quarters away from the deadline for The Will to Win strategic plan to have reached its targets. Looking back over the many changes the company had undergone, and preparing for his speech, Ditlev Engel had to recap the impact of the strategic and operational initiatives implemented under his command. It was time to let the numbers speak...

2005: EBIT –3.2%

In spite of a substantial 52% increase in revenue, and a 40% growth in the world market for wind energy, Vestas reported entirely unsatisfactory results in 2005. The Group reported an operating loss (EBIT) of €116m, which translated into an EBIT margin of –3.2%. This disappointing performance was primarily due to three factors:

- *Earnings on the major projects in North America were much too low:*
  Vestas' extraordinary effort to complete a number of major projects in North America on time reduced the already low profitability of these projects. To this should be added the consequences of Vestas' prioritisation of resources, which delayed deliveries for other more profitable projects.

- *Component shortage:*
  Vestas' substantial growth in 2005 resulted in major planning and capacity challenges for both the Group and its suppliers. One of the consequences of this pressure was that a number of suppliers were unable to supply the necessary components in due time, causing delays and increasing the costs of completing orders.

- *Warranty provisions:*
  Following an extraordinary review of warranty provisions in autumn 2005, Vestas resolved to increase its provisions above the original figures for the year. These additional provisions reflected the insufficient quality of certain components in Vestas' turbines, and concern the product warranties provided to customers upon the conclusion of delivery contracts. Product warranties, which in most cases cover faulty components, malfunctions and any financial losses incurred by the customer in connection with unscheduled interruptions, usually apply for two to five years from the date of delivery. For the customers, the specific warranty period and warranty terms form part of the individual contract. Of the approximately 30,700 turbines manufactured and sold by Vestas in total, about 7,900 were covered by a full or partial warranty at the end of 2005.

However, in spite of the large loss in 2005, the Group succeeded in maintaining positive liquidity:

- Vestas generated a cash inflow from operations of €148m in 2005.

- At the end of the year, net working capital stood at 14% of the revenue for the year. This was a substantial improvement over the corresponding figure of 29% in 2004, and far better than the target defined for 2008.

- Vestas' backlog of firm and unconditional orders increased by 81% during 2005 to an all-time high of €3 bn.

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2006: EBIT 5.2%

Two years after the launch of the "Will to Win", with the constitution projects well under way, Vestas managed to achieve an EBIT margin of 5.2%, up from –3.2% the year before, with an 8% increase in revenues to €3.85 bn. The EBIT improvement in 2006 was primarily attributable to better selling prices and terms of delivery. Also, net working capital was at an all time low of 3% of revenues, and Vestas had a market share of approximately 28%. 2006 was a good year for the company, and the many strategic initiatives started to show results.

An important contribution to the good performance in 2006 was the implementation of Constitution Project number 6, which dealt with improving the planning and utilisation of production and delivery capacity. Through increasing accountability and transparency, the project provided cultural cohesion and clear business rules among all business units.

At the end of the year, however, the company was still facing major challenges in terms of product and component quality across the value chain. The main operational risks were related to increased transport costs, insufficient quality, late component delivery, and high warranty provisions (4.5% of revenues). Managing people represented another major challenge to sustainable growth in the years to come: Vestas already had 12,000 employees at year end, and was expecting a headcount of 14,000 by the end of 2007.

Figure 8: The Will to Win core benchmarks

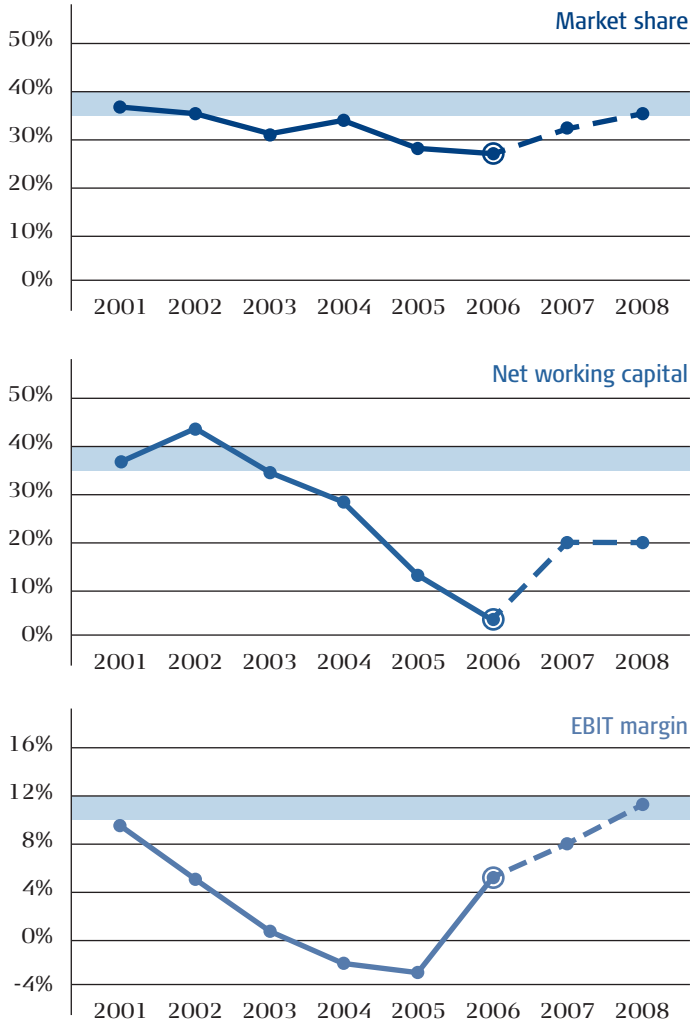

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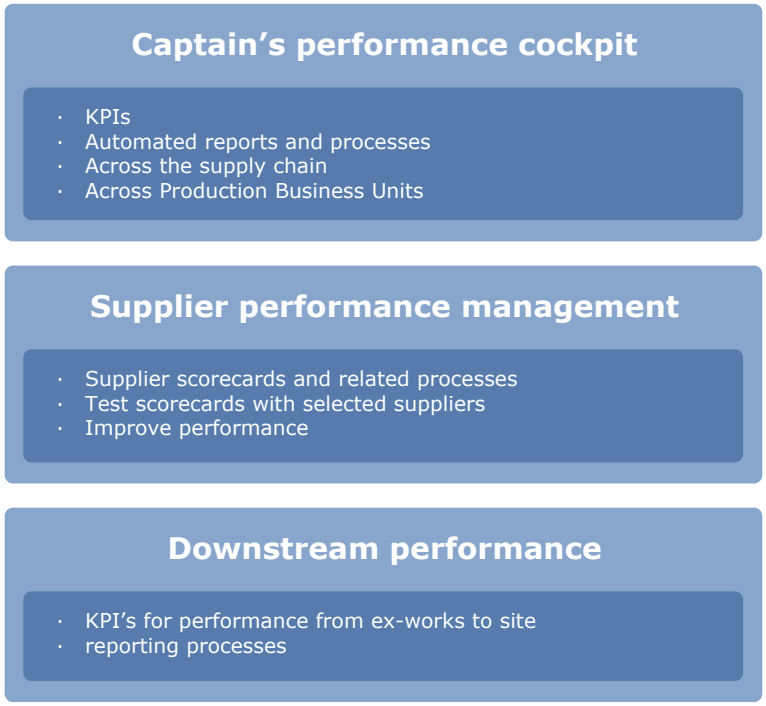
Figure 9: Elements of Constitution Project 6:
Accountability and transparency



2007 and beyond: performance, goals and forecast

In Q3 2007, Vestas generated revenues of €1,150m (2006: €842m), achieving an EBIT of €102m (2006: €40m) and lifting the EBIT margin from 4.8% to 8.9% over the past 12 months. Warranty provisions stood at 5%. Vestas shipped 1,245 MW during the quarter as against 1,060 MW the year before, an increase of 17%. The order backlog at 30 September 2007 was €4.1 bn, against €3.1 bn in 2006. There was no room for discussion: the company was growing, and growing profitably. The Will to Win was finally starting to pay off.

Before entering the press room, Ditlev took one more look at the forecast for 2007 and 2008:

2007: Revenue is expected to continue to increase to approximately €4.5 bn, and the EBIT margin is forecast at about 8% on the back of warranty provisions of approximately 5%. Net working capital is expected to be a maximum of 10% of annual revenue, as compared with the previous maximum forecast of 15%. Working capital is expected to be higher at the end of the year than it was at 30 September because of the uncertainty associated with the execution of orders and the timing of customer payments during the final months of the year. Unstable shipments during the course of the year led to a disproportionately high volume of orders being executed in the fourth quarter, increasing risk and costs and slowing down the profitability improvements.

2008: An increase in revenue of a little more than 25% is forecast, to approximately €5.7 bn, and an EBIT margin increase to 10–12%. The improved EBIT margin is to be achieved through better interaction with suppliers and in-house initiatives. Warranty provisions are expected to be unchanged, at 3–5% of revenue. Net working capital is now expected to represent a maximum of 15% of annual revenue, as compared to 20% last year. By the end of 2008 at the latest, Vestas and all of its sub-suppliers must have reached a Sigma quality level of 4. A persistent enhancement of profitability in the years ahead is a precondition for the industry to play a key role in developing the world's energy supply.

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Looking at all these numbers, Ditlev knew that to ensure sustainable growth, one issue will have to be at the top of the agenda: people. To ensure high-quality operations, Vestas has to recruit new employees before increasing its business volume. This approach is part of the "People before megawatts" policy within Vestas. During the past 12 months Vestas has increased its headcount by 2,706, bringing the total number of employees to 14,607 as of 30 September 2007. By the end of 2007, Vestas will have more than 15,500 employees working at more than 50 locations in 20 countries. By the end of 2008 Vestas expects to have 18,000 employees, of whom approximately 13,700 will be located in Europe, approximately 1,700 in North America and approximately 2,600 in Asia/Pacific. It will certainly be a challenge to attract, engage and retain so many new employees in such a short time, Ditlev said to himself. But he was confident that the People and Culture business unit was up to the challenge.

However, there were other issues threatening the sustainability of Vestas' profitability and growth. The overall demand pressure on the industry over the last few years had persisted, and there were still long lead times—up to 15 months—for a number of key components. This in turn was triggering price increases for a number of key components, which needed to be offset by higher prices for Vestas turbines. In this regard, Ditlev was certain that it would take several years before supply could match demand.

Other than the above, the most important risk factors for the profitability targets remained the additional warranty provisions due to sub-standard quality, rising raw materials prices and transport costs, disruptions in production and installation, and movements in the USD/EUR exchange rate—important since Vestas generates substantial net income in US dollars and currencies whose value depends heavily on the dollar.

Challenges

What have been the most important changes begun by Ditlev Engel since he became CEO? How relevant have those changes been to the company's situation in 2004?

Is there a direct relationship between the vision, mission and core benchmarks of The Will to Win and the initiatives and constitution projects proposed by Ditlev? Why?

What would you have done differently?

Taking into account the results of Q3 2007 and the forecasts for the remainder of 2007 and 2008, what do you think Ditlev should focus on next?

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Case Study 1
External positioning

Excerpt from Q3 2007 press release:

During the past few years, Vestas has extensively changed the way in which it thinks and operates as a high technology company to ensure that it can expand its position as the world's largest manufacturer of wind power plants and thereby play a key role in the proliferation of wind power.

Vestas knows that it will require substantial investments throughout its value chain and a repositioning of wind power for Vestas to retain its market-leading position. To achieve this, the company is replacing its internally-focused strategy "The Will to Win" with the externally-oriented strategy "No. 1 in Modern Energy". As part of these endeavours, many of the company's suppliers and their sub-suppliers have started to invest in new skills and capacity, although they are still a long way from a sufficient rate of expansion.

No. 1 in Modern Energy does not change the previous strategic priorities in terms of:

1. EBIT margin,
2. net working capital, and
3. market share.

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Figure 1: Strategy dynamics

Vestas' vision of Wind, Oil and Gas has been adopted by politicians and energy and utility customers around the world, even though specific political initiatives remain to be implemented in a number of markets. Wind power will be able to make a key contribution to rising global energy needs because it is competitive with conventional power plants in terms of costs; because the price of wind is known for eternity; because wind is a local source of power that reduces dependence on imported energy; because wind power can be installed quickly; and, finally, because wind power is good for the environment, with no hazardous emissions or CO_2. Also, unlike coal-fired and nuclear power plants, wind power does not require water. At the end of their working lives, wind turbines can be recycled. After approximately seven months a modern Vestas turbine has generated as much energy as is used to manufacture, transport, install and dismantle the turbine. No other source of energy is currently able to match wind power in this respect.

Vestas expects that wind's share of global power generation—presently about 1%—will grow to at least 10% by 2020. Targets for renewable power in the EU and China will account for 20% and 15%, respectively, by 2020, and the US is expected to adopt similar targets. These targets mean that installed capacity is set to rise from 75 GW in 2006 to at least 1,000 GW in 2020, which translates into annual growth of more than 20%.

"In our capacity as market leader, we are dedicated to lifting the entire capacity of the supply chain to substantially

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increase production output and quality and, by extension, profitability throughout the supply chain in the years ahead; this is a prerequisite for Vestas to achieve its Wind, Oil and Gas vision. Consequently, by the end of 2008 at the latest, Vestas and all our suppliers must have reached a Sigma quality level of 4, equivalent to an error margin of 0.06%. Compared with the present situation, this represents a substantial quality improvement".

To provide all stakeholders with a fact-based decision-making basis and an overview of the legislative measures required to achieve the political targets for energy consumption, Vestas intends to invest heavily in an information campaign aimed at putting wind power at the top of the global energy agenda, where the political targets in many countries have already been defined. Detailed legislation still needs to be put in place for the industry to make investments in the necessary capacity and the skills required. Another outstanding issue is the requirements placed on educational institutions worldwide. It is Vestas' goal that at least 10% of the world's power production should be based on wind energy by 2020. To achieve this, the wind turbine industry must install a total of more than 900,000 MW over the next 13 years. The global market in 2006 was 15,000 MW.

Challenges

More than a year before the deadline for the strategic plan The Will to Win, Vestas is announcing a shift in strategy. Why do you think this has been done? How would you judge this decision?

Taking into account the forecast and the challenges foreseen by Ditlev for the coming years, what strategic objectives should Vestas target in connection with this campaign, and how can those objectives be measured?

Which are the main stakeholders of Vestas? Given the facts presented in the press release, what do you think the new strategy should focus on, for each stakeholder group?

How would you design the global information campaign aimed at putting wind at the top of the global energy agenda? What specific initiatives would you choose?

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Case Study 2

Changing market conditions

Very large and specialised energy utilities represent an increasing proportion of Vestas' customers, demanding reliability in wind power plants that is on a level with that of conventional power plants. Also, a number of big players from the conventional energy sector are starting to enter the renewable energy market. As a result, a completely new market situation is emerging—one distinguished not only by customers becoming bigger, more professional and more farsighted in their investments, but also by established developers and energy utilities being joined by some of the world's largest players within fossil fuels.

Within the past few years, a number of new and very large competitors have become extremely active and visible. These players include, in particular, some of the world's huge industrial conglomerates, which are characterised by massive financial strength and a tradition of strong political ties. To this should be added the fact that these companies, owing to their size and market reach, have been used to servicing some of the largest buyers in the world. More and more often, these customers are the buyers of the largest wind power plants.

Moreover, over recent years, Vestas has been facing customer satisfaction figures that have declined from 90% in 2000 to a mere 60% in 2004. However, a number of internal initiatives have been taken, and, as a result, the downturn in customer satisfaction has stopped, as the percentage of satisfied customers has begun to increase, reaching 63% in 2006. What else should Vestas do to increase its customer loyalty, thus securing its leadership position in the industry and ensuring further growth?

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Leading fossil fuel companies invest in renewable energy

Back in 1997, Shell established a dedicated renewable energy business unit, Shell Renewables, as the company's fifth core business. Graeme Sweeney, Executive Vice President of Renewables, Hydrogen and CO_2 at Shell, gives the following explanation for Shell's involvement in renewable energy: "Our participation in the alternative energy market has three main objectives: expanding energy options; making alternative energy solutions competitive with conventional energy sources; and establishing a leading position in the alternative energy sector—a sector which is expected to make up between a quarter and a third of the energy mix by 2050." Shell has already invested over USD 1 bn in renewables over the past five years and the company believes that by focusing on a carefully selected set of technologies, which demonstrate the best combination of reliability, cost-effectiveness and sustainability, it will succeed in creating a strong business which will provide a substantial contribution to the future energy mix. "Managing the carbon footprint is one of the biggest challenges for all of us, Graeme Sweeney adds. "In the energy sector, we carry a particular responsibility not only to reduce the impact of our production and manufacturing processes, but also to help our customers reduce their impact. We see wind energy as one of the key new energy technologies, capable of delivering outstanding results and generating clean energy all over the world." In 2006, Shell WindEnergy, a division of Shell Renewables, invested in the first Dutch offshore wind power plant at Egmond aan Zee through a joint venture with Nuon, one of the largest energy companies in the Netherlands.

In 2005, British Petroleum (BP), another major player in the fossil fuels sector has also introduced a new business unit in the company's portfolio: BP Alternative Energy. This is a unit that gathers together all BP's activities in the production and sale of energy with low or no CO_2 emissions: energy from the wind, sun, hydrogen and natural gas.

There are many reasons why wind power has begun to make its way onto the agendas of some of the biggest energy companies in the world. Firstly, their interest is an admission that the steadily rising energy consumption worldwide is making it essential to think in terms of options to fossil fuels—partly on account of the effects on the environment, partly due to rocketing oil prices, and partly because fossil fuels are limited resources that are going to run out at some point. Secondly, political frameworks for investing in wind power today are much more stable than they were just a few years ago. And finally, technological development has by now made it clear that wind is more than "just" an environment-friendly and inexhaustible source of energy; it is also a form of energy that can compete with, for example, oil and gas on a fully commercial basis, as long as comparisons are made on equal terms.

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Improving working relationships with existing customers

In 2005, Vestas launched the Dialogue for Development, an initiative to increase the loyalty and satisfaction of its customers. The objective of this comprehensive customer relations project has been to achieve closer and more open dialogue, and thereby ensure improved collaboration for the benefit of the Group's customers and Vestas. The project builds on large-scale customer satisfaction surveys and subsequent follow-up with the individual customers under three heading: Listen, Reflect, and Act.

The "Listen" stage is focused on analysing current customer relations, through a yearly customer loyalty survey measuring customer responses to everything from the purchase of wind turbines, through to project completion, after-sales servicing and maintenance.

The results of the 2005 survey revealed that 60% of respondents were either "satisfied" or "very satisfied" with their working relationship with Vestas—the same low level as in 2004, a result less than satisfactory. However, the same survey revealed that three out of four customers considered Vestas as attractive as or more attractive than its competitors. Through the survey, customers made it clear that Vestas needed to improve in two main areas of its products and services: increase turbine reliability, and provide better documentation and reporting.

Secondly, customers indicated that Vestas needed to take a more proactive approach to information and communication. Customers pointed towards the need for better insight into the progress of projects and turbine operation in general, and also regarding the technological and operational problems that may arise—and the solutions Vestas applies to deal with them.

Italian best practices

Rainer Karan, General Manager of Vestas Italia, a sales unit of Vestas Mediterranean, explains the main conclusions of the Italian survey: "Wind energy is big business in Italy. Today we have bigger customers and the framework has changed. Our customers are asking us to direct more attention at their growing business and business requirements and improve our understanding of their organisation."

As a result of the "Listen" stage carried out in the Italian market, a number of new initiatives have been implemented:

- Within sales, a core target was improved communications, both internally and with the customer. Vestas Italia is now working to establish a common internal platform for customer information, which can then be shared among relevant employees. A new behavioural standard is also under way to ensure customer requests are prioritised and that customers know when they can expect a response.

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- Where projects are concerned, Vestas Italia has now started to appoint a dedicated customer project team at the beginning of each wind project, providing the customer with an organisation chart showing the roles and responsibilities of each team member. The organisation chart is to be shared with the customer at a project kick-off meeting, when the customer will also be asked to provide an organisation chart of their own. To ensure customer experiences improve, the internal resources dedicated to each project team have been increased.

- A particular criticism of the Vestas service package was the incomplete nature of service reports and the long delay before they were sent to the customer. This has caused Vestas Italia to focus on service reports, with more and better training for service technicians, a commitment to producing complete and accurate reports, and regular report assessments to ensure they are of the necessary standard.

Challenges

Discuss the challenges Vestas is facing with regard to its customers.

How are the strategies The Will to Win and No. 1 in Modern Energy addressing these challenges? Which of the specific initiatives of the two strategies are oriented towards those issues? How relevant do you think they are?

Vestas Italia represents best practice in customer relations management within the Group. Can those best practices be implemented on a global level? How?

What more can the company do to secure its leadership position within the industry and to ensure further growth?

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Case Study 3

Operationalising strategy through performance measurement

Between 2005 and 2007 Vestas launched two complementary strategies, meant to strengthen the company's financial and market position: the internally-focused "The Will to Win" and the externally-focused "No. 1 in Modern Energy". Vestas has hired you as an external consultant to help the company implement a performance measurement system across the organisation, with the aim of supporting and monitoring the implementation of its strategies.

The Vestas Government believes that the performance management system must focus on the key value drivers of the business, both short-term and long-term, and measure the vital function of supply chain, production, project execution, service, warranty and customer satisfaction. The performance measurement system should also help to align the company with the many challenges posed by the external environment.

Vestas is structured into business units of three types: Production Business Units (PBU), Sales Business Units (SBU) and Supporting Business Units. Every business unit has a president, member of the Vestas Government, who is responsible for the performance of the individual business unit. The responsibilities of each business unit within the Group are shown in the Figure 1:

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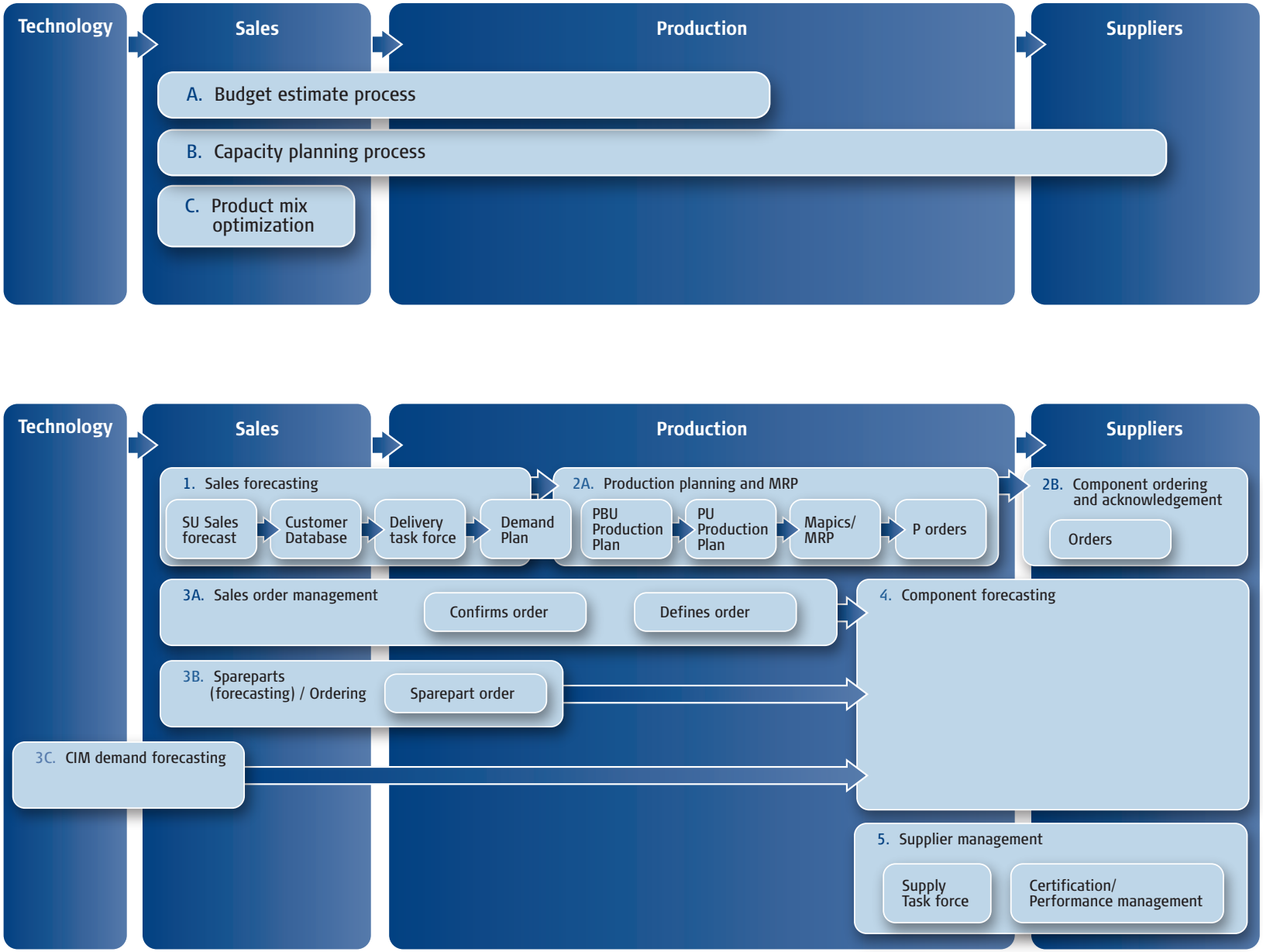
Figure 1: Vestas supply chain: who is responsible?
Information and materials flows within Vestas Supply Chain (SUs = Sales units, PU = Production Unit, PBU = Production Business Unit, SBUs = Sales Business Units)



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The blue arrows (right to left) represent flows of information within the supply chain. The planning and production process for a new turbine starts with the customer indicating an interest, (1. Sales forecasting) or placing an order (3. Sales order management). This information is fed into the demand plan and subsequently into the production plans (2A. Production planning and Material Resource Planning) and further into the MRP system which generates purchase orders. Subsequently the local buyers ensure execution of the component purchase orders in coordination with the suppliers (2B. Component ordering and acknowledgement).

In addition to this primary flow there are several other supporting flows of information:

- The cross business units budget estimate process, capacity planning process and product mix optimisation processes (A+B+C)
- Spare-parts ordering (4) and CIM demand forecasting (5) processes, both of them feeding into the component forecasting process which is run by the Buyers as they confirm capacity with suppliers (6).
- The supplier management process, representing supplier performance management, certification of new suppliers, negotiations etc. (7).

Challenges

Identify and construct a set of relevant KPIs which can help Vestas top management in aligning its strategies within the organisation.

Discuss and explain how the identified KPIs can be utilised and fit into a strategic modelling tool such as Balanced Scorecard framework.

Vestas is also considering the potential of the Business Excellence model as a strategic tool. Assess the strengths and weaknesses of the Balanced Scorecard and Business Excellence models and discuss the possibility of a hybrid of the two.

People and Culture

Organic Growth and the People Pipeline

Case Study 1: People before megawatts
Case Study 2: Employer branding challenges
Case Study 3: Corporate social responsibility

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Organic Growth and the People Pipeline

Learning objectives

Helps understanding of several aspects of human resources practices when managing a company experiencing rapid growth in both employees and capacity. Students will also need to grasp the challenge of communicating and implementing a coherent and consistent strategic plan to reach specific financial targets presented to the shareholders.

This collection also gives insights into multinationals' strategies for corporate social responsibility (CSR). Many aspects need to be considered when designing the "right" corporate image.

Keywords

- Human resource management, corporate culture, corporate social responsibility, employer branding

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The impetus for change

"We wish to create a new global Vestas culture. Globalisation creates fantastic opportunities for Vestas, but it takes courage to seize them. At the same time, it means goodbye forever to a local mindset. Focusing on culture, we set up a corporate function called Vestas People and Culture, as the previous organisational structure proved to be an impediment to the intended development." Ditlev Engel, President and CEO.

Ditlev Engel took over as CEO of Vestas Wind Systems on 1 May 2005, 15 months after the merger of Vestas and NEG Micon, which positioned the Group as the undisputed world leader within the wind power industry, with a market share of approximately 35%. However, even though the basis for the merger was the desire to create a group large enough to exploit growth opportunities for wind power, the financial results at the end of 2004 were less than satisfactory. Despite a 43% increase in revenues, in 2004, Vestas recorded an operating loss of €49m, the first negative result for many years. Moreover, the annual customer survey showed that the level of satisfaction for the company's customers had dropped from 90% in 2000, to a mere 60% at the end of 2004.

Vision, strategy and strategic goals in 2004

In 2004, the company's vision was "with quality and care to use the wind to generate competitive, clean and renewable energy. In future, wind energy will cover a substantial part of the global energy supply and contribute to substantial development for the benefit of future generations. Vestas is to be the international market leader in wind power solutions—valued by customers, shareholders employees and other stakeholders."

The strategy communicated by the company, at that time, was "to supply customised wind power systems based on standard wind turbines and standardised options that can generate electricity of the optimal quality at the most competitive price". Vestas' strategic goal, as stated in the 2004 Annual Report, was "to be an international leader and to ensure sufficient financial strength to continue internationalisation."
To achieve this strategic goal, the Group was to strive for:

- A global market share of at least 35% by installed capacity,
- Earnings before financial items and tax (EBIT margin) of at least 10%,
- Net working capital (NWC) at year end to be a maximum of 25–30% of turnover.

Organisational structure following the NEG Micon merger

Following the combination of Vestas and NEG Micon, a new organisational and corporate structure was laid down, dividing the organisation into four global production units and six regional sales and service units (see figure below). In addition, the central technology, finance and staff functions were established at the Group's headquarters in Randers, Denmark.

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Figure 1: Organisation of Vestas Wind Systems A/S in 2004

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May 2005: The start of the turnaround

In May 2005, Ditlev Engel, as newly appointed CEO presented The Will to Win, the Group's strategy plan for the period until the end of 2008. The overall objective of the strategy, built on Vestas' core values—trustworthiness, care, the power to act, and development—was to move Vestas past the earnings crisis that marked the situation at the time and to exploit the vast potential of the company's products, employees and know-how. Accordingly, enhanced profitability was the goal for the comprehensive changes the strategy involved.

A new vision: Wind, Oil and Gas

The Will to Win strategy emphasises that Vestas' customers should perceive wind as an energy source on par with oil and gas. In connection with The Will to Win, Vestas presented a new vision: Wind, Oil and Gas. With these words, Vestas signalled the Group's intention, as a market leader, to assume leadership in making wind a source of energy on a par with conventional energy sources. The vision was intended to help make Vestas stand out as the best and most trustworthy provider of wind energy in the world.

To achieve the bold vision of having wind on par with oil and gas, Ditlev Engel also presented the company's new mission statement: "At Vestas, failure is not an option". In other words, Vestas should no longer apply the concept of "good enough". The company must always be perceived as a reliable collaboration partner, supplier and employer—at technical, financial, environmental and personal levels.

New strategic goals

Earnings ahead of growth represented the cornerstone of Vestas' new strategy. Moreover, competing with some of the world's largest corporations, Vestas needed to intensify its already strong global presence at that time and strengthen its global corporate culture.

At the overall level, The Will to Win defined three benchmarks for the Group's results at the end of 2008.

Priority	Benchmark	Objective
1	EBIT margin	At least 10%
2	Net working capital	20–25%
3	Market share	At least 35%

The order of priority for the three benchmarks of the plan was important because Vestas was previously to a great extent driven by a target of constant growth in terms of megawatt capacity (i.e. market share). Under The Will to Win, this was no longer the top priority. Instead, rhe most important priority for Vestas was for the Group to generate a profit again. Starting from 2005, the Group's strategic and commercial development would therefore be planned with a view to realising an EBIT margin of at least 10% in the 2008 financial year.

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New management, new organisation

Another important part of The Will to Win was the significant changes brought to the organisation and management structure of the company. The Vestas Executive Management shrank from five members to two. In return, a new Government was set up, comprising not only the Executive Management but also the Presidents of all 13 Vestas business units—of which three were new additions to the organisation. The term Government was used deliberately. Having accepted a seat in the Government, by definition, a member opted not to be part of the opposition.

Explaining the reason for the new management structure, Ditlev Engel, President and CEO said: "Previously, it was said that the big prey on the small. We at Vestas are convinced that in a world distinguished by globalisation and competition, it is rather a matter of the quick preying on the slow." For that reason, it was essential to create a management structure with the shortest possible routes from idea to action: "The various business units within the Vestas organisation depend on each other because everything is inextricably linked."

Moreover, as both political and competitive conditions in the wind power market change almost from one hour to the next, it was important to bring the people who have the everyday responsibility for—and thus a keen understanding of the actual circumstances of—the various business units as close as possible to the Executive Management. The result was the creation of the new Vestas Government which, to ensure maximum power to act in all areas of the Group, holds telephone conferences once a week, and physically meets 8–10 times a year.

Another factor that carried a lot of weight in the planning of the new structure was the desire to divide responsibility clearly and unambiguously between the business units. Previously, there were a number of areas of overlap in decision-making. Even though it was impossible to eliminate "grey areas" completely, the new structure at Vestas made it much easier to define precisely who is responsible for what.

The implementation of the new structure saw the appearance of no fewer than three new business units on the Vestas organisation chart. The three new business units—Vestas People and Culture, Vestas Technology R&D and Vestas Offshore—are all units which before the implementation of the new structure were either staff functions or skill centres under a different business unit. By making these independent units with representation in the top management—the Government—Ditlev was making it absolutely clear that in future, these three areas will be given much greater priority within the company. The new structure was also meant to increase transparency, and to transfer responsibility and skills to the relevant parts of the organisation. Within the new structure, the management of each individual business unit reports to the Executive Management, for example through weekly telephone conferences held by the Vestas Government.

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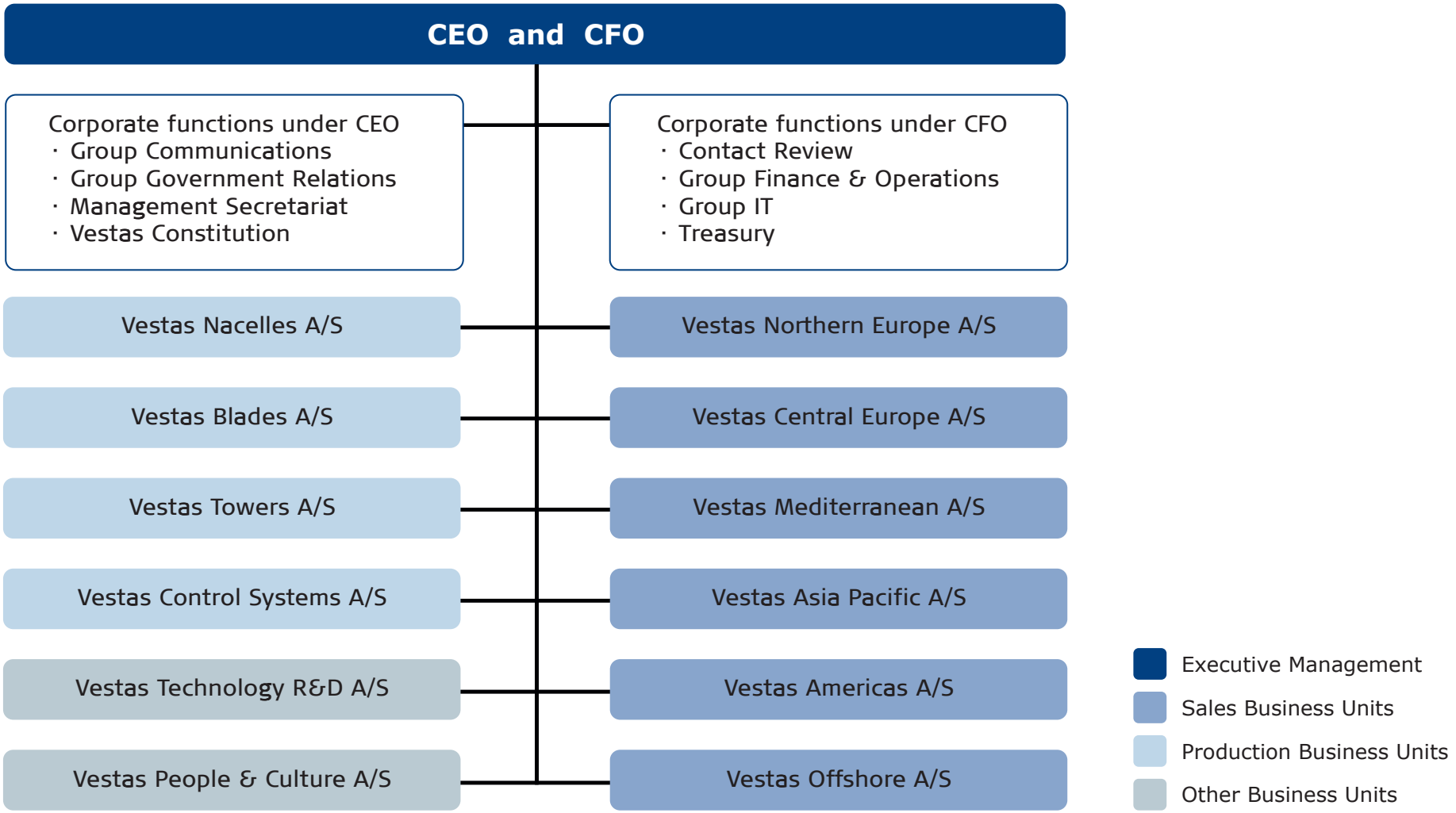
Figure 2: New organisational and corporate structure (Vestas Mediterranean West and Vestas Mediterranean East were joined into one business unit in 2006)



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Implementing strategy: The Vestas Constitution

Another new concept that Ditlev Engel introduced to ensure the success of the new strategy was the "Vestas Constitution", a foundation on which the Group would build its development and which would direct the company's every move. The Will to Win stipulates that decisions should be made on the basis of what serves Vestas best, and this became the key issue in the job description for all the company's employees.

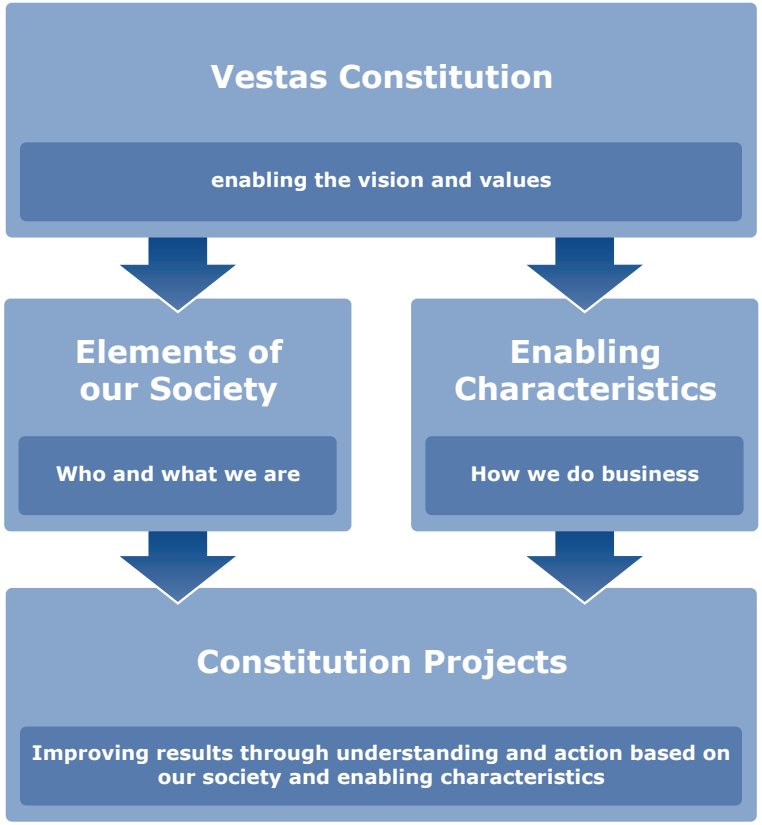
The Vestas Constitution was meant as the Group's future decision-making platform, indicating what Vestas stands for (the "social elements"), which policies to pursue, and which business procedures to follow (the "enabling characteristics").

The Vestas constitution

Social elements:

- We are an organisation which values its people and understands that success is a result of their efforts.
- We are an organisation which defines itself by product performance.
- Performance improvement is always attainable.
- We will always view customer needs as an expectation of product performance.
- We take full responsibility for poor performance. We will not seek to find blame or circumstances out of our control, for nothing is out of our control.

Figure 3: The Vestas Constitution



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Enabling characteristics:

- Discipline to process, and reliance on process, are fundamental to our business practices, business model, behaviour and policy.
- Quality is defined and designed into our processes and products.
- Each group, department and individual has specific accountabilities with specific performance expectations (KPI). These accountabilities are set out under the headings of quality, cost, delivery, safety, and corporate responsibility.
- Variability in product and process performance is the basis of our performance evaluation and the goal or target of our efforts. The degree of control is our measure of performance.
- We evaluate the risks attached to varying outcomes in all matters and decisions.
- We manage with and through facts. Each activity, project or effort has specific measures of expected performance and value. No effort, project or activity is resourced without a forecast achievement of appropriate value.
- We keep customers informed about our products and process performance, and understand that this is vital to our success. We engage customers with honesty and integrity, and we will not surprise them.

Linked to the Constitution, 13 projects were also set up to aid the implementation of the new strategy, each playing a pivotal role in enhancing Vestas' efficiency and product quality:

The philosophy behind the Vestas Constitution was that the 13 projects would bridge the Group's external communication with customers and the in-house follow-up procedures to ensure that strategic goals are reached. This was to be achieved through new, detailed and, most importantly, timely reporting. The 13 projects address all the identified focus areas in The

Figure 4: Constitution enabling projects

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Will to Win, paying special attention to business understanding, product quality, service, and maintenance. The People and Culture BU was the key actor in most of these projects, coordinating a coherent effort across the globe that is consistent with the strategy set out by headquarters.

The Vestas Constitution was the script written to drive the cultural change Ditlev Engel aimed to achieve through The Will to Win. The fact that both customers and competitors had changed placed substantially more stringent demands on Vestas and its products. To live up to these demands, the entire Vestas organisation had to adopt a corporate culture based on unambiguous responsibility, clearly-defined reporting procedures, close follow-up, and the ability to foresee consequences.

The People and Culture Business Unit

"Vestas is about people. And only about people". This unambiguous statement from Ditlev Engel, President and CEO, explains why the further development of a shared corporate culture and employee skills has high priority within Vestas. So high, in fact, that, in 2005, in the new management structure decided in connection with the launch of The Will to Win, the former Human Resource department was given the same weight as the other business units and changed its name to Vestas People and Culture. The new unit is responsible for developing employees, recruiting new staff, creating the framework for a high level of safety and a healthy working environment, and supporting the development of a shared Vestas culture with a clear division of tasks and responsibilities. Massive investments in Vestas People and Culture—a tenfold increase from 2005 to 2006—prove the importance of the new unit for the success of Vestas.

Roald Jacobsen heads up this new business unit. Within the new management structure, he has been given a seat in the Vestas Government and is now a kind of "Minister of Culture" for the entire Group. Of his work to develop Vestas' culture and employees, he says: "For a global group such as Vestas to succeed, it is essential that we all have the capacity to navigate through a world where the only constant is change. This requires us to act on the basis of a shared set of fundamental values and attitudes; otherwise we end up running off the rails at some point."

Developing employees and managers and creating a common Vestas corporate culture is one of the most important components of The Will to Win, a basic precondition for Vestas' ability to retain and expand its leadership position in the wind power industry. Vestas operates in a market characterised by globalisation, strong growth and a distinct shift in the composition of customers and competitors, which today to a very large extent consist of international and highly professional players with extensive experience and expertise in energy. For Vestas to match these new requirements, it needs to upgrade skills and know-how in all parts of the organisation.

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To ensure high-quality operations, in addition to developing its existing employees, Vestas has to recruit new employees before increasing its business volume. This approach is part of the "People before megawatts" policy. During the first part of 2007 Vestas increased its headcount by 2,706, bringing the total number of employees to 14,607 as at 30 September 2007. By the end of 2008 the headcount is expected to be 18,000, of whom approximately 13,700 will be located in Europe, 1,700 in North America and 2,600 in Asia/Pacific.

Specific initiatives within People and Culture

Since Vestas People and Culture was established, several initiatives have already been implemented. Each will help to generate a shared "global winner" culture:

Skills development

First of all comes the development of skills. Many internal programmes have been set up to help with this, including talent programmes, leadership training and networks. Development programmes have been prepared for all employees, to make sure that the workforce has the necessary skills, motivation and commitment. In 2005, Vestas focused in particular on designing training programmes for the Group's top management, as good management is crucial to the development of the organisation and in making sure employees thrive in their work.

In 2006 the Group concentrated on designing development programmes for middle managers and a talent programme for existing employees. Good management is a precondition for the development of Vestas' organisation, so a large proportion of Vestas' managers were enrolled in a management development programme in 2006. Vestas has a defined goal of recruiting most of its managers and specialists from in-house candidates.

Accordingly, the Group has launched a talent programme aimed at identifying and developing employees who have the potential to become future leaders. The Vestas Business Academy offers a broad programme of commercial, technical and management courses to all employees, including safety courses and training in the Six Sigma management philosophy, which improves Vestas' ability to make fact and data-based decisions.

Employer branding

One of the key challenges faced by Vestas in human resources is to attract internationally-oriented employees with unique technical skills, especially employees who can help Vestas design and market innovative products.

Accordingly, in 2006 Vestas launched initiatives aimed at attracting the best-qualified candidates from all over the world.

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These include a project intended to brand Vestas as a workplace and a two-year graduate programme. Both initiatives are aimed at people who have recently completed their formal education. Targeted branding is one of the initiatives Vestas will use to recruit employees from around the world.

Consequently, in 2006 the Group took the first steps in a global strategy to direct attention to Vestas as an attractive workplace. One of the initiatives is the Vestas Graduate Programme, a two-year programme aimed at young candidates. Comprising 19 participants from Europe, North America, the Middle East and Asia, the programme will continue to expand in the years ahead.

Compensation programmes

In 2006, Vestas introduced Mercer's International Position Evaluation System, which categorises all managerial positions across national boundaries. This helps to make Vestas into a global business that goes beyond its Scandinavian roots to offer competitive compensation at all Group locations. The Group has also launched a performance management programme for its managers. The programme is directly linked to Vestas' Compensation and Reward programme aimed at building a performance-driven corporate culture.

In 2006, Vestas set up an incentive scheme for the Vestas Government and selected senior executives of the Group, covering a total of 20 people. The scheme comprises bonus and options that entitle the holder to buy shares from the company's holding of its own shares. Options are awarded on the basis of the Group's financial performance in 2006 and 2007, respectively. The benchmarks used for the award are EBIT, net working capital, market share and customer satisfaction.

Bonus programme

As a key component of The Will to Win, Vestas has introduced a bonus scheme, effective from 1 January 2008, which is linked primarily to the performance of the Vestas Group and, to some extent, to a number of sub-targets defined for the business unit of each individual employee. The bonus takes into account factors such as EBIT margin, cost-efficient design and customer loyalty. If the defined targets are achieved, an employee with one year's seniority would get a bonus of 5% of his or her annual basic salary, corresponding to a total of approximately €45m for all Vestas. The maximum bonus is 8% of basic salary.

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Case Study 1

People before megawatts

"The most important resources for Vestas' continued development are the expertise, power to act and determination of our employees. Competence development and recruitment are therefore key issues for Vestas, and in 2007 we are taking on an average of five new employees a day. This growth, too, presents a considerable challenge, but it is a precondition for Vestas' ability to fulfil its leading role in the new energy picture, where modern energy is to help raise the standard of life for more and more people in more and more countries." (Ditlev Engel, Vestas President and CEO).

Organic growth and the People Pipeline are two terms continually used by top management to emphasise this challenge. The first covers a natural and internal capacity expansion; the second refers to the human resource challenge in recruiting, motivating, training and developing a skilful and competent workforce.

"We focus very much on our organic growth, and this is why we are posting a huge amount of money into our People and Culture department. The People Pipeline is to ensure that Vestas attracts, develops and retains the best employees from all over the world. And as we say in our mission statement: failure is not an option," says President and CEO Ditlev Engel.

The task of attracting, developing/training and retaining an increasing number of employees has been labelled Vestas People Pipeline.

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Figure 1: Mitigating risk by taking in people ahead of growth (+80%)

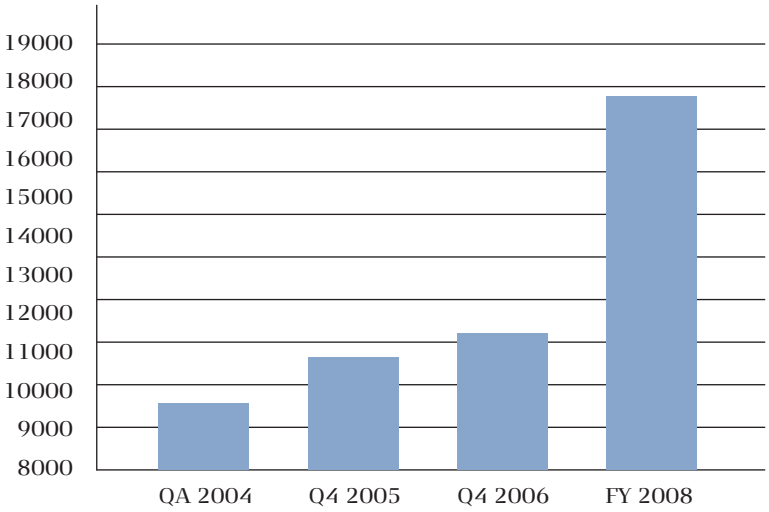
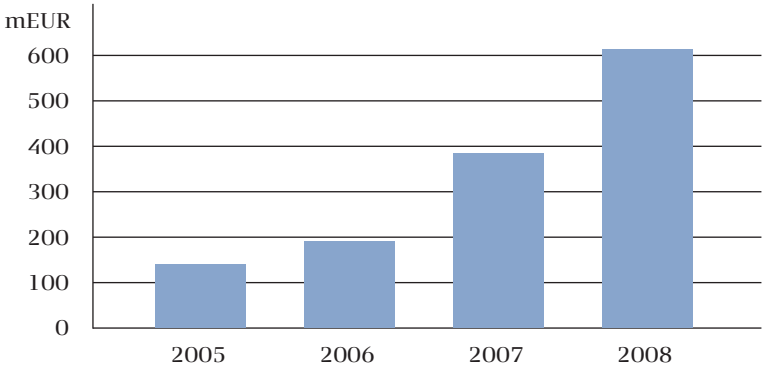


Figure 2: Massive investments (+450%)



Building employee skills at all levels and recruiting new colleagues are crucial activities for Vestas. That was the case in 2006 and it will continue to be the case for many years to come. People and Culture is not merely something people talk about at Vestas—it is an area in which the company invests substantially.

It is crucial to Vestas that growth does not damage product quality. In an industry marked by heavy demand this is quite a challenge, and it puts two of Vestas' core values—care and development—to the test. Both values should power the company's growth. More specifically, this involves boosting capacity according to a principle referred to as "people before megawatts". In other words, Vestas recruits and trains its employees before increasing production. This means that sometimes capacity costs increase more rapidly than revenue. The strategy helps to ensure better order and project execution, however, as more experienced employees will be managing the growth. With this principle in mind, the number of employees increased considerably during 2006, from 10,618 at the beginning of the year to 12,309 at the end, despite revenue growth of

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only 8%. The increase in the number of employees was evenly distributed between sales and service units, production units and corporate functions. By the end of 2007, Vestas had grown even more, reaching 15,305 employees.

This principle also applies to the new factories that are being built or which recently started production: two new factories in China for hub and nacelle assembly and production of generators, and blade factories in the US and Spain. At the same time, Vestas invests heavily in R&D facilities that will yield the reliable and robust wind power systems of the future. Combined, these measures provide the foundation for high-quality products. The new facilities represent total investments of more than €400m, clearly demonstrating the massive capacity expansion Vestas is currently making.

Challenge

Discuss the terms "organic growth" and "People Pipeline" in relation to the growth strategy that Vestas has adopted. What HR challenges do these raise and what should the People and Culture BU consider when implementing the constitution projects?

Identify and explain the various HR practices in Vestas. Assess their relative importance and their alignment to both Group strategy and the People Pipeline, including vision, mission and financial targets.

Why is top management so concerned with strategic alignment across the various business units?

Identify and assess Vestas' current and future needs for skills and competences based on strategic intent, challenges, etc. What requirements should the People Pipeline meet to encompass this, how should it be designed, and what should be its main ways of attracting, developing and retaining the right people?

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Case Study 2
Employer branding challenges

To sustain its leading position in wind power, Vestas needs to improve the recruitment of students, young and senior professionals in engineering and business, and skilled workers in the target countries of Denmark, India, China, Spain, Germany, Italy, Singapore and the US.

In the last decade, Vestas and the wind power industry in general have had to fight for credibility and ownership of brand elements like "reliable", "established", "safe" and "environmentally sound". Vestas' position language and campaigns were focused on grouping wind with oil and gas, for clear reasons. However, times are changing. Environmental and corporate social responsibility movements have challenged companies across the globe to re-evaluate the way they do business and, in the most immediate sense, how they talk about themselves internally and externally. This has created a shift in corporate and employer branding—instead of competing on size and scope, many companies now compete on the growth rates of their investment in communities and the environment.

Market environment

It is hard to generalise about the employer market environment, because Vestas competes for talent in so many areas. In general, however, the company is facing a rapidly changing global marketplace, as the new generation of graduates reflects a new set of group identities. The global trend is towards identities that are less national, and aspirations that balance personal accomplishment with a global career and social responsibility.

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In Europe and America, in particular, the new generation saw all of the hard work and long hours invested in the 1980s and 1990s with little or no return. They seek more balance in their lives and are less likely to sacrifice quality of life in the present for the possibility of economic freedom later. Instead, they want a better quality of life now while they pursue financial success later in life as well. Although graduates of the new global generation pose a challenge in shaping recruitment and communication practices towards their preferences, they also bring significant advantages to Vestas. Because graduates worldwide now tend to show similar preferences with respect to employers, the environment, planning their time and so on, Vestas as a global company will be able to address an entire generation with one global strategy.

Other target groups, including older professionals and skilled workers, still have differences in their career preferences based on the country-specific recruitment market situation.

Competitive environment

With headquarters in Randers, Denmark, Vestas is currently the world leader in wind technology and a driving force in the development of the wind power industry. Its footprint is worldwide. From a product standpoint, competitors include Gamesa, Enercon, Siemens, GE Wind Energy, and Suzlon. From a recruiting standpoint, however, the company competes with companies like BMW, IBM, Grundfos, Danfoss, and Infosys—a broad array of companies that, like Vestas, are global leaders in their respective industries. However, most of these competitors operate in industries and markets that are far better understood by the target audience than the wind power business. Vestas is therefore competing first with overall awareness of other industries, and then with individual brand awareness of these companies.

The survey

To understand how Vestas is perceived internally and externally, by current and potential employees, as well as to confirm its desired profile among target candidates, Vestas has started to collect both quantitative and qualitative data worldwide. The Group has surveyed and conducted focus groups with students, young professionals, senior professionals and skilled workers in eight countries (Denmark, Germany Spain, Italy, Singapore, China, India and the US), as well as its current employees in each marketplace. The quantitative data was used to determine which themes should be considered for the Employer Value Proposition to define how the company should position itself as an employer, as well as how it should communicate and build relations with its recruitment target groups in ways that are attractive to potential employees, respectful of current employees, and in line with Vestas management's vision of its employer brand. The qualitative data helped to answer questions about why each theme should be considered and why certain communication channels should be explored. Together they have helped Vestas to better understand itself, its target market, its goals, and ways to get there.

The results of the survey showed that in Denmark, all prospective audiences are aware of Vestas and familiar with the company as an employer, but do not know how Vestas might be a good match for their skill sets. In all other countries, awareness of the wind power industry as a whole, as well as of

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Vestas as an employer, is quite low. Only 4% of senior professionals and 5% of young professionals/students would ideally like to work in the energy/power industry. Once they are educated about the wind energy industry, though, they become interested. Overall, students worldwide indicated that they get employer information through websites, campus visits, career fairs, acquaintances and media reports.

Employer value proposition

The results of the survey have contributed to the definition of Vestas' employer value proposition: the intersection of what the company is (identity), what it wants to be (profile), and how the outside world sees it (image). These components were measured and detailed by the research outlined above and, following a review of the IPI gap analysis (see Figure 1), the following set of values were formulated as the company's unique employer value proposition. They represent the soul and personality of Vestas as an employer:

Driven

- Willpower
- Challenging working tasks
- Taking initiative, desire to innovate, passion for our work, "guts to fight", "face the challenge"

Global

- No. 1 in Modern Energy
- Global employer offering international career opportunities
- International workforce, global teams

Learning

- Focus on innovation for commercial success
- Opportunities for professional development throughout the organisation
- Attracts and develops the best workforce to develop market leadership
- Continuously learning from customers and new technologies

Sustainable

- Facts about modern energy
- Credible energy source for present and future
- Vestas' expectations for the wind power industry in 2020

Open

- Open to new ideas, challenges, and innovations
- Open and honest dialogue
- Open towards all cultures

Respectful

- Respect for individuals and their development
- Mutual respect among colleagues
- Employees are trusted to plan and perform their work
- Respect for the environment
- Facts on greenhouse gas emissions
- Responsible and caring; serious about quality and safety

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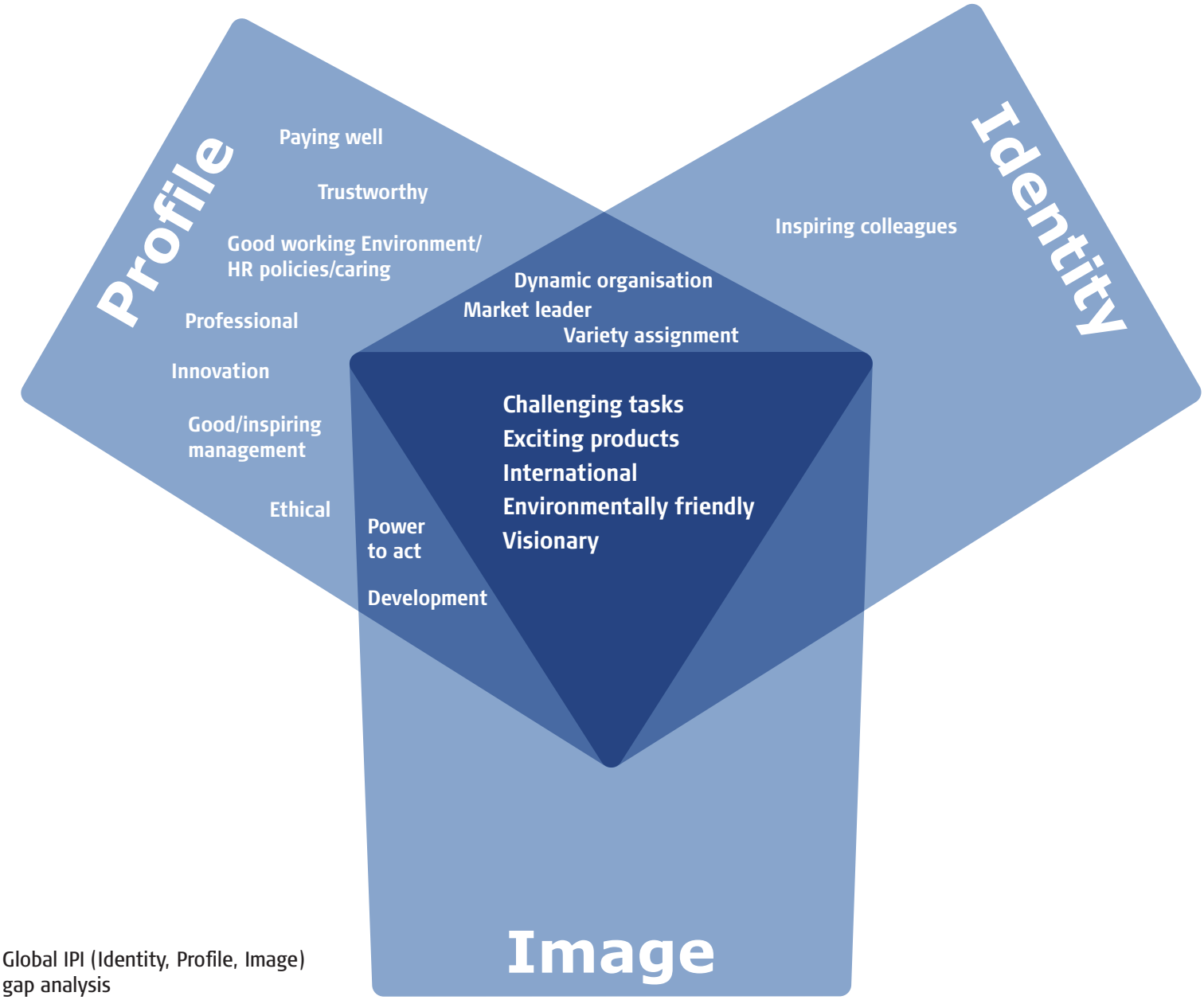

Figure 1: Global IPI (Identity, Profile, Image) gap analysis

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Challenges

Discuss employer branding and what challenges Vestas is facing in terms of its massive expansion and recruitment needs.

Vestas management has set the following short-term and long-term goals in relation to its employer branding efforts. Taking into account the overall human resource challenges the company is facing, both externally and internally, discuss what strategic employer branding initiatives Vestas should undertake to reach its goals.

Short-term (one year)

To be a more attractive employer in the eyes of current and future employees.

When students and young professionals in target markets, and current employees, are surveyed one year later, the values they associate with Vestas will begin to reflect the values in the company's EVP.

Vestas' external image, internal identity, and desired profile will match one another more closely than today.

In particular, internal research will show that all core values will be within the Profile and Identity of the IPI gap analysis.

For non-Danish target countries: increased awareness of the wind power industry in general and of Vestas' offerings as an employer in particular.

For Denmark: increased pool of candidates who understand Vestas' offerings and consider the company as an attractive employer.

Long-term (three years)

To be a leading employment brand in every market in which Vestas recruits.

When students and young professionals in target markets, and current employees, are surveyed, the values they associate with Vestas will mirror the values in Vestas' EVP.

Discuss specific suggestions on how Vestas can brand itself to potential employees in India, the US, Southern Europe, China and South America.

Should the employer branding strategy differ between these countries, and what are the main barriers?

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Case Study 3

Corporate social responsibility

The vision of becoming No. 1 in Modern Energy is closely related to the image and brand of Vestas Wind Systems. Producing "clean, sustainable energy" and having a "green profile" is not enough to meet this target. Vestas needs to maintain and excel on this issue in everything the company does, whatever the activities are and wherever they are located. Accordingly, top management has focused intensively on the CSR message both internally and externally.

Jakob Larsen, Director of Safety and Environment, was well aware of this issue. Reading an article in the UK newspaper *The Independent* which labelled Vestas "the greenest company in the world", he reflected on the ever-increasing expectations the company needed to live up to: "While other companies are fighting a tough battle to improve their environmental profile as perceived by the outside world, Vestas' challenge in this area has more to do with continuously ensuring the greatest possible accordance between the positive perception the outside world has of the company and the realities."

Jakob knew that in many areas Vestas was a particularly green company; not only on account of its products and their positive influence on the climate and the environment, but also due to a succession of environmentally friendly initiatives, like, for example, the fact that two-thirds of the electricity that the Vestas Group consumes now comes from sustainable sources. But was that enough? What more could be done to ensure that Vestas was measuring up to its stakeholders' expectations? The Vestas Government wanted him to present more possible ideas for global CSR initiatives which could increase the company's positive contributions to the communities it operates in.

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A case of best practice came from Vestas India, a unit with a very proactive and innovative approach to CSR. But was this a case that could be adapted for the company's other markets?

Jakob was browsing the report he had just received from the CSR manager in India: "CSR in India is more external. We believe that it is the responsibility of every corporation to give something back to society. It of course provides intangible benefits for the company in many ways. We do it in very small way in India, but there are other corporations in India who extend the effort much further." (Madhu Kumar, Communications Manager, Vestas India, 2007)

In the previous year several local CSR initiatives had been set up in four main areas: health, education, environment and training. Today, the various initiatives relate to either wind farm project areas, areas in and around the corporate offices, or tailor-made programmes for employees and corporate houses.

The objectives for CSR in Vestas India are:

- Create and strengthen goodwill in society through need-based initiatives for smooth functioning of projects, project development and customer service activities at new and existing wind farm sites.
- Ensure a blend of time, effort and money, rather than simply chequebook donations.
- Make CSR not just an activity but a movement that makes a difference.
- Create a positive image of the brand among the Vestas family, employees, local community, customers, vendors and corporate houses.
- Encourage employee volunteering and public-private partnerships.

The four CSR programs initiated by Vestas India over the last year are summarised below:

Health

The main objective of the health programme was to provide need-based healthcare services to neighbourhood groups in partnership with the Government Health Department, NGOs and others. Awareness workshops were conducted to influence local groups on health and hygiene. Another objective of the programme was to create employee involvement in local problems. So far, eight health camps have been established at seven wind farm sites: Ravengaon, Brahmanvel, Gudhe Panchaghani, Tenkasi, Adivelli, Pukullam and Suraj Bari. Overall this has benefited 3,800 families.

Education

The education programme was designed to identify and provide financial assistance to meritorious students from rural areas, especially girls and families with first-generation school pupils. An educational committee to monitor the progress of students was also to be established.

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Other objectives for this programme were:

- "Talent expos" where students can exhibit and enhance their skills
- Career guidance programmes for under-privileged school children
- Special programmes for mentally ill children.

As a result of these initiatives, 85 educational scholarships have been granted so far, primarily for children in rural areas. Talent Expos have been launched in ten schools, reaching approximately 750 children. 11 schools have been provided with school furniture and educational aid from 75 part-time teachers, and regular sports and especially cricket tournaments have been set up.

Environment (1)

The objectives of this programme have been:

- Recycling and reuse
- Promoting alternative livelihood
- Greening of Mother Earth (tree planting)
- Conducting awareness campaigns on environmental protection
- Advocacy on wind energy in terms of environmental sustainability and decreased pollution.

So far, 650 trees have been planted in a Global Mother Earth Campaign. Advocacy for wind energy, in the form of local presentations about wind farms, have increased awareness of Vestas and the industry as a whole.

Environment (2)

This programme has trained young people, mostly from tsunami-affected areas, in carpentry skills. They recycle wood from Vestas packaging to make school furniture and educational aids. The finished products are to be donated to deserving schools, mainly near Vestas wind farm sites. Currently, 25 young women and men are being trained at the Life Skilled Carpentry Centre. The Centre is a joint initiative between Vestas India and Aid-India, a Chennai-based NGO that promotes alternative livelihood skills and recycling of wood.

Employee volunteering programmes

Besides the initiatives described above, a number of employee volunteering programmes (EVPs) have also been set up to promote the involvement of Vestas employees in CSR. These events seek to build a positive image of Vestas, sensitise employees to societal issues, and build teamwork among different departments. Each year all programmes are checked by both external and internal assessors to ensure that they meet their objectives and to suggest new ideas.

Examples of such initiatives include:

- A day out with NGOs organised for employees.
- A blood donation campaign in three locations: Chitradurga, Kongal Nagar and corporate headquarters.
- A screening of the global warming movie *An Inconvenient Truth* for employees.
- Street theatres to sensitise employees to health and hygiene issues.
- Awareness campaigns on preventive measures for various diseases.

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Local and global CSR strategies

Vestas executives are considering making India an example of best practice in CSR, and want to assess the potential of expanding the ideas used in India to other markets like China. In the light of the corporate strategy No. 1 in Modern Energy and the CSR initiatives in India, how can Vestas transfer local experience into a more global CSR strategy?

Challenges

Discuss CSR and why the concept is gaining momentum around the world. What issues does it raise to the managers of a corporation? Is CSR a strategy that all companies can or should pursue?

Why are Vestas India's CSR initiatives controversial, and something to be discussed by top management? Discuss the initiatives from both stakeholder and shareholder perspectives. What are the motives behind Vestas' local CSR strategy, what does Vestas India hope to gain from these initiatives, and why have they chosen exactly these areas to focus on?

What is the potential of transferring experience from these projects to other local business units? What are the barriers? Are the same initiatives relevant in, for example, the Americas or southern Europe?

Discuss the position of CSR effort in the entire Vestas group from both global and local perspectives. What are the managerial challenges? How can Vestas ensure both global and local consistency in the messages the business units represents?

Supply Chain Management

Vestas: a Supply Chain Organisation

Case Study 1: Supplier loyalty
Case Study 2: Measuring supplier's performance
Case Study 3: Competitor aggression

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Vestas: a Supply Chain Organisation

Learning objectives

High growth rates in the wind industry are putting great pressure on the entire supply chain. Vestas faces a major challenge in ensuring sufficient and timely high-quality supplies from a number of key suppliers.

To improve this situation Vestas has put in place a series of strategic and operational initiatives. These include the introduction of Six Sigma for production and the downstream supply chain, a supplier loyalty programme, and scorecards to quantify supplier performance.

This collection of case studies explores how initiatives like these can increase the competitiveness of a company, and how they can be aligned with corporate strategy.

Keywords

- Six sigma, supply chain management, supplier performance

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High growth forecasts for the wind power industry

As the world's largest manufacturer of wind power plants, Vestas is dedicated to lifting the entire capacity of the supply chain so that the company can capitalise on the huge growth potential shown by the market. Vestas expects that wind power's present share of about 1% of global power generation will grow to at least 10% by 2020. The targets for renewable power in the EU and China are 20% and 15%, respectively, by 2020, and the US is expected to adopt similar targets. With these figures, global installed capacity is set to rise from 75 GW in 2006 to at least 1,000 GW in 2020, equivalent to annual growth of more than 20%.

Such high growth puts a great deal of pressure on the entire supply chain, however. Vestas faces a big challenge to ensure sufficient and timely high-quality components from a number of suppliers. The present situation is costly for both Vestas and its suppliers. More professional collaboration with suppliers is necessary to improve execution ability on both sides and to realise the earnings potential behind the Vestas vision of "Wind, Oil and Gas".

The wind power industry is characterised by intensifying competition: driven by expectations of high market growth, manufacturers are expanding in an attempt to secure a strong portfolio of customers and profitable projects. Despite increased government support for national green energy initiatives, political and governmental risks create market uncertainties. As clients have become larger and more demanding, both products and projects have become more complex. Reliability of products and operations have become the key competitive measures in the industry, putting pressure on both internal and external supply chains.

Component shortages and quality issues

In recent years the industry has suffered from a shortage of both components and skills. The continuously increasing demand, which despite increased capacity still exceeds supply, threatens overheating. Long and expensive lead times on key components are therefore expected to remain an issue for years to come.

Especially because of its size, Vestas has faced great challenges in securing sufficient capacity and timely deliveries of quality components. With lead times up to 15 months, a stable supply of key components is crucial to Vestas' ability to fulfil its obligations. Vestas is currently trying to limit the risks by signing long-term framework agreements and intensifying working relationships with suppliers.

Vestas also aims to have at least two suppliers for every strategic component. Figure 1 below is taken from the accounts for 2005, the year of the company's worst financial performance (an EBIT margin of –3.2%). This shows the domino effect that key component shortages have on the delivery and overall performance of the company:

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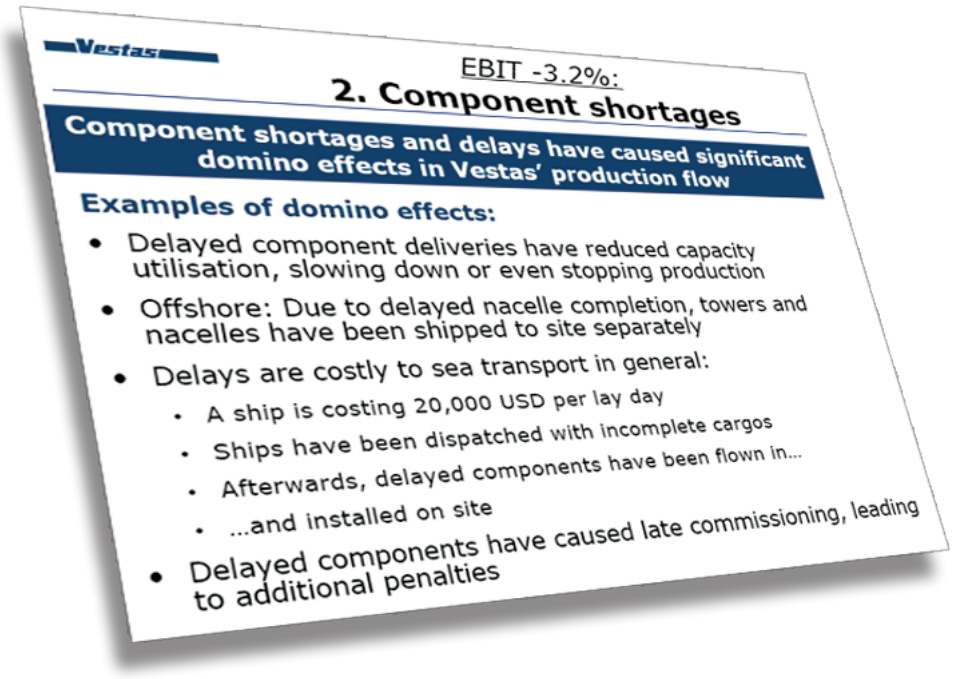
Figure 1: Domino effects in Vestas' supply chain performance (2005)



Reliability (delivery, product longevity, capacity) is another key competitive parameter in the industry, and Vestas' ability to deliver on its service and maintenance commitments is also crucial in the near future. Whilst clients are willing to take on more development risk in exchange for a focus on reliability, these issues can potentially stifle a company's plans to develop and expand. Because Vestas manufactures globally, the company is far more affected by long lead times than most of its competitors, who operate primarily within selected geographic regions.

The lack of reliability in several of the company's products was the main cause of the poor financial performance in 2005, when, despite a 52% increase in revenues, Vestas made a loss of €116m. Most of this was from an extraordinary increase in warranty provisions, caused by faulty components in turbines delivered, and from delays caused by shortages of key components.

To respond to the challenges of the supply chain and support the Will to Win corporate strategy launched in 2005, Vestas has redefined its production and sourcing strategies and made organisational changes covering structure, roles and responsibilities within the supply chain.

Overall production strategy

The main objective of Vestas' production strategy is "to achieve a system that produces a continuous flow of materials and products driven by a fixed and level production plan, with maximum flexibility and based on LEAN concepts". The management has defined four key factors:

- small and frequent deliveries to keep stock levels low
- stable production plans
- the ability to respond quickly to customer requests
- eliminating waste and reducing stocks.

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Overall sourcing strategy

Securing key supplies is the most important precondition for capitalising on the high growth potential of wind energy. Accordingly, the Vestas Government has set strategic objectives for sourcing:

- "As the world's leading manufacturer of wind power systems, Vestas will be present in the new fast-growing markets"
- "Vestas will source in low-cost countries to secure more competitive prices"
- "Vestas will source more in US dollars, since in the current situation the company is vulnerable to currency fluctuations"
- "Vestas will never depend on only one supplier"
- "The mission statement "Failure is not an option" applies to strategic suppliers as well as Vestas"
- "Vestas will prefer suppliers that are present in all the key regions, as this increases flexibility for Vestas"
- "Vestas wants its strategic suppliers to follow its expansion from Europe into the global world of wind energy."

The globalisation challenge

Historically, Vestas has sourced components from European suppliers—companies with high levels of technical skill and proven service performance. As more and more of the company's turnover is being generated outside Europe, however, it has become necessary to supplement the existing network of suppliers with new partnerships.

Figure 1 shows the current geographical locations of Vestas' production units and key suppliers. Although the strategic suppliers are concentrated in Europe, other regions are catching up fast as economic and educational conditions improve. This trend is also visible in Vestas' sourcing strategy, where the company's "global/local" ambition shows increasing awareness of the advantages of local representation in terms of transport costs, market access and market intelligence.

Buying components from suppliers in western Europe and selling the resulting turbines in other markets has exposed the Group to major exchange rate fluctuations. One goal is therefore to establish procurement in currencies other than euro. Another is to reduce purchase prices through improved market knowledge, including local conditions such as the requirement in the Chinese market to have 70% local production, cost synergies and control of currency exposure. This goal was one reason why Vestas opened a procurement office in Shanghai, China, in 2005.

The technically complex main components of Vestas turbines are developed and manufactured in collaboration with existing suppliers, many of whom are currently working to set up operations outside Europe. As such, these companies will be significant in the globalisation of Vestas' supply chain. The aim of setting up the Shanghai procurement office was thus primarily to build relationships with Asian companies that can supply the less complex components such as steel fittings, small machined parts, plastic units, cables and screws.

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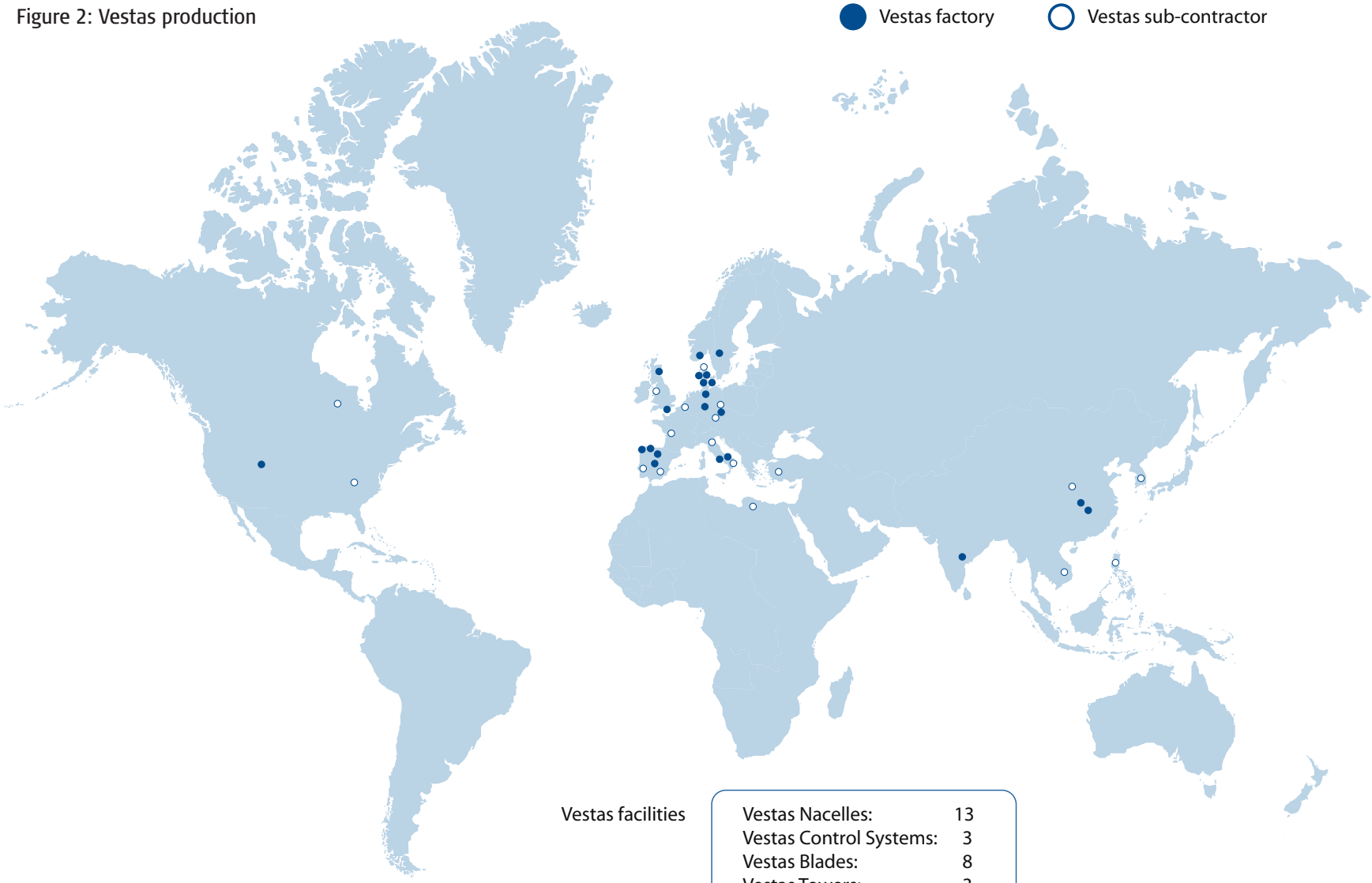
Figure 2: Vestas production



Vestas facilities

Vestas Nacelles:	13
Vestas Control Systems:	3
Vestas Blades:	8
Vestas Towers:	3

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In the medium term, the intention is to build a real Asian supply chain, furthering Vestas' strategic plan to becoming a global player through local presence—which naturally involves a large number of local partnerships. At the same time, sourcing larger volumes of components in Asia will make Vestas less dependent on the euro exchange rate, and this position will be further strengthened by the establishment of factories outside EU.

Overview of Vestas' supply chain organisation

In a growing market, Vestas is distinguished by a high degree of vertical integration, manufacturing most components that cannot be purchased from external suppliers in standard or slightly modified forms. By manufacturing the principal parts of the turbine itself, Vestas increases the flexibility of its product development, reduces its dependence on suppliers, and maintains its high level of manufacturing know-how. Figure 3 shows the company's value chain:

Vestas has four Production Business Units:

- Vestas Blades A/S: manufactures blades
- Vestas Towers A/S: manufactures towers
- Vestas Control Systems A/S: manufactures controllers
- Vestas Nacelles A/S: manufactures nacelles, including castings, machine parts and generators.

In addition to the four Production Business Units there are six Sales Business Units and a Technology R&D Business Unit. The company also has several corporate support functions and a People and Culture Business Unit, located at the headquarters. Figure 4 shows the responsibilities of each unit within the supply chain:

Figure 3: Vestas value chain

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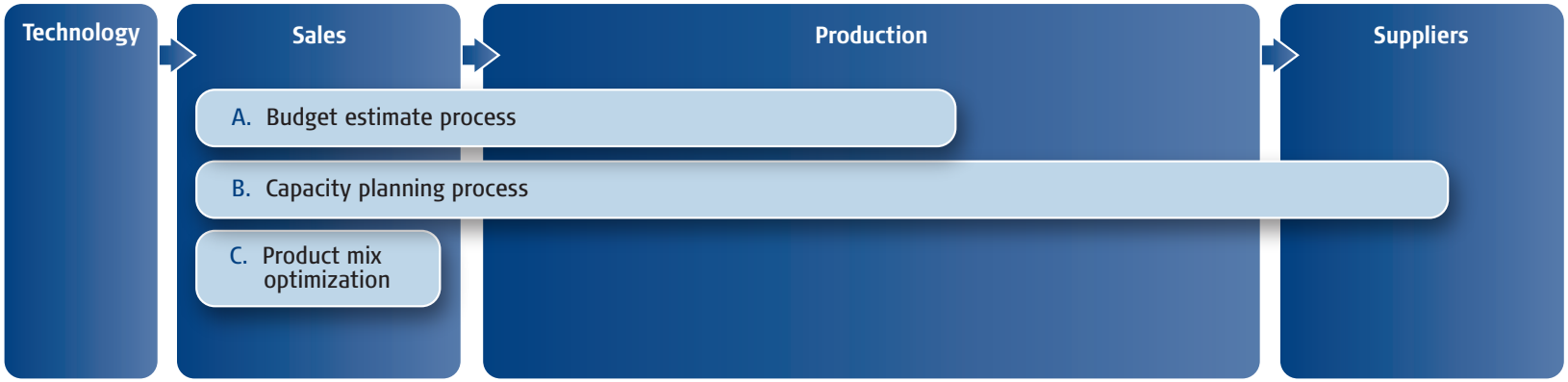
Figure 4: Vestas supply chain: who is responsible?
Information and materials flows within Vestas Supply Chain (SUs = Sales units, PU = Production Unit, PBU = Production Business Unit, SBUs = Sales Business Units)



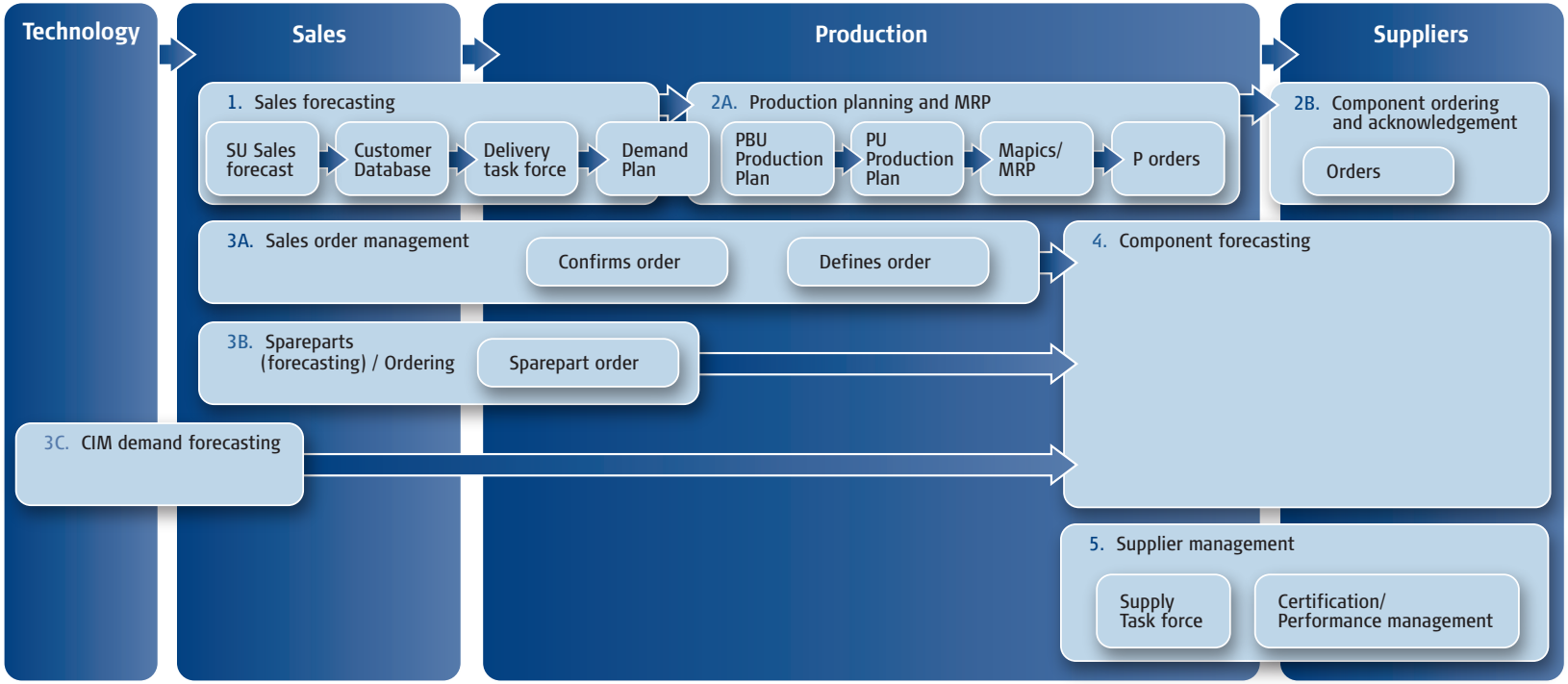


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Figure 4 shows the flow of information and materials within the Vestas supply chain, together with the frequency of each process.

The blue arrows (left to right) represent information flows within the supply chain. Planning and production for every new turbine starts with interest from a customer (1. Sales forecasting) or an order (3A. Sales order management). This information feeds into the demand plan and subsequently into the production plans (2A Production planning and Materials Resource Planning), and thence into the MRP system which generates purchase orders. Subsequently, local buyers ensure execution of the component purchase orders in coordination with the suppliers (2B Component ordering and acknowledgement).

In addition to this primary flow, there are several other supporting flows of information:

- The cross business units budget estimate, capacity planning, and product mix optimisation processes (A+B+C)
- Spare-parts ordering (3B) and CIM demand forecasting (3C), both of which feed into the component forecasting process which is run by the purchasers as they confirm capacity with suppliers (4).
- The supplier management process, representing tasks such as supplier performance management, certification of new suppliers, and negotiations (5).

Improving product quality: Six Sigma

As part of the 2005 corporate strategy The Will to Win, Vestas launched a corporate-level initiative—a "constitution project" in Vestas terms—to improve product quality by bringing the concepts of Lean and Six Sigma to its production and supply chain. The aim was to reduce the amount of money wasted through inadequate quality, referred to as COPQ—Cost Of Poor Quality.

With the introduction of Six Sigma, Vestas can now measure in detail the quality of products and processes at both its own production units and its external suppliers. Even small improvements in the Sigma level can generate appreciable savings and other benefits for all the parties.

For example, if an error is detected before an item leaves the supplier's factory, the cost of fixing it might be €1,000. If the error is not picked up until the item reaches Vestas' production line, the associated cost rises to €10,000. And if the defective component passes unobserved through the entire process and is installed in a wind turbine at a site, the total cost of repairing the fault will be around €100,000.

For 2008, the company has set the goal of reaching Four Sigma both internally and at key suppliers. The reason it is so important to raise the Sigma level is that this directly reflects the degree of control of the Critical To Quality (CTQ) process. The Sigma level is thus a measurement of variance in the process, and is therefore crucial to the uniformity of product quality.

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Sigma level

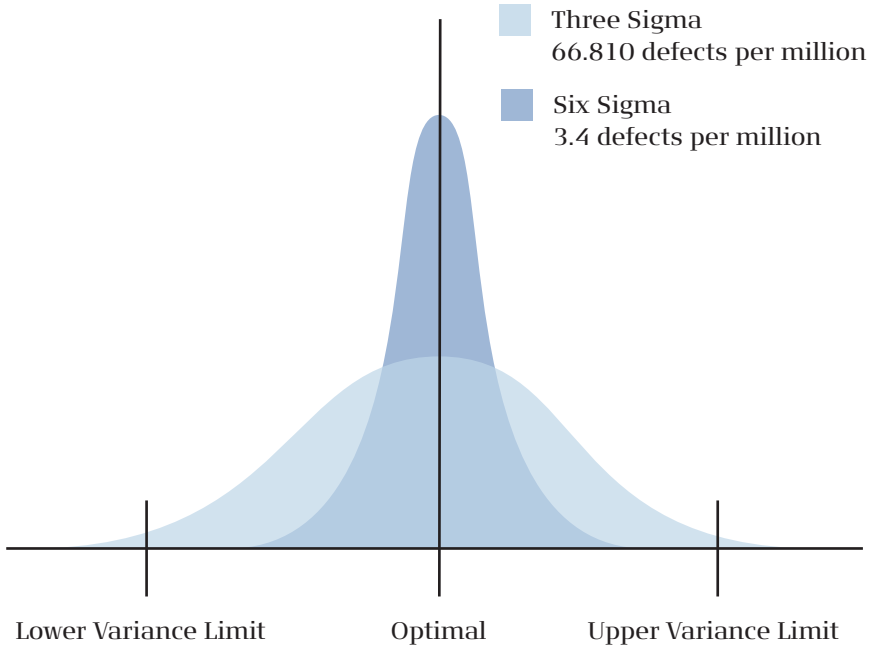
The Sigma level is a measure of how much variation exists in a process, compared to the specification limits of the process. Figure 5 shows values of a process variable, for instance the measured length of a machine part, plotted against the frequency with which these values occur. The graph also shows the specification limits: the acceptable upper and lower values for the size of this part, based on the original engineering design.

To calculate the Sigma level it is first necessary to work out the mean and the standard deviation of the measured values. The Sigma level is then simply the number of standard deviations that fit between the mean value and the nearer of the two specification limits.

The Sigma level shows how many products or processes could potentially fall outside the threshold values and therefore constitute defects (such as too small or too large a shaft diameter) if the defect management process fails. Table X shows the relation within Vestas between the Sigma level and the number of defects per million opportunities (DPMO):

Figure 5: Six Sigma

Sigma level	Defects Per Million Opportunity
1	697.700
2	308.700
3	66.810
4	6.210
5	233
6	3.4



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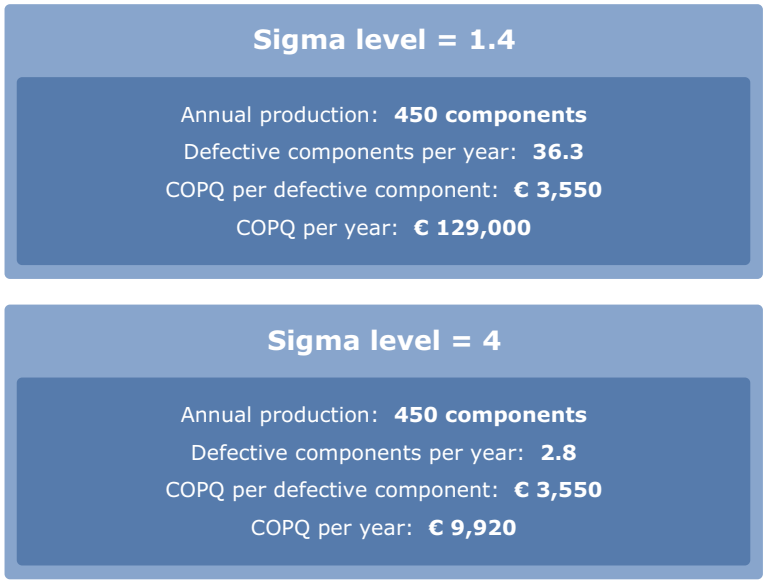
Calculating the Sigma level

The performance of a supplier with a Sigma level of 1.4 clearly indicates that the benefits of raising the "Sigma bar" are not just theoretical. The supplier in this example manufactures shafts for wind turbines. Including both direct and indirect expenses, it is possible to calculate the total COPQ (Cost of Poor Quality) of a shaft that exceeds the maximum permissible diameter. Raising the Sigma level from 1.4 to 4 helps the supplier in question, and Vestas, to save €119,080 a year.

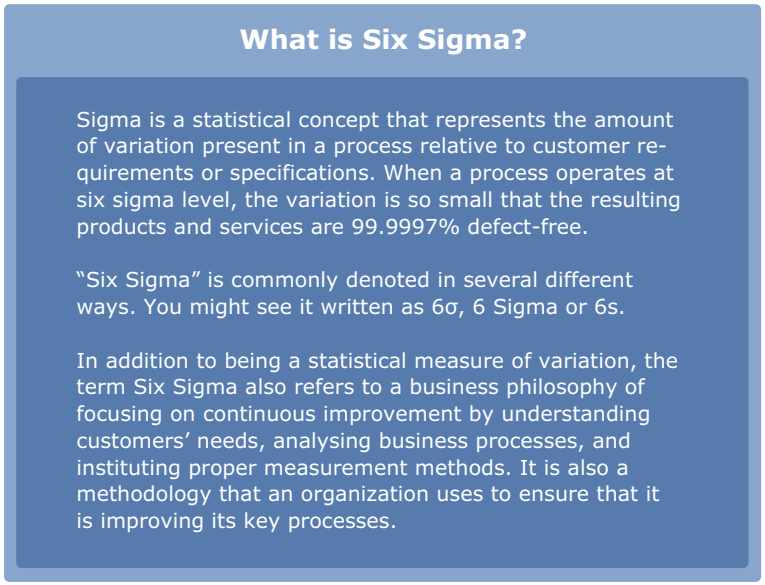
Figure 6: Calculating the Sigma level



Sigma levels for the company's strategic suppliers. A key effort in this direction has been the creation of a Supplier Development Group which will work with key suppliers to assess their current Sigma levels and improve these through the use of standard tools such as PPAP (Production Part Approval Process).

Side thoughts

Figure 7: What is Six Sigma?



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Challenges

What are the main challenges Vestas faces in connection with the high growth potential of the market and the industry's trend to globalisation?

How can the company overcome and avoid bottlenecks in its production process created by the shortages of key supplies?

What initiatives should the management take to convince its key suppliers to build capacity outside Europe?

Can Vestas prevent another increase in warranty provisions? How can the company reduce the impact on its bottom line of product quality faults? Can some of these costs be avoided or transferred to the suppliers?

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Case Study 1
Supplier loyalty

"It is essential to remember that the performance of our suppliers depends on our own performance. You could say that with our supplier loyalty concept we are taking a dose of our own medicine."

Søren Husted, President, Vestas Nacelles

The following material is an edited excerpt from the November 2006 edition of Vestas Win[d], the company's external magazine:

Customer loyalty has long been a focus for Vestas. With the annual customer satisfaction survey as a key performance indicator, work is under way on pointing this section of the Group's value chain in the right direction.

When the Presidents of Vestas' four Production Business Units and Vestas Technology R&D got together at the end of 2006 and sketched out the first draft of a holistic—and unconventional—approach to working relationships with suppliers, the plan constituted quite a shift in attitudes to the value chain. Even the title of the project, "Supplier Loyalty", indicates a new approach: after all, why devote time and energy to reinforcing ties with suppliers? Surely all they have to do is live up to their obligations and otherwise provide good service?

"The world is not that simple today," explains Søren Husted, President of Vestas Nacelles, the man with ultimate responsibility for the project. "Fundamentally, we are increasing our requirements on our suppliers' performance. But it is essential to remember that their performance depends on our performance, so you could say that with our Supplier Loyalty concept we are taking a dose of our own medicine."

Søren goes on to explain that the challenges stem especially from the fact that today many suppliers have multiple contacts with Vestas: "We have to admit that as things stand today our suppliers do not always receive the same signals. That is why Supplier Loyalty largely has to do with calibrating the processes and producing a more uniform approach to supplier partnerships."

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Side thoughts

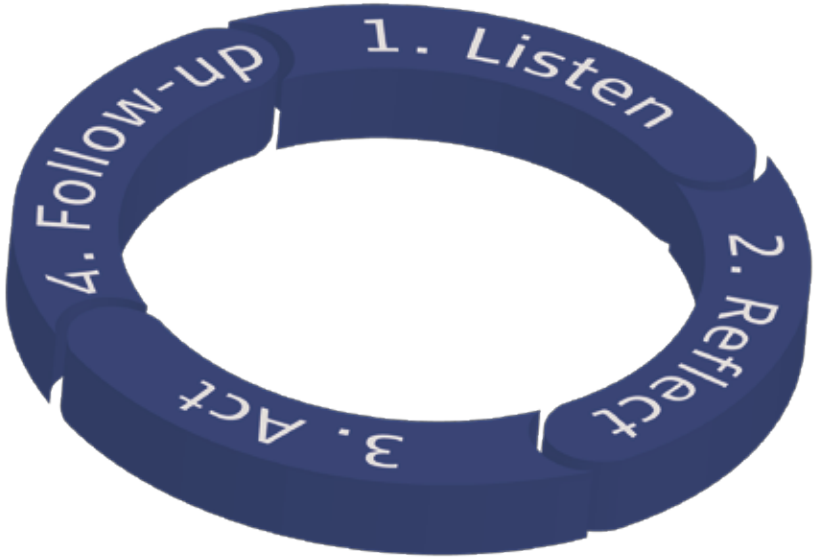
In all, the four production units work with approximately 1,500 suppliers who manufacture a variety of parts and components for the company's wind turbines. The suppliers are based all over the world, in countries including Australia, Canada, China, Denmark, Egypt, France, India, Italy, Korea, Mexico, South Africa, Spain, Great Britain, Germany, Vietnam and the United States

Søren Husted is convinced that the project will yield specific information about areas where there is room for improvement. Subsequently, he expects to deploy improvement initiatives throughout the value chain. These initiatives will improve Vestas' performance in relation to customers, and this in turn will have a positive domino effect on customer loyalty. According to Søren, the Supplier Loyalty project is a long-term, proactive initiative that will help the Vestas supply chain achieve its goal of world-class performance—at present still a long way off.

Constructive dialogue

The Supplier Loyalty project is firmly rooted in Vestas' new Global Capacity Planning department. Amir Farooq, Project Manager, explains that there are many parallels between the new plan for suppliers and the customer loyalty programme Vestas calls "Dialogue for Development". Supplier Loyalty has four phases: Listen, Reflect, Act, and Xxxx. The first three of these have been carried over from Dialogue for Development.

Figure 1: The four supplier loyalty phases



Listen up

"In the 'Listen' phase, Vestas carries out structured telephone interviews with suppliers—just like in the Dialogue for Development programme," says Amir. He stresses that during this phase, strategic suppliers are given unlimited opportunity to comment on the working relationship and to highlight both positive and less positive aspects. "One of the key aspects of the concept is constructive dialogue, and here, honesty is

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absolutely crucial. At the same time, it is an aspect that carries obligations, because in this context, 'constructive' means backing words up with actions. Otherwise, we will simply end up with a lot of well-meaning words and good intentions without having made any progress," says Amir.

Loyalty is a two-way street

In connection with Supplier Loyalty, the very concept of loyalty needs to be seen in a broad context. It is not simply a question of whether or not a supplier wants to carry on supplying Vestas. "Mutual loyalty between Vestas and the supplier largely has to do with the willingness to pursue shared goals for improvement," Amir emphasises.

"We are already well aware that our own commitment to the working relationship is crucial to the results we achieve, which is why in practice, this project actually starts in the internal arena. We have to encourage the entire organisation to take a more uniform and holistic approach to suppliers. The aim is to recognise, to a much larger extent, that we are dealing with real partnerships based on mutual dependence, rather than conventional customer/supplier relationships."

From words to action

Once the strategic suppliers have provided their input in the form of answers to questionnaires and interviews, Vestas analyses the results and draw up proposals for improvement. Each draft is presented to the supplier in question at a follow-up meeting, where the entire survey is examined and discussed in detail—in an atmosphere conducive to open and constructive dialogue. "On the basis of these follow-up discussions, we work together with the supplier to draw up a specific action plan and launch improvement initiatives," says Amir. The initiatives in a particular action plan might have to do with everyday communication, for example, long-term production planning, or the wording of contracts. Amir makes it clear that both Vestas and the supplier are expected to make an effort to improve performance.

Shared framework for product development

While the four Production Business Units are busy optimising partnerships with their various suppliers through the Supplier Loyalty programme, Vestas Technology R&D—the Vestas Business Unit for technology and development—is working to expand its external partnerships. In this context, relationships are crucial to results.

"At Vestas we pursue integrated product development. This is why smooth collaboration with our suppliers is vital," explains Finn Strøm Madsen, President of Vestas Technology R&D. He believes that all the players in the wind power sector are facing a major challenge in professionalising the value chain and building up greater mutual understanding of each other's businesses. In this regard, he considers supplier loyalty to be key.

Finn Strøm Madsen stresses that during the initial phase of the project, the focus is very much on operational performance. This means that the Production Business Units' supplier relations must take centre stage. "In the longer term, however, I expect us to develop the concept to include research and development," he says.

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To highlight the fact that supplier partnerships are crucial to the work carried out at Vestas Technology R&D, Finn Strøm Madsen also points out that the new "home" of this business unit—currently being built in Skejby, close to Aarhus in Denmark—includes facilities for suppliers. "We will be giving them the opportunity to work side by side with us at times, and they will also have access to our new state-of-the-art test centre, which we are currently constructing at the harbour in Aarhus," he says.

Supplier Scorecard

In the future, the Supplier Loyalty initiative will interact closely with another important initiative to empower Vestas' suppliers: the Supplier Scorecard. According to Amir Farooq, these two concepts together will provide a fine balance between identifying where suppliers need to improve, and establishing where Vestas would do well to turn the spotlight on itself. "You could say that the Supplier Scorecard is the everyday management tool, focused on the transaction part of our working relationship with the supplier," he says. "Supplier Loyalty focuses more on relationships *per se*, and on future-oriented, proactive actions."

Global launch on track

By early 2008, Supplier Loyalty had been rolled out to Vestas' 110 biggest suppliers. The process began with the "Listen" and "Reflect" phases so that, according to Søren Husted, the company should be in a position to present specific results and an overall loyalty index on Suppliers' Day in April 2008.
"We are already well under way with the interviews and with action plans for the first set of suppliers, and it is no secret that I am very keen to get my hands on the data," says Søren Husted. "I said at the start that with Supplier Loyalty we will be taking a dose of our own medicine. To continue the metaphor, I am convinced that in both the short and the long term, the project will give Vestas a healthier relationship with all its loyal and skilled suppliers."

Challenges

Why is Vestas launching the Supplier Loyalty programme? What makes it worth the considerable financial cost?

What does "supplier loyalty" mean? Can Vestas really trust its suppliers?

What is a strategic supplier?

How close is Vestas' collaboration with suppliers in general, and how does the focus on quality fit into this picture?

How does the relationship to suppliers affect Vestas in regard to competitive advantage?

How can Vestas make itself less dependent on its suppliers, while making the suppliers more dependent on Vestas?

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Case Study 2
Measuring supplier's performance

It could be argued that securing key supplies is the main risk Vestas faces today. This implies the need for better supplier-buyer relations. To secure and increase output stability, Vestas needs better joint planning and cooperation with suppliers. In effect, the supplier situation and lack of collaboration are the primary obstacles to Vestas' plans to expand in Asia and elsewhere. To reduce the risk, it is vital to identify potential strategic partnerships with key suppliers, and to reduce the costs of monitoring and controlling suppliers of standard components.

Mitigating supplier-related risks

Vestas currently differentiates between strategic suppliers and suppliers of standardised components. Vestas classifies suppliers using a two-by-two matrix based on the Kraljic model (see below) which takes into account the economic importance of the purchase and the complexity or difficulty of the purchasing process.

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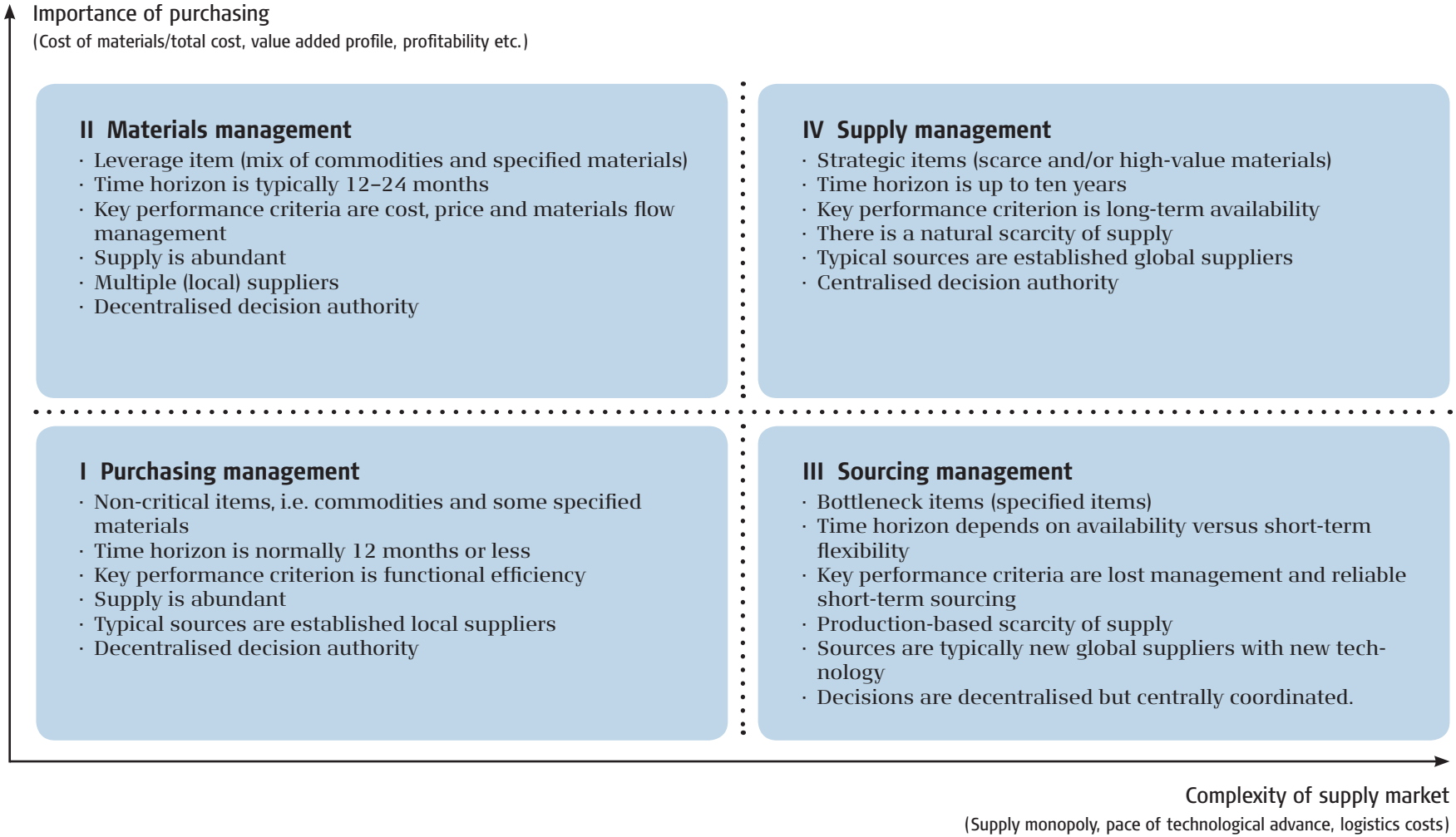
Figure 1: A purchasing management portfolio [adapted from Kraljic, 1983]



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Vestas has identified as strategic suppliers around 150 companies, most associated with the Nacelles Production Business Unit. The Kraljic model (economic importance and difficulty of the purchase) is not the only way to define a strategic supplier. For Vestas, strategic suppliers include any company for which Vestas has unique design requirements, or where there is no alternative supplier, or where the sourced product is a key component of the wind turbine.

For each of these suppliers, the strategic purchaser at each PBU carries out a risk assessment based on cost, availability and quality. Vestas uses a performance management system to monitor the behaviour of its strategic suppliers. The system is based on standardised supplier scorecards containing 14 KPIs (see below). The KPIs measure timely delivery, the number of times orders have been changed, and the number of non-conforming deliveries (deliveries that must be returned to the supplier). Figures 2 and 3 shows a typical supplier scorecard.

The scorecard system provides a consistent and objective way to assess risk and evaluate performance. The benchmarks for the KPIs of each supplier are related to their specific industries. Vestas discusses performance with each supplier every month; critical problems are referred to the Vestas Government through the GCP unit. For each strategic supplier, Vestas has a dedicated supplier development team. These teams work with suppliers to control emerging risks, deal with quality certification, and help with the Lean and Six Sigma programmes.

Figure 2: Example of a supplier KPI scorecard

KPI	Target
1. Supplier delivery accuracy (%)	95
2. Supplier delivery capability (%)	95
3. Shortages of critical components in 12-week production plan	N/A
4. Secured critical components (%)	95
5. Capacity assurance of critical components this year (%)	95
6. Capacity assurance of critical components next year (%)	95
7. Production plan stability, nacelle (%)	95
8. Production plan stability, hub (%)	95
9. Production plan backlog, nacelle (units)	0
10. Production plan backlog, hub (units)	0
11. Production vs. budget, nacelle (MW)	0
12. Production vs. budget, hub (MW)	0
13. Production vs. estimate, nacelle (MW)	0
14. Production vs. estimate, hub (MW)	0

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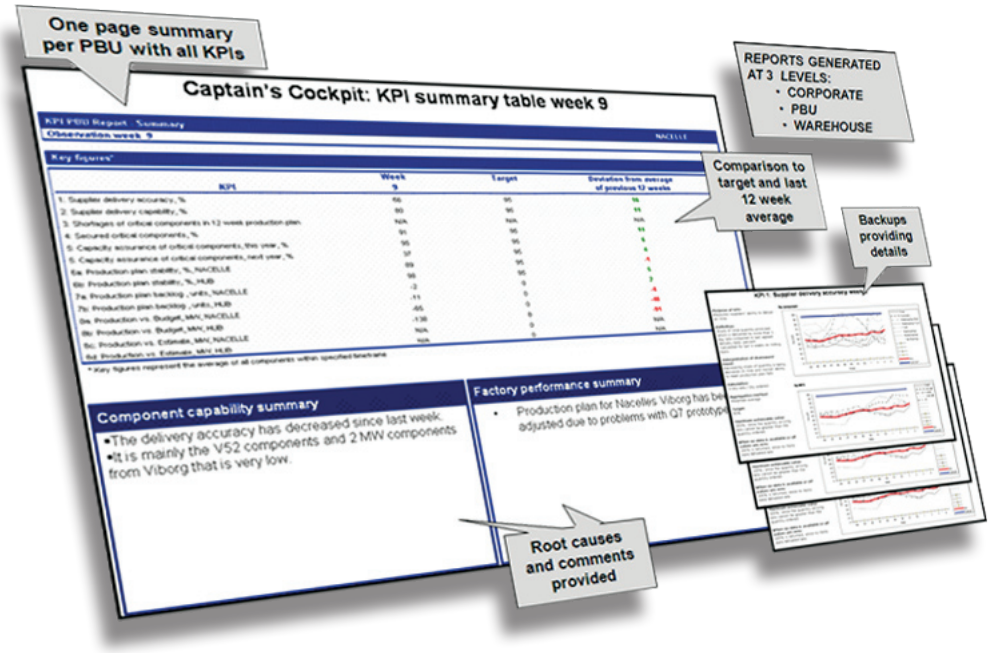
Figure 3: Example of a supplier scorecard



Challenges

How does Vestas define a strategic supplier? How effective do you think these criteria are? What are the advantages and disadvantages of the current supplier segmentation model? Can Vestas improve the segmentation of its suppliers?

What does Vestas want to achieve through supplier scorecards? What are the challenges and pitfalls when implementing performance measures in the downstream supply chain?

What is Vestas measuring with the 14 KPIs on the supplier scorecards? Are these measures aligned with the overall strategy of the company? How effective do you think these KPIs are? Can the performance measurement system be improved?

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Case Study 3
Competitor aggression

At a capacity planning meeting, Vestas managers were discussing the shortage of gearboxes. In the last year the supply of gearboxes had become an increasing concern, as very few suppliers were able to meet Vestas' quality requirements and deadlines.

Traditionally, wind turbine manufacturers have outsourced their gearboxes. Gearboxes are a core component of wind turbines, however, and as demand for turbines has increased, so has the demand for gearboxes. With relatively few gearbox suppliers in the marketplace, wind turbine manufactures have come to consider gearboxes a strategic component and some are even beginning to in-source production to ensure a reliable supply. Vestas has not yet done this, but with fewer and fewer independent gearbox suppliers, the threat of stifled growth through a shortage of gearboxes is becoming serious.

Recently one of Vestas' most important suppliers, gearbox maker Hansen Transmissions of Belgium, had been acquired by the Indian turbine manufacturer Suzlon Wind Energy. Vestas' top management was becoming worried. Gearbox supply was now seen as the primary bottleneck within Vestas, and something had to be done. The top management in Vestas—the Government—gathered to discuss general sourcing strategy and especially the threats and opportunities facing the critical supply of gearboxes.

One of the management team made a presentation on strategic sourcing issues and how Vestas planned to establish more partnerships with strategic suppliers to avoid becoming completely dependent on single suppliers. The gearbox situation was a clear signal that this was a real danger, especially in the light of Vestas' extensive need for both global and local suppliers.

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Gearbox suppliers

This section gives an overview of the companies supplying gearboxes to the wind energy industry.

Figure 1: Overview of gearbox suppliers in the wind energy industry

Gearbox manufacturers	Wind turbine manufacturers										
	Acconia	Ecotecnia	Fuhrländer	Gamesa	GE Wind	Mitsubishi	Nordex	Repower	Siemens	Suzlon	Vestas
Winergy				X	X		X	X	X	X	X
Hansen				X					X		X
Moventas	X			X	X			X			X
L&S		X		X	X			X			X
Eickhoff				X			X	X			
Echesa				X							
GE					X						
JaKe			X								
Ishibashi						X					
RENK								X			

Source: MAKE Consulting, 2006.

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Figure 1 shows that Vestas has four gearbox suppliers: Winergy, Hansen Transmissions, Moventas and L&S. Winergy, which is owned by Siemens, is the biggest supplier of gearboxes in the wind energy market. The second-largest supplier, Hansen Transmissions, was acquired by Suzlon in 2006. Moventas is controlled by the Nordic private equity firm, Industri Kapital 2004 Fund. L&S, the smallest of the four, is owned by the Bosch-Rexroth Group.

Figure 2: Forecast capacity for selected gearbox suppliers

MW capacity	2006	2007	2008
Winergy	6000	7500	8500
Hansen	4600	4600	6000
Moventas	2000	2000	2500
L&S (Bosch Rexroth)	1200	1000	2500
Eickhoff	600	1000	1200
Echesa	500	1200	1200
GE	400	600	500
JaKe	200	200	–
Ishibashi	200	200	500
RENK	100	100	150
Nanjing			500
Total	15,800	18,400	23,550

Source: MAKE Consulting, 2006.

Figure 2 shows forecast increases in production capacity (MW) for the various gearbox suppliers. Table 3 shows Vestas' sales figures (MW delivered) for the last five years.

Figure 2 shows there are a few large gearbox suppliers, and also that it is the largest suppliers who are forecast to grow most in the next few years.

The discussion at the capacity planning meeting revolved around Vestas's options to ensure a reliable future supply of gearboxes. Something had to be done to avoid a bottleneck. Vestas' closest competitors had apparently made their choices, and now Vestas needed to meet the challenge.

Figure 3: Vestas sales (MW delivered)

Vestas	2006	2005	2004	2003	2002
MW delivered	4.239	3.185	2.784	2.667	2.670

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Challenge

What options does Vestas have in regard to the future supply of gearboxes?

What would be the implications of an alliance with, for instance, Moventas, in regard to both R&D and sourcing issues? Which is the best approach?

Side thoughts

(From a Suzlon press release)

- Suzlon Wind Energy in Agreement to Acquire Belgium's Hansen Transmissions
- Press Release from Suzlon Energy Ltd
- Pune, India / Munich, Germany

Suzlon Wind Energy signed a definitive agreement for the strategic acquisition of Hansen Transmissions. Hansen Transmissions is a major wind turbine gearbox manufacturer with state of the art manufacturing facilities in Edegem and Lommel in Belgium. Suzlon gains technological leadership from the integration of research and development, design and production to evolve the next generation of more reliable wind turbines.

Suzlon Energy Limited ("Suzlon") announced today that its subsidiary, AE-Rotor Holding BV based in the Netherlands, has entered into definitive agreements to acquire Hansen Transmissions International NV ("Hansen"), based in Belgium, one of the largest wind energy and industrial gearbox manufacturers in the world, for €465m (USD 565m) enterprise value, in an all-cash transaction.

The transaction is subject to merger control approval and on completion will result in Suzlon acquiring shares of "Eve Holding", the holding company of Hansen from private equity firms Allianz Capital Partners GmbH and its affiliates and funds advised by Apax Partners Worldwide LLP.

Suzlon intends to fund the transaction using a combination of Suzlon's internal cash reserves and credit facilities. Acquisition financing for this transaction is being underwritten and syndicated by Barclays Capital, Deutsche Bank AG and ICICI Bank. YES Bank is the sole financial advisor with Linklaters Oppenhoff and Radler, Cologne and Khaintan and Co. as legal counsel to Suzlon for this transaction. UBS Investment Bank is acting as financial advisor and Hengeler Mueller as the legal counsel to the sellers.

In a statement made on this occasion, Mr Tulsi R Tanti, Chairman and Managing Director, Suzlon Energy, said, "The acquisition of Hansen gives us technological leadership and will make Suzlon a leading integrated wind turbine manufacturer in the world. Although the company will be run as an independent business unit, the acquisition of Hansen will allow us to integrate gearbox technology into the total turbine solution enabling a more reliable and competitive product in the marketplace. We find Hansen's technology, products and production facilities to be of the highest quality."

"The company has an excellent management team and over a period of time we will work with them in developing supply chain synergies, expanding capacity in Belgium and develop-

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ment of additional capacity in new emerging markets in Asia. We would like to welcome the Hansen team across the World into Suzlon. Hansen's strong presence in the industrial gearbox market is also an important dimension of the business and we see a good opportunity to strengthen it further."

Hansen Transmissions International NV ("Hansen"), headquartered in Belgium, is a leading gearbox and drive train manufacturer with strong R&D capabilities and modern manufacturing facilities. Hansen has a focus on the fast growing wind turbine generation sector and is also active in other industrial segments of the gearbox market. The Company was founded in 1923 and its primary manufacturing facilities are in Belgium, with sales, assembly and service centres in the UK, US, South Africa and Australia. It currently employs 1200 engineering and management professionals spread across these establishments. Hansen's current manufacturing capabilities include 3,600 MW of wind turbine gearboxes and 3,000 units of industrial gearboxes per year.

Today, Hansen designs and manufactures its wind turbine gearboxes in association with the leading global wind turbine manufacturers and its product specifications range from outputs of 1.5–3 MW, torques of 700–3500 kNm and weights of 14,000–22,000 kg. It has a proven track record in developing new products with the research and engineering capability needed for the new generation of larger wind turbines. Hansen's product range in the industrial gearbox segment consists of core standardised products covering various applications in the torque range of 6–800 kNm. The Company provides customised products and drive package solutions to suit the customer's requirements. For the year ending March 2005, Hansen had total sales of €213m.

Commenting on the transaction, Mr Matts Lundgren, President and CEO, Hansen said, "The entire management team is very pleased with this opportunity. The deal has the ability to fuel further growth in Belgium and in Asia. At Hansen we will have business as usual, managing ourselves as an independent business unit, and we shall continue to strive to exceed customer expectations. We are appreciative of the trust and confidence shown by Suzlon on the management team's ability to grow the business."

Describing this as a significant milestone, Mr Girish R. Tanti, Director International Business Development and HR, Suzlon Energy, said, "Hansen is an efficiently run business and the quality of team and manpower has been most impressive. Hansen has a healthy order book position for the next two years and we expect the business to be managed in the same manner as the management has very ably done over the last couple of years. We are pleased to have emerged as the successful bidder."

Mr. Aditya Sanghi, Country Head-Investment Banking, YES Bank, said, "With this acquisition Suzlon has truly emerged as a global player with significant market presence, manufacturing base and R&D centres across North America, Europe, India China, South Korea and Australia. With a presence across the entire turbine technology chain, we see Suzlon becoming further cost competitive and providing an efficient and robust wind energy solution to its customers."

Finance

Vestas: a Growing Company

Case Study 1: The effect of external shocks
Case Study 2: Creating a financial forecast
Case Study 3: Maximising wealth for shareholders

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Vestas: a Growing Company

Learning objectives

- Assessing different forms of risk exposure in a global manufacturing company
- Forecasting from external sources and taking into account unforeseen shocks in financial projections
- Analysing company and market data to make a financial evaluation of the company

Keywords

- Business risks, maximising shareholder value, financial forecasting

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Navigating in a fast-moving power industry

Vestas installed its first wind turbine in 1979 and since then has played an active role in the fast-moving wind power industry. Starting as a pioneer with a staff of approximately 60 in 1987, today Vestas is a global market leader employing more than 14,500 people. Vestas is the leading producer of high-tech wind power solutions.

Between 1987 and 1997 Vestas saw strong organic growth, rapid international expansion and technological innovation. The company's international growth was largely through subsidiaries set up in India (1987), Germany (1989), Sweden (1992), the US (1992) and Spain (1994). In terms of technology, Vestas has over the years decreased the cost per kW of wind power by steadily increasing turbine size.

A successful initial public offering in 1998 provided a boost to the company's already strong growth. The shares were eight times oversubscribed and the company raised €175m of fresh equity capital, which it used among other things to finance new international subsidiaries and production facilities. Since then, increasing political emphasis on cutting our dependence on conventional energy sources had led to subsidies and other measures that have escalated the demand for wind turbines. This market growth has helped Vestas become a strong player in a very global business.

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Case Study 1

The effect of external shocks

As Vestas has become increasingly global, the company has found itself exposed to a number of potential risks. When presenting the third-quarter 2007 financial results in London, President and CEO Ditlev Engel pointed out the deteriorating euro/USD exchange rate and escalating prices for steel, oil, gas and coal price as the "megatrends in modern energy". These uncertainties are forcing the world to rethink the balance between its various sources of energy. A plummeting euro/USD rate, for instance, could have important consequences for the modern energy sector.

The paragraphs below explore some of the risks that are relevant to Vestas: foreign exchange, state subsidies, and warranties.

Exchange risk

For Vestas, the US market is important. In 2006, the US accounted for 654 MW, or 15.5% of Vestas' total sales (see Appendix); Germany was the only country with bigger sales (788 MW). Although data for the first half of 2007 suggests a lower absolute demand from the US (248 MW), this is 17.2% of total sales. North America (the US and Canada) accounted for sales of €849.0m, out of a total of €3854.3m.

Wind power in north America has a promising future. In August 2007, for example, a new energy tax bill with a four-year extension of the Production Tax Credit (PTC), plus a new incentive for small wind turbines, passed to the Senate. A separate energy policy bill with a 15% national Renewable Portfolio Standard (RPS) and an extension of the clean renewable energy bonds programme has also been legislated.

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On the supply side, Vestas' aggressive growth strategy in the US and China implies that a large volume of US dollars will need to be mobilised for capacity-building investments in the US. The targets for 2009 are:

- Blades: 50% expansion of the new Colorado plant (US)
- Towers: a new production facility to be established (US)
- Nacelles: machining factory and foundry to be established (China)
- Controls: new cabinet facilities to be established (China)

These large inflows and outflows of USD give Vestas significant foreign exchange exposure. The challenges are to predict exchange rates in the years to come, and to find new ways to hedge against currency risks.

As the sidebar shows, many economists believe that the downturn of the dollar is gathering momentum (Figures 1 and 2).

Side thoughts
Why the dollar is looking greener than usual

Thanks to the Fed's surprise rate cut, the greenback has "turned garishly green around the gills", says Alan Abelson in Barron's. Falls across the board have left the US dollar at a new record low against the euro—more than $1.41 to the euro—and at parity with the Canadian dollar. Against a basket of six major trading partners' currencies, the USD has plummeted to a 15-year low.

The rate cut lowered the yield on the dollar, so the prospect of more rate cuts as the US economic outlook darkens implies further weakness; Ian Stannard of bnP Paribas reckons the euro may breach $1.45 in weeks . But a longer-term issue is also coming to the fore. America's ten-year Treasury bond yield ticked up by almost 0.2% last week, and gold hit a 27-year high of over $730 an ounce, reflecting fears that the rate cut, along with record oil prices, could fuel inflation. The US depends on foreigners scooping up its assets to plug the gaping current account deficit.

Trust in the US authorities' inflation-fighting credentials "is one of the pillars that support the trade deficit", as Edward Hadas points out on Breakingviews.com. If foreigners decide they will no longer accept US securities because they are worried about inflation eroding their value, the dollar's decline could turn into a rout; most economists anticipate a 30%–40% slump if this happens. (MoneyWeek, September 28th 2007)

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Challenge 1

Consider the assumptions in the following financial forecast, and assess the effect of a 30% slump in the USD on Vestas' profitability in 2007.

Financial forecast 2007

2006:

- Revenue €3.85 bn (+8%)
- EBIT 5.2% up from –3.2%
- NWC 3%
- Operating CF +€450m
- Global market share ~28%
- Constitution projects well under way

2007:

- Sufficient Vestas capacity
- Main risks are quality and timely component deliveries
- Revenue ~€4.5 bn (+17%)
- EBIT 7–9%
- NWC ~20%
- Investments in property, plant and equipment €310–330m
- Investments in intangible assets €50–60m

2008:

- Will to Win objectives sustained
- Comment on possible actions, such as real options, that Vestas could use to counteract the effect of the falling USD.

Warranty risk

According to US Bancorp, spare parts in the US alone cost $700 bn, or 8% of GDP. Industries pay out bns in warranty costs: the North American automotive industry, for instance, spends $10 bn on warranty service each year. Warranty cost matter, and they can affect any company's bottom line. Very often warranty can be linked to differentiation, customer loyalty, brand reputation and lifetime value. With warranty having such a multitude of consequences, it is not difficult to see why so many companies are adopting quality improvement programmes to increase the reliability of their products.

Vestas has chosen the Six Sigma philosophy and has now finished the first stage of implementation, which focuses on internal improvements. The company is now ready to embark on the second stage, which delivers external improvements. The transition from internal to external focus is reflected in the change of company strategy from "The Will to Win" to "No. 1 in Modern Energy".

Ditlev Engel, President and CEO of Vestas Wind Systems, says that the company and its suppliers are very close to the Four Sigma performance standard, and he believes that Six Sigma is definitely achievable in the near future. His slogan "Failure is not an option" clearly reflects this determination.

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Challenge 2

Vestas: "For us and our suppliers, Four Sigma is a prerequisite for growth in profitability beyond 2008". For the questions that follow, assume that Vestas and its suppliers reached Four Sigma at the end of 2006, not the end of 2008. Use figures from the Appendix, with the following additional notes:

Warranty provisions in 2006 were €50m higher than anticipated:

- €26m due to commercial settlements (announced in Q2);
- €24m due to faster implementation of upgrades.

The standard warranty period for new contracts is two years. Previously, warranty periods were 2–5 years.

Turbine reliability is improving steadily.

Discuss the impact of Six Sigma performance on warranty provisions and Vestas' subsequent financial results, if the estimated cost of poor quality is attributed solely to warranty provisions.

Forecast these figures through to 2010.

Figure 1: Warranty provisions (€ m)

	2006	2005	2004
Warranty provision at 1 Jan	221	148	98
Exchange rate adjustments	(2)	5	(2)
Acquired business	--	--	86
Provisions for the year	174	127	87
% of revenue	4.5%	3.5%	3.7%
Extraordinary provisions	--	106	--
% of revenue		3.0%	
Used warranty provisions	(188)	(165)	(121)
Warranty provisions at 31 Dec	205	221	148
Due in less than one year	139	138	85
Due in more than one year	66	83	63

Figure 2: Sigma performance

Sigma level	Defects per million opportunities	Process yield	Estimated cost of poor quality (% revenue)
1.0 σ	670,000	33%	>40%
2.0 σ	308,537	69.2%	30–40%
3.0 σ	66,807	93.32%	20–30%
4.0 σ	6,210	99.38%	15–20%
5.0 σ	233	99.9767%	10–15%
6.0 σ	3.4	99.99966%	<10%

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Government subsidies

The success of the wind turbine industry has to a large extent resulted from policy-led demand. In other words, subsidies influence the decision process, because they can increase returns or reduce risks. More specifically, energy support mechanisms generally aim to increase revenues, improve cash flow and enable new energy sources to compete for capital with investment options in other energy sectors or other industries.

Government subsidies are a double-edged sword: as well as encouraging growth, they can create dependency, and they can be withdrawn suddenly following a change in government or an economic downturn. Unlike the risks discussed above, the subsidy issue is hard to avoid, yet it can undermine revenue and steer the company into financial uncertainty.

A working paper by the UK Energy Research Centre (November 2006), *Investment: Risk, Return and the Role of Policy*, points out that the detrimental effect of the "on again, off again" US Production Tax Credit (PTC) disrupts the entire wind turbine supply chain. This translates into risk for every company along the supply chain. Although everyone agrees on the benefits of PTC in nurturing the alternative energy industry, it is clear that such an incentive represents a large financial commitment from the government, with a corresponding likelihood of temporary suspension during periods of financial difficulty.

Challenge 3

Assume that the US government decides to play it safe by reducing the PTC substantially to lessen the financial burden after a prolonged period of economic downturn. Assume that the knock-on effect of such a decision is equivalent to a 20% drop in US demand.

Assess the effect of this on Vestas' profitability in 2007.

Are there any ways in which Vestas could counteract such an effect?

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Case Study 2

Creating a financial forecast

Steffen is a new recruit in Vestas working as an assistant finance controller. His manager has asked him to evaluate some recent external publications. More specifically, Steffen is going to assess whether Vestas' own capacity growth will meet the ambitious forecast put forward by the European Renewable Energy Council. The comparison would be used as a point of reference when considering future capacity expansion.

Steffen's manager has already found plenty of evidence to support a rosy outlook for the wind turbine industry into the foreseeable future. One example is Vestas' backlog of orders for the next two years, which is typical of a growing industry in which demand outpaces supply. Equally impressive is the recent pace of global capacity growth. For example, annual growth in Europe has been running at 15% or higher for some years. Below are the main points Steffen has gathered about growth drivers for the wind turbine industry, together with some unique features of wind energy.

All around the globe, there is a strong urge to expand capacity in the alternative energy industry to accommodate a rapidly growing market:

- EDP acquired Horizon Wind Energy (2006)
- NRG energy acquired Padoma Wind Power (2006)
- GE Energy acquired AstroPower Inc (2004)
- Suzlon acquired REpower (2006).

In fact, the growth of the global market for renewable energy is nothing short of astonishing: in 2006 its turnover was US$ 38 bn, 26% more than the previous year, according to the report *Energy [R]evolution: A Sustainable World Energy Outlook* by the European Renewable Energy Council and Greenpeace International (2007). The phenomenon can be seen as an

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indication of a new beginning: Sheikh Zaki Yamani, former Arabian oil minister, said: "The Stone Age did not end for lack of stone, and the Oil Age will end long before the world runs out of oil." During this "New Age", world electricity demand will double between 2002 and 2030. This vision is shared by Ditlev Engel, President and CEO of Vestas Wind Systems and one of the main advocates of "modern energy". "Vestas expects global wind power penetration to go from 1% to at least 10%. When this happens, the world will move from 75,000 MW to at least 1,000,000 MW," he says.

This robust growth can be traced to two basic drivers:

- Leaps in technology: wind turbines have come a long way in a short time. From the 55 kW turbines of 1982 to today's 5 MW machines, with rotor diameters growing from 15 meters to 126 meters, the technological advances have been remarkable. On average a modern wind turbine will run for 120,000 hours over its design lifetime of 20 years. A single 1 MW turbine on a good site can power 650 households. Over the years, generating costs have fallen by 80%, and since there are no fuel costs or CO_2 emission expenses, this form of alternative energy has taken the world by storm. The bottom line is that wind energy is now becoming very cost effective.

- Global warming and governmental green policies: many countries have provided strong support to energy providers. An example is Germany, with its "feed-in" law offering wind producers a price linked to the retail price of electricity and well above that of fossil fuel. Another well-known example is the US Production Tax Credit (PTC), a form of federal government subsidy. Since its introduction under the Energy Policy Act of 1992, the PTC has provided a tax-deductible business credit of 1.5 cents/kWh (currently 1.9 cents/kWh after adjustment for inflation).

Wind energy has some attractive characteristics that will ensure its competitiveness into the future. These include:

Clean, low-cost energy

Figure 1 illustrates that both the capital and generating costs of wind energy are comparable to those of conventional energy sources. This comparison takes into account the additional costs normally associated with conventional energy production, such as carbon taxes and the cost of carbon capture and storage.

Figure 1: Costs of different generating technologies

Source	Capital cost ($/kW)	Generating cost (cents/kWh)
Coal	1250	2.6–3.0
Conventional gas	400	3.8–12.1
Wind	1700–1800	4.0–6.0
Solar	6000–9000	20.0–32.0
Biopower	1500–3000	8.0–12.0
Geothermal	2770	5.5–7.5
Hydro	1200–3600	3.0–4.0

Source: European Renewable Energy Council, 2007

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Figure 2: Predicted future performance of selected generating technologies, including CO_2 emissions

	2010	2030	2050
Coal-fired condensing power plant			
Efficiency (%)	41	45	48
Investment cost ($/kW)	980	930	880
Electricity generating costs[1] ($ cents/kWh)	6.0	7.5	8.7
CO_2 emissions (g/kWh)	837	728	697
Oil-fired condensing power plant			
Efficiency (%)	39	41	41
Investment cost ($/kW)	670	620	570
Electricity generating costs[1] ($ cents/kWh)	22.5	31.0	46.1
CO_2 emissions (g/kWh)	1024	929	888
Natural gas combined cycle			
Efficiency (%)	55	60	62
Investment cost ($/kW)	530	490	440
Electricity generating costs[1] ($ cents/kWh)	6.7	8.6	10.6
CO_2 emissions (g/kWh)	348	336	325

Source: European Renewable Energy Council, 2007

Figure 2 forecasts the performance of some generating technologies in the period up to 2050, including CO_2 emissions. It is assumed that carbon emissions will fall as technology advances, but this will not necessarily reduce the final cost (generating costs + emissions costs). New technology for carbon capture and storage may require radical restructuring or substantial investment from the utility companies.

Moreover, the costs per tonne of CO_2 emissions are very likely to escalate over time (Figure 3).

Figure 3: Forecast CO_2 costs ($/t CO_2)

Countries	2010	2020	2030	2040	2050
Kyoto Annex B countries	10	20	30	40	50
Non-Annex B countries		20	30	40	50

Source: European Renewable Energy Council, 2007

Hedging fuel price volatility and security of supply: Shimon Awerbuch, a well-known financial and energy economist, has pointed out that there are two ways by which wind energy can help to mitigate the price risks associated with conventional energy:

1. Having wind energy in a power generating portfolio can reduce overall generating costs and risks, even if renewables cost more. This is because renewable energy costs do not correlate with fossil fuel costs. Diversifying the portfolio by including renewables decouples some of the volatility of fossil fuel prices, so the generating portfolio as a whole is likely to perform better.

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2. A macroeconomic phenomenon known as the oil-GDP effect can be significantly reduced by introducing renewables. It has been estimated that Germany, for example, will see a 10% drop in GDP if the price of oil doubles. As Shimon Awerbuch says: "Just a ten percentage point increase in the worldwide share of renewables-based generation is worth $200 bn in avoided GDP losses. [...] When you invest $1000 per kilowatt in a wind turbine, one quarter of that is potentially offset by avoided GDP losses."

Other important characteristics are:

- Unlike fossil fuels, wind energy is free, abundant and inexhaustible.
- Wind energy can be deployed rapidly: compared to, say, a nuclear power plant, individual wind turbines are small. This minimises the time and cost needed to choose a location, get the necessary approvals and build the plant. In fact, Vestas is installing a wind turbine every four to five hours.
- Wind energy is "land friendly": land around wind turbines can still be used for agriculture.

Side thoughts

Cost and risk at a glance

Financial economist Shimon Awerbuch has researched and published at length about the price risks of fossil energy sources and ways to minimise them.
The general impact that oil and gas price fluctuations have on economies translates to what is called the oil-GDP effect. Research into this dates back to the 1940s. Alice Rivlin, for example, calculated that the 1973 oil crisis generated some $350 bn in costs to the US economy. In a 2005 study based on a series of previous analyses, Shimon Awerbuch and Raphael Sauter demonstrate that the development of renewable energy sources has two positive effects: the direct delivery costs of oil and gas drop and macroeconomic losses incurred by the oil-GDP effect are massively reduced. The authors estimate that for the European Union, developing renewables to provide 20% of European energy demand would be compensated to the extent of about a third by way of avoided oil-GDP losses.
Another central point made by Awerbuch is the so-called portfolio approach. Using model calculations the economist proves that a significantly higher proportion of renewables in the energy mix does not drive up electricity prices. On the contrary, steady prices reduce the danger of price fluctuations.

More information and studies on this topic can be found at: www.awerbuch.com

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Challenges

Make financial forecasts for Vestas in 2010, 2020 and 2030. Assume that Vestas maintains a 35% share of the global market.

Re-assess the forecast growth in wind capacity assuming a permanent 15% increase in fossil fuel prices.

Discuss the consequences of a 30% increase in global wind turbine demand accompanied by a 15% increase in fossil fuel prices.

(See Appendix for more financial information)

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Case Study 3

Maximising wealth for shareholders

"The Danish wind turbine producer Vestas is launching a long-term plan with expected growth rates of 20% annually until 2020. With current prices for wind turbines this will generate a tenfold increase in revenue. Industry experts and speculators recognise the ambition as both realistic and achievable." *Borsen* (November 2007)

In the coming decades, many existing power plants in OECD countries will reach the ends of their working lives and will need to be replaced. This means that the demand for wind turbines is expected to increase substantially. The Global Wind Energy Council is confident that by 2020 the wind industry will be a dynamic and innovative billion-euro business.

Ditlev Engel, President and CEO of Vestas Wind Systems, says: "Almost two years ago, Vestas laid out an ambitious new agenda for its business with its simple vision of Wind, Oil and Gas—which describes wind as a source of energy on a par with fossil fuels. Today, less than two years down the road, both scientific results and political statements from all sides indicate that not only is our vision now accepted, but it is seen as a political and environmental necessity."

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The smooth transition of wind into mainstream energy is not without its hiccups. Some of the more prominent issues at present are:

- Bottlenecking: under-invested suppliers have created a chronic shortage of some key components (gearboxes, transformers and generators). Price increases of 10–40% are anticipated.
- Grid compatibility: the need to upgrade the electricity transmission grid is the most important factor limiting the growth of wind power in Europe.

"If we are to increase the pace at which wind power is expanding, politicians will have to back their visions with action in improving the grid—and quickly." — Ditlev Engel, Vestas President and CEO

Challenges

Evaluate the viability of Vestas as an investment by benchmarking the company with its peers.

Assess Vestas' "no dividend" policy and explain its effects on investors' perception of the company.

Compare Vestas with other industry sectors such as utility companies, Internet and software businesses, and airlines. Which industry gives the fairest comparison with a growth stock like Vestas?

What other considerations are needed to ensure that Vestas is really maximising shareholder wealth.

(See Appendix for more financial information)

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Appendix

Financial highlights for Vestas and its competitors

mEUR	2006	2005	2004	2003	2002
Income statement					
Revenue	3,854	3,583	2,363	1,653	1,395
Gross profit/(loss)	461	84	120	150	142
Profit/(loss) before financial income and expenses, depreciation and amortisation (EBITDA)	328	9	64	142	142
Operating profit/(loss) (EBIT)	201	(116)	(49)	74	74
Profit/(loss) after financial income and expenses	161	(158)	(89)	53	60
Profit/(loss) before tax	161	(158)	(89)	54	60
Net profit/(loss) for the year	111	(192)	(61)	36	45
Balance sheet					
Balance sheet total	3,654	3,085	2,881	1,390	1,269
Equity	1,262	962	1.162	613	596
Provisions	265	239	181	166	130
Average interest-bearing liabilities (net)	299	560	625	236	173
Net working capital (NWC)	122	498	686	603	627
Cash flow statement					
Cash flow from operating activities	598	148	(30)	153	(126)
Cash flow from investing activities	(144)	(137)	(201)	(119)	3
Change in cash and cash equivalent less current portion of bank dept	353	(35)	227	15	(106)

mEUR	2006	2005	2004	2003	2002
Financial ratios					
Gross margin (%)	12.0	2.4	5.1	9.1	10.2
EBITDA (%)	8.5	0.3	5.0	8.6	8.9
Operating profit margin (EBIT) (%)	5.2	(3.2)	(2.1)	4.5	5.3
Return on invested capital (ROIC) (%)	11.9	(13.2)	(3.8)	8.1	9.6
Solvency ratio (%)	34.5	31.2	40.3	44.1	47.0
Return on equity (%)	10.0	(18.1)	(6.9)	5.9	7.8
Gearing (%)	13.8	51.2	50.1	40.4	44.5
Share ratios					
Earnings per share	0.6	(1.1)	(0.5)	0.3	0.4
Book value per share	6.8	5.5	6.6	5.8	5.7
Price/book value	4.7	2.5	1.3	2.2	1.7
P/E	52.8	(12.7)	(18.2)	38.6	21.9
Cash flow from operating activities per share	3.2	0.8	(0.2)	1.5	(1.2)
Dividend per share	0.0	0.0	0.0	0.0	0.1
Payout ratio (%)	0.0	0.0	0.0	0.0	23.5
Share price 31 december (EUR)	32.0	13.9	8.8	13.1	9.4
Average number of shares	182,722,520	174,911,173	150,815,322	105,003,966	104,892,414
Number of shares at the end of the period	185,204,103	174,911,173	174,911,173	105,003,966	105,003,966
Employees					
Average number of employees	11,334	10,300	9,449	6,394	5,974

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Peer analysis and performance

GE fundamentals					
GE (USD bn)	**2005**	**2006e**	**2007e**	**2008e**	**2009e**
Layout	149,702	160,732	172,117	184,560	
EBITDA	30,379	30,936	34,622	43,123	
EBIT	22,333	25,692	29,047	32,616	
Net	17,882	20,567	22,957	25,637	
EPS	1.72	1.98	2.25	2.48	
Layout growth (%)		7.4	7.1	7.2	-
EBIT growth (%)		15.0	13.1	12.3	-
EPS growth (%)		15.2	13.4	10.5	-
EBITDA margin (%)	20.3	19.2	20.1	23.4	-
EBIT margin (%)	14.9	16.0	16.9	17.7	-

GE Valuation					
GE	**2005**	**2006e**	**2007e**	**2008e**	**2009e**
EV/Sales	4.90	4.55	4.33	4.19	
EV/EBITDA	24.1	23.6	21.5	17.9	
EV/EBIT	32.8	28.5	25.7	23.7	
P/E	20.7	17.9	15.8	14.3	
K/I	3.43	3.23	2.88	2.79	
ROCE (%)	5.3				
Return data (%)	**-1w**	**-1m**	**-6m**	**-1y**	**-3y**
Share performance (%)	-0.1	3.3	10.2	4.6	5.3
Relative MSCI performance (%)	-0.4	-0.8	0.0	1.7	-15.3

Siemens fundamentals					
Siemens (EUR bn)	**2005**	**2006e**	**2007e**	**2008e**	**2009e**
Layout	88,993	107,946	104,427	110,221	115,665
EBITDA	8,091	9,030	11,867	13,412	14,142
EBIT	4,225	5,059	7,850	8,990	9,832
Net	3,167	3,979	5,894	6,870	6,639
EPS	3.66	4.50	6.53	7.55	7.14
Layout growth (%)		21.3	-3.3	5.5	4.9
EBIT growth (%)		19.0	56.1	14.5	9.4
EPS growth (%)		23.0	45.3	15.5	-5.4
EBITDA margin (%)	9.1	8.4	11.4	12.2	12.2
EBIT margin (%)	4.7	4.7	7.5	8.2	8.5

Siemens fundamentals					
Siemens	**2005**	**2006e**	**2007e**	**2008e**	**2009e**
EV/Sales	0.88	0.78	0.81	0.73	0.57
EV/EBITDA	9.7	9.3	7.2	6.0	4.6
EV/EBIT	18.5	16.7	10.8	9.0	6.7
P/E	24.6	20.0	13.7	11.9	12.6
K/I	2.51	2.25	2.02	1.76	1.66
ROCE (%)	8.4%				
Return data (%)	**-1w**	**-1m**	**-6m**	**-1y**	**-3y**
Share performance (%)	6.0%	4.9%	12.1%	-6.8%	22.8%
Relative MSCI performance (%)	5.6%	0.8%	1.9%	-9.7%	2.1%

Source: Alm. Brand Henton, 2006

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Gamesa fundamentals

Gamesa (EUR bn)	2005	2006e	2007e	2008e	2009e
Layout	2,156	2,787	3,365	3,988	4,499
EBITDA	385	471	605	700	775
EBIT	278	349	439	501	565
Net	179	351	319	377	456
EPS	0.78	1,16	1.31	1.52	1.51
Layout growth (%)		29.2	20.7	18.5	12.8
EBIT growth (%)		25.5	25.8	14.0	12.9
EPS growth (%)		47.9	13.0	16.2	-1.1
EBITDA margin (%)	17.9	16.9	18.0	17.5	17.2
EBIT margin (%)	12.9	12.5	13.1	12.6	12.6

Gamesa Valuation

Gamesa	2005	2006e	2007e	2008e	2009e
EV/Sales	2.28	2.49	2.01	1.66	1.35
EV/EBITDA	12.8	14.7	11.2	9.5	7.8
EV/EBIT	17.7	19.8	15.4	13.2	10.8
P/E	29.6	20.0	17.7	15.3	15.4
K/I	5.68	4.47	3.79	3.31	
ROCE (%)	11.0				
Return data (%)	**-1w**	**-1m**	**-6m**	**-1y**	**-3y**
Share performance (%)	3.5	11.4	13.3%	4.7%	70.1
Relative MSCI performance (%)	3.1	7.3	3.2%	1.8%	49.5

Repower fundamentals

Repower (EUR bn)	2005	2006e	2007e	2008e	2009e
Layout	389	578	816	1,004	1,155
EBITDA	4	25	51	71	60
EBIT	-5	18	43	63	51
Net	-7	9	26	32	32
EPS	-1.28	1.26	3.17	3.96	4.02
Layout growth (%)		48.5	41.1	23.1	15.0
EBIT growth (%)		-446.5	142.8	47.3	-17.9
EPS growth (%)		-198.7	151.2	24.8	1.5
EBITDA margin (%)	1.0	4.4	6.3	7.1	5.2
EBIT margin (%)	-1.3	3.0	5.2	6.2	4.5

Repower fundamentals

Repower	2005	2006e	2007e	2008e	2009e
EV/Sales	0.52	0.84	0.64	0.52	0.38
EV/EBITDA	50.1	19.1	10.1	7.3	7.4
EV/EBIT	high	27.5	12.2	8.4	8.6
P/E	high	59.1	23.5	18.9	18.6
K/I	3.68	2.42	2.29	2.02	1.91
ROCE (%)	-6.5				
Return data (%)	**-1w**	**-1m**	**-6m**	**-1y**	**-3y**
Share performance (%)	4.1	7.9	25.3	23.5	112.6
Relative MSCI performance (%)	3.8	3.8	15.1	20.6	91.9

Suzlon fundamentals

Suzlon (INR bn)	2005	2006e	2007e	2008e	2009e
Layout	848	1,582	2,257	2,985	
EBITDA	201	375	534	665	
EBIT	191	343	471	573	
Net	168	288	384	455	
EPS	0.64	0.96	1.31	1.58	
Layout growth (%)		86.5	42.6	32.2	
EBIT growth (%)		79.8	37.3	21.5	
EPS growth (%)		50.3	37.5	20.3	
EBITDA margin (%)	23.7	23.7	23.6	22.3	
EBIT margin (%)	22.5	21.7	20.9	19.2	

Suzlon fundamentals

Suzlon	2005	2006e	2007e	2008e	2009e
EV/Sales	6.71	5.54	3.92	2.96	
EV/EBITDA	28.3	23.4	16.6	13.3	
EV/EBIT	29.8	25.5	18.8	15.4	
P/E	46.1	30.7	22.3	18.5	
K/I	13.85	10.17	7.44	5.59	
ROCE (%)					
Return data (%)	**-1w**	**-1m**	**-6m**	**-1y**	**-3y**
Share performance (%)	-1.6	7.9	43.8	4.4	96.2
Relative MSCI performance (%)	-2.0	3.9	33.7	1.6	

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Country contribution to MW (Vestas only)

Sales (deliveries) Sales in MW	Q2 2007	Q2 2006	1st half 2007	1st half 2006	Full year 2006
Belgium	0	0	0	0	8
Denmark	0	11	0	11	11
France	48	87	63	87	199
Greece	0	0	3	0	62
Netherlands	30	1	45	63	222
Ireland	0	14	0	19	41
Italy	128	16	243	16	90
Lithuania	0	0	16	0	0
Poland	0	0	0	40	40
Portugal	10	150	10	150	237
Spain	145	73	165	73	168
UK	12	18	12	49	196
Sweden	4	1	36	2	2
Czech Republic	0	0	4	0	8
Turkey	24	0	24	0	1
Germany	51	119	113	347	788
Hungary	0	0	0	0	16
Austria	0	20	0	20	20
Total Europe	452	510	724	877	2109

Sales (deliveries) Sales in MW	Q2 2007	Q2 2006	1st half 2007	1st half 2006	Full year 2006
Canada	30	47	70	167	416
US	108	113	248	175	654
Total Americas	138	160	318	342	1070

Sales (deliveries) Sales in MW	Q2 2007	Q2 2006	1st half 2007	1st half 2006	Full year 2006
Australia	75	0	75	0	79
India	19	115	98	241	393
Japan	2	50	2	50	63
China	11	72	82	94	379
New Zealand	93	0	93	0	0
South Korea	38	0	38	0	100
Taiwan	0	0	0	46	46
Total Asia/Pacific	238	237	388	431	1060

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Revenue contribution by region

Segment information

Geographic: primary segment	2006				
	Europe	Americas	Asia/Pacific	Not allocated	Total
Segment results					
Revenue	2,184.0	849.0	821.3	0.0	3,854.3
Operating profit/(loss)	94.2	72.3	34.1	0.0	200.6
Share of profit/(loss) in associated companies	0.0	0.0	0.0	(0.1)	(0.1)
Financial items (net)	-	-	-	(39.6)	(39.6)
Profit/(loss) before tax	-	-	-	-	160.9
Corporation tax	-	-	-	(50.0)	(50.0)
Net profit/(loss) for the year	-	-	-	-	110.9
Other segment items					
Depreciation and amortisation	87.8	18.6	13.0	0.0	119.4
Impairment losses (recognised in the income statement)	0.0	0.0	4.0	0.0	0.0
Additions to property, plant and equipment and intangible assets	134.2	23.4	30.6	0.0	188.2
Non-current assets	780.0	87.6	100.0	184.6	1,152.2
Total assets	2,005.9	483.2	525.7	639.6	3,654.4
Total liabilities	1,293.9	497.5	334.7	266.6	2,392.7
Geographical location of total assets	2,824.8	357.6	472.0	-	3,654.4
Geographical location of additions to property, plant and equipment and intangible assets	143.9	19.1	25.2	-	188.2

Segment information

Geographic–primary segment	2005				
	Europe	Americas	Asia/Pacific	Not allocated	Total
Segment results					
Revenue	2,179.0	894.9	508.4	0.0	3,582.6
Operating profit/(loss)	17.1	(136.3)	3.5	0.0	(115.7)
Share of profit/(loss) in associated companies	0.0	0.0	0.0	(0.1)	(0.1)
Financial items (net)	-	-	-	(33.3)	(42.4)
Profit/(loss) before tax	-	-	-	-	(158.2)
Corporation tax	-	-	-	(33.3)	(33.3)
Net profit/(loss) for the year	-	-	-	-	(191.5)
Other segment items					
Depreciation and amortisation	90.5	15.9	6.2	0.0	115.0
Impairment losses (recognised in the income statement)	8.2	0.0	0.0	0.0	8.2
Additions to property, plant and equipment and intangible assets	108.9	15.9	5.6	0.0	130.4
Non-current assets	768.5	127.3	47.9	156.7	1,100.4
Total assets	1,994.0	503.6	285.9	301.9	3,085.4
Total liabilities	939.1	420.2	204.0	560.3	2,123.6
Geographical location of total assets	2,473.6	365.6	246.2	-	3,085.4
Geographical location of additions to property, plant and equipment and intangible assets	105.3	15.0	10.1	-	130.4

There is no significant revenue between segments and no significant non-cash transactions in the year

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Projected global renewable electricity generating capacity

	2003	2010	2020	2030	2050
Hydro	728,000	854,800	994,190	1,091,490	1,257,300
Biomass	48,030	110,000	211,310	305,780	504,610
Wind	30,280	156,150	949,800	1,834,290	2,731,330
Geothermal	10,170	20,820	40,780	70,380	140,010
Photovoltaic (PV)	560	22,690	198,900	727,820	3,033,370
Concentrating solar thermal	250	2,410	29,190	137,760	404,820
Ocean energy	240	2,250	13,530	28,090	63,420
Total	817,000	1,169,120	2,437,700	4,195,610	7,134,860

Source: European Renewable Energy Council and Greenpeace International, 2007

Assumed trends in fossil fuel prices

Fossil fuels	2003	2010	2020	2030	2040	2050
Crude oil ($2000/bbl)						
	28.0	62.0	75.0	85.0	93.0	100.0
Natural gas ($2000/GJ)						
America	3.1	4.4	5.6	6.7	8.0	9.2
Europe	3.5	4.9	6.2	7.5	8.8	10.1
Asia	5.3	7.4	7.8	8.0	9.2	10.5
Hard coal ($2000/t)						
	42.3	59.4	66.2	72.9	79.7	86.4

Source: European Renewable Energy Council and Greenpeace International, 2007

Investment cost projections for renewable energy

	2003	2010	2020	2030	2040	2050
Photovoltaic						
Capacity	0.56	22.9	202	511	735	894
Cumulated capacity (GW)	2.88	25.4	214	604	1032	1485
Investment cost (€/kW_p)	5750	2853	1436	1126	1038	994
Generating cost, min (ct/kWh)	0.37	0.21	0.11	0.07	0.06	0.05
Generating cost, max (ct/kWh)	0.76	0.45	0.22	0.14	0.11	0.1
Concentrating solar thermal						
Capacity	0.354	4.6	72	273	459	628
Cumulated capacity (GW)	0.354	4.7	74	311	634	1032
Investment cost (€/kW_p)	2300	1426	858	738	701	676
Generating cost, min (ct/kWh)	0.18	0.08	0.06	0.06	0.06	0.0
Generating cost, max (ct/kWh)	0.20	0.12	0.09	0.09	0.09	0.09
Wind						
Capacity	41	256	1024	1509	1884	2225
Cumulated capacity (GW)	41	270	1166	2163	3293	4576
Investment cost (€/kW_p)	1350	1141	1001	948	913	886
Generating cost, min (ct/kWh)	0.08	0.07	0.06	0.05	0.05	0.05
Generating cost, max (ct/kWh)	0.1	0.08	0.07	0.06	0.06	0.06

Source: EREC (Future Investment—A sustainable investment plan for the power sector to save the climate, European Renewable Energy Council)

Technology and Innovation

Wind Turbine Technology: Creating a Better Understanding

Case Study 1: Doubly-fed induction generator
Case Study 2: Full-scale power converter
Case Study 3: HVDC-based transmission system

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Wind Turbine Technology: Creating a Better Understanding

Learning objectives

- A better understanding of wind energy from an engineering perspective
- An overview of the various technological challenges facing wind energy systems

Keywords

- Wind technology, energy technology, wind farms, turbines, grid integration, gearboxes, generators, wind modelling and forecasting

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Wind turbine technology

The European Union has a goal of 22% electricity generation from renewables by 2010. The European Wind Energy Association estimates that wind can deliver 12% by 2020 and more than 20% by 2030. Wind energy is gaining increasing recognition, and attracting large investments. The tendency is towards offshore sites, large wind farms, and increased system stability. This has had interesting implications for wind turbine technology.

Wind turbine technology has developed at a pace to match the rapid expansion of the global wind energy sector. Increased political attention and high oil prices have led to accelerating growth in recent years. However, the competitiveness of wind energy relative to other energy sources, both traditional and alternative, still depends on the efficiency and reliability of the turbines.

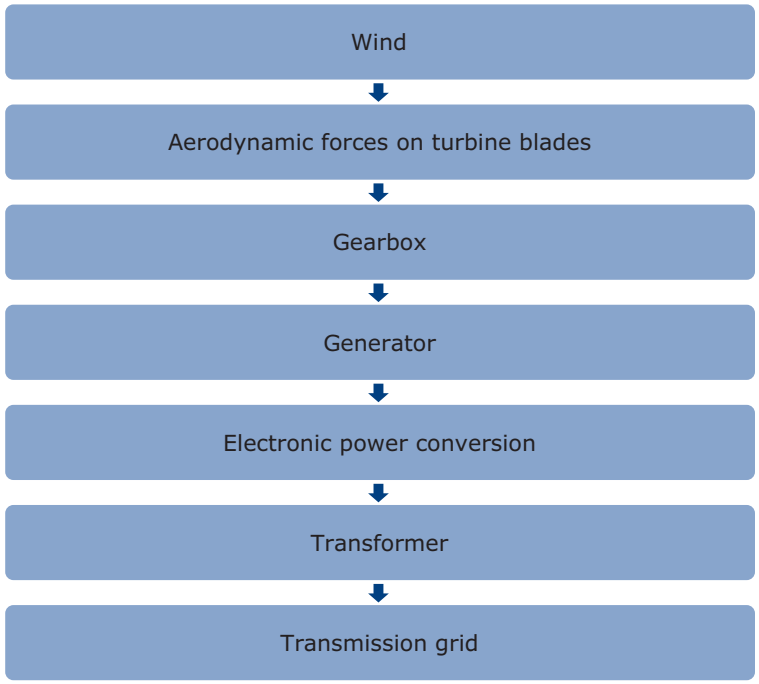
The main challenge in the next 20 years is to cut by nearly half the price per kWh. This can be done by reducing the production costs of turbines, and also by improving their reliability and reducing maintenance costs.

Research and development in wind turbine systems combines expertise in power systems, electrical machines, power electronic systems and energy resources.

Wind turbines can be installed on scales from stand-alone machines in the kW range and to complete wind power stations generating hundreds of megawatts. As wind power grows in importance, engineering standards governing the way wind turbines connect to the power grid continue to evolve, and this poses new challenges for the design and control of the turbines.

Figure 1 shows the main phases in the production of wind energy. For a company like Vestas it is crucial to ensure continuous improvement in all areas. This has led to recent collaboration with one of the leading energy technology research institutions in Denmark: Aalborg University Institute of Technology.

Figure 1: Main phases in the production of wind Power



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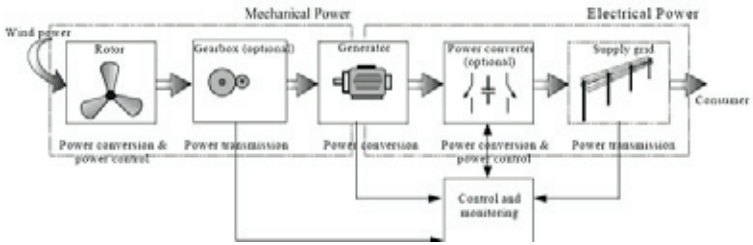
From a more technical perspective, a wind turbine may be divided into a mechanical part and an electrical part. Figure 2 shows how wind energy is converted into electrical power, which is then transferred to the electrical grid. There are several important areas where research and development can improve the performance of wind power systems.

Figure 2: Mechanical and electrical parts of the energy conversion process



The Power Programme

Recently Vestas formed a strategic R&D alliance with the Institute of Energy Technology at Aalborg University, named the second-best research institute of 2007 by the European Power Supply Manufacturers Association (EPSMA). The alliance, which is known as the Vestas Power Programme, runs from September 2007 to August 2012. The research will be carried out by a group of researchers led by Remus Teodorescu, a Vestas Professor in Power Electronics at Aalborg University. Other world experts will be invited to join the programme as guest professors.

Through visionary and coordinated research, the Vestas Power Programme will push wind power technology to even higher levels of reliability and functionality, enabling more efficient renewable power generation. The programme will cover three main topics:

- Power electronics
- Power systems
- Electrical energy storage.

The main research objectives are:

- to identify the most suitable converter technology and control strategy for large turbines in large wind farms,
- to assess the effect of large amounts of wind power on utility stability and reliability, and
- to determine the most suitable storage technology to enable higher levels of wind energy on the grid.

The collaboration has also led to the establishment of new research areas in energy technology, ensuring a tight relationship with the industry in general. Some of the essential research subjects are described below.

Component functionality, control and monitoring

It is important to gain better understanding of the performance of components including generators, gearboxes, power electronic converters and protection systems. This will aid the design of wind turbines that are highly efficient, highly reliable and low in cost.

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Reliable techniques for data acquisition and advanced signal processing will improve the monitoring of wind turbines. This may lead to the development of new control methods for power converters and generators, increasing performance and reliability, and meeting new requirements for interconnection within the turbine and also within each wind farm. The most important point is the control of what electrical engineers call active and reactive power.

Simulation, design and optimisation of large wind farms

Scientists are developing an extended simulation platform for the electrical part of a wind turbine. Their work will produce models which may be used for electrical power system analysis using the DigSilent simulator, and for integration with mechanical aero-elastic design tools such as HAWC and FLEX.

Such a simulation platform will be able to determine the performance of the critical components in wind turbines and complete wind power systems. It can thus be used to simulate, design and optimise the individual parts of wind turbines and wind energy systems. The aim is to develop a platform for the cost-effective design of future large wind farms. Starting with the main components of the electrical system and key technical specifications, the simulator will allow the design of a power plant with the minimum overall cost.

This approach will produce useful knowledge for the optimal planning and design of large numbers of wind farms, allowing wind power system planners to compare the various options for constructing a wind farm in terms of its electrical systems.

These options include both newly-developed power electronic systems and traditional methods of controlling power.

The network integration of wind turbines is a key issue for the large-scale use of wind power, and it presents many technical challenges. It is necessary to address these to meet the requirements of the utility companies, including power quality, system stability and dynamic performance.

Hubs, gearboxes and generators

Turbine hubs and gearboxes are complex mechanical components. The hub incorporates a pitch control mechanism that twists the blades, enabling the turbine to vary its power output to match wind speed and electricity demand. Several advanced pitch control methods exist and new ones are continuously being developed, thanks to advances in other fields of engineering.

As some of the largest gearboxes ever made, wind turbine gearboxes operate near the limits of current engineering knowledge. Manufacturers strive to reduce gearbox weight while increasing reliability. New “gearboxes” based on permanent magnets offer the promise of being lighter and more durable under the sudden high loads imposed by strong gusts of wind.

Generators for wind turbines are available in many different types, for example with multiple stator windings, switched-reluctance machines, and transverse-flux permanent magnet machines. Besides the basic design, condition monitoring and diagnosis is another important area for generators.

Power electronics

Power conversion electronics help to improve wind turbine performance by maximising generating capacity across a range of wind speeds and ensuring that the power delivered to the grid is "clean", so that it meets the stringent requirements of the utility companies. Scientists are experimenting with different power conversion strategies, such as:

- back-to-back voltage source converters,
- matrix converters,
- multi-level converters, and
- other emerging topologies.

Figure 3 shows the back-to-back voltage source converter and multi-level converters, but there are many other options.

Figure 3: Back-to-back voltage source converter

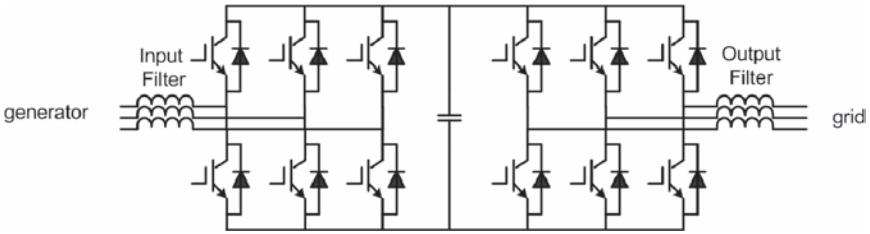
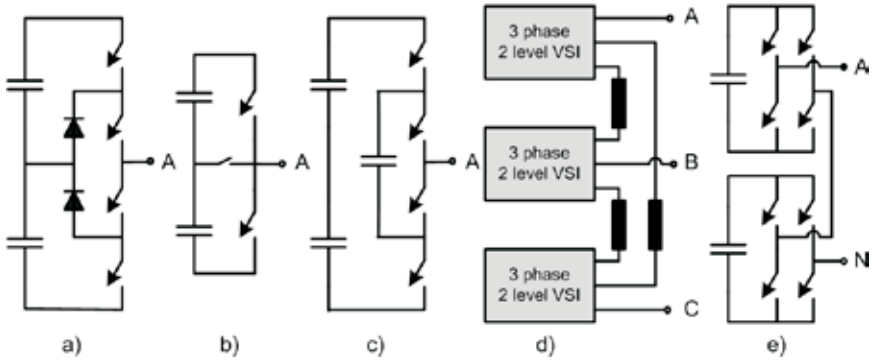


Figure 4: Multi-level converters



a) Three-level diode clamped,

b) Three-level with bidirectional switched interconnection,

c) Three-level flying capacitor,

d) Three-level using three two-level converters, and

e) Three-level H-bridge cascaded.

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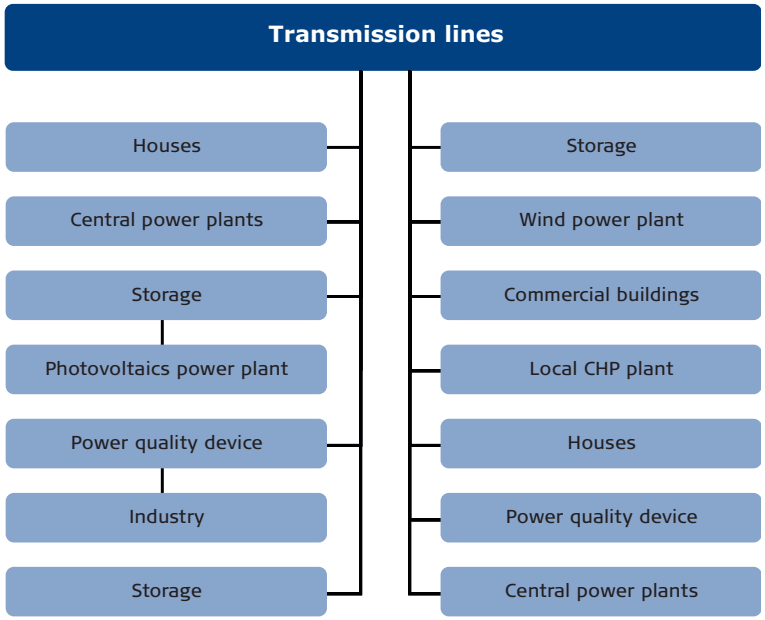
Figure 5: Multi-level converters



Grid connection

Another area with great potential for improvement is the grid connection: the point at which a wind farm is integrated into the local power network. Most existing grids are designed for centralised generation, with long-distance power transmission treated separately from local power distribution. Governments are now talking about grids designed to gather power from many different types of generator and distribute it efficiently to users.

Connecting wind power plants to the grid is a complex matter because of the short-term variability of wind power. R&D into power quality, power control and monitoring will help the smooth integration of wind energy with other power sources. The ability to store electricity cheaply and in large quantities would also have huge implications for wind power, and this is an important research area.

As a leading manufacturer of wind turbines, Vestas has seen rapid technological development. Figure 6 shows how quickly wind turbines have grown in size.

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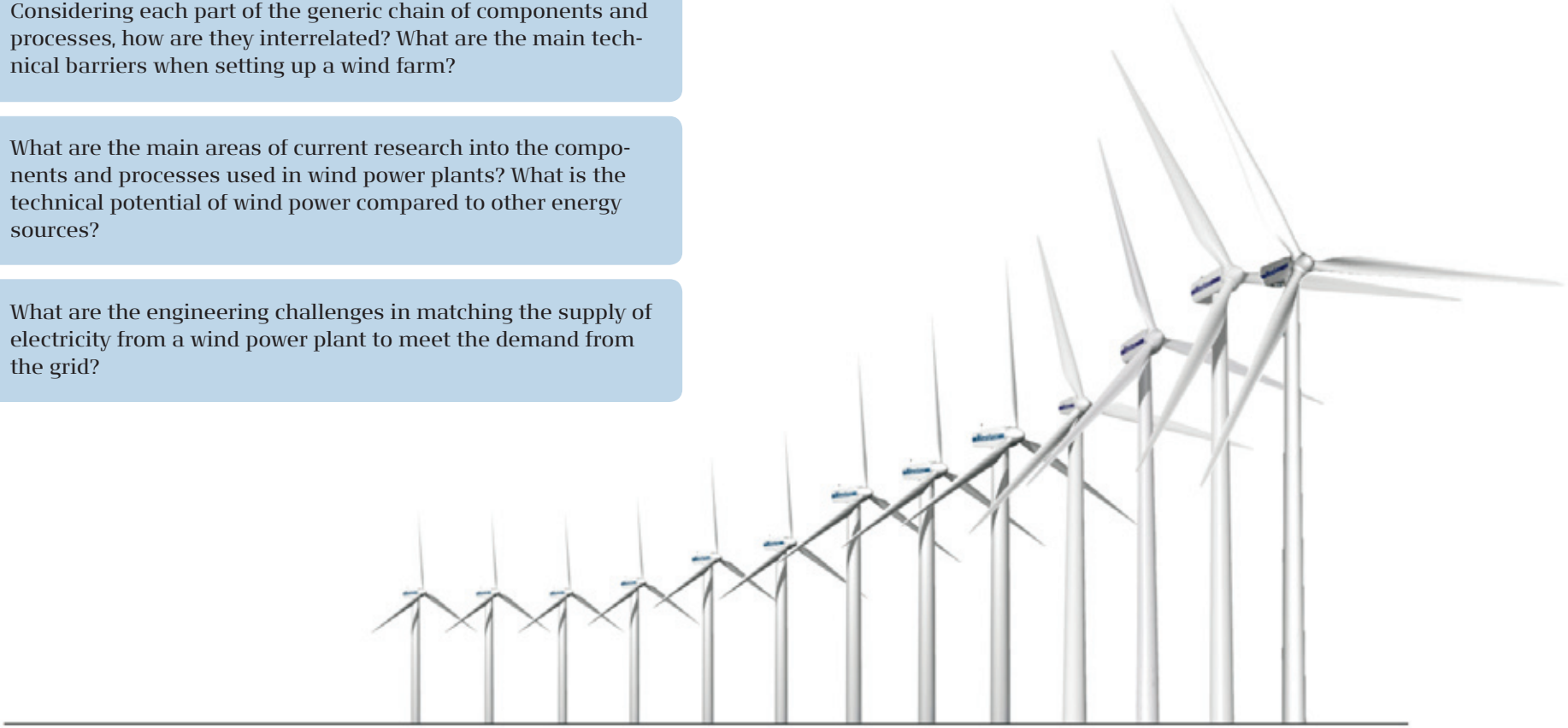
Challenges

Considering each part of the generic chain of components and processes, how are they interrelated? What are the main technical barriers when setting up a wind farm?

What are the main areas of current research into the components and processes used in wind power plants? What is the technical potential of wind power compared to other energy sources?

What are the engineering challenges in matching the supply of electricity from a wind power plant to meet the demand from the grid?

Figure 6: Evolution of wind turbine size



Product/Rotor diameter (m)	V15	V17	V19	V20	V25	V27	V39	V44	V47	V52	V66	V80	V90
Year of installation	1981	1984	1986	1987	1988	1989	1991	1995	1997	2000	1999	2000	2002
Capacity (kW)	55	75	90	100	200	225	500	600	660	850	1750	2000	3000
MWh/year	217	265	301	346	481	647	1304	1581	1947	2530	4705	6768	–

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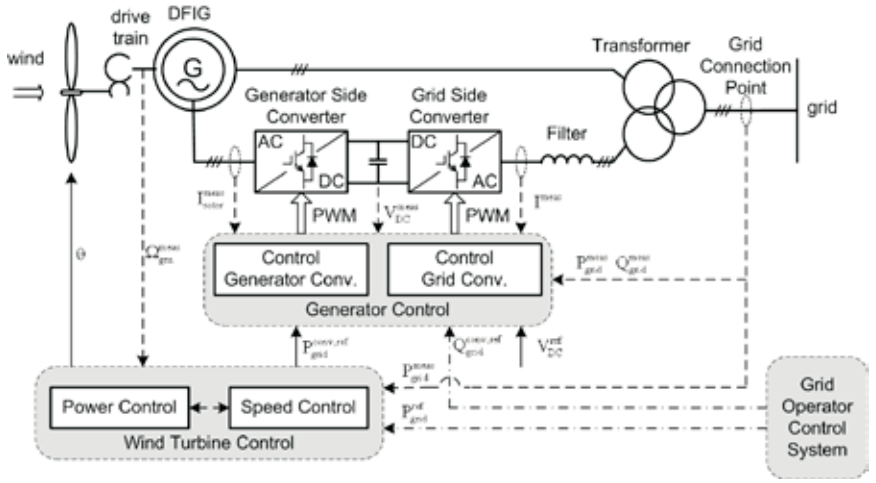
Case Study 1
Doubly-fed induction generator

Objective
Design a control scheme for a variable pitch/speed wind turbine based on a doubly-fed induction generator (DFIG).

Description
A variable speed/pitch wind turbine uses two hierarchical control levels, strongly connected to each other and with different bandwidths (Figure 1).

Figure 1: Control systems for a wind turbine with a DFIG



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The DFIG control level, which has a fast response, encompasses the electrical control of the power converters and the generator.

The wind turbine control level, which has a slower response, supervises the blade pitch system and the active power set-point of the DFIG control level.

The targets of the control system of a variable-speed wind turbine with a DFIG are:

- To control the power drawn from the wind turbine generator such that it tracks the optimum operating point of the turbine;
- To limit the power at high wind speeds;
- To control the delivery of active power according to the specifications of the utility company; and
- To control the exchange of reactive power between the wind turbine generator and the grid.

Challenges

Literature study: review the existing methods for controlling variable-speed wind turbines with DFIGs, including Maximum Power Point Tracking algorithms.

Investigate the modelling and simulation of the system using different tools. such as a circuit simulator and a power system simulator. Each of these tools will require a different level of modelling and therefore a different analytical focus

Learn how the system is analysed for grid integration studies, including power quality, power control based on system operator demands, and low voltage ride-through.

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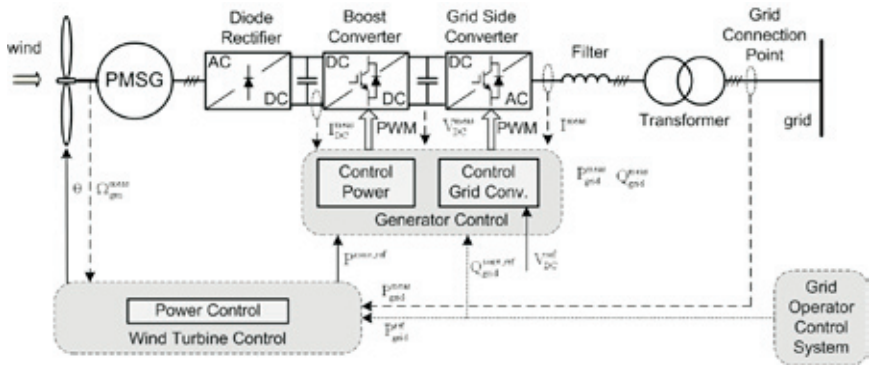
Case Study 2
Full-scale power converter

Objective
Design a control scheme for a variable pitch/speed wind turbine using a full-scale power converter for grid connection.

Description
Different generator types can be used, including a squirrel-cage induction generator, synchronous generator with field winding, or permanent magnet synchronous generator. Each of these requires a different layout of the conversion stages between the generator and the grid. Figure 1 shows a typical schematic for a wind turbine equipped with a permanent magnet synchronous generator.

Figure 1: Typical schematic for a PMSG-based wind turbine



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The targets for the control system in this case are:

- To control the power drawn from the wind turbine generator such that it tracks the optimum operating point of the turbine;
- To limit the power at high wind speeds;
- To control the delivery of active power according to the specifications of the utility company; and
- To control the exchange of reactive power between the wind turbine generator and the grid.

Challenges

Selection of the generator type and then of the layout of the power conversion stages

Literature study: review the existing methods for controlling variable-speed wind turbines with full-scale power converters.

Investigate the modelling and simulation of the system using different tools. such as a circuit simulator and a power system simulator. Each of these tools will require a different level of modelling and therefore a different analytical focus

Learn how the system is analysed for grid integration studies, including power quality, power control based on system operator demands, and low voltage ride-through.

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Case Study 3

HVDC-based transmission system

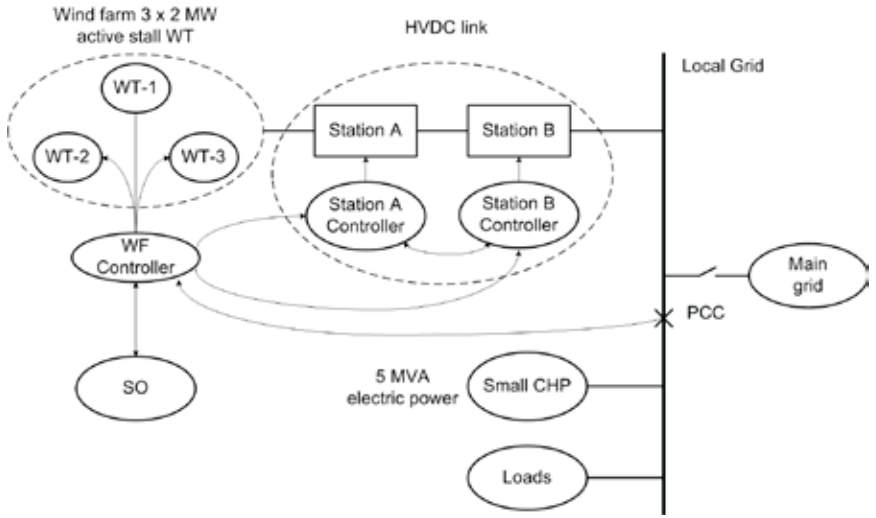
Objective

Build a dynamic model of a HVDC-based VSC transmission system for connecting wind farms to the grid.

Description

The main goal in this project is to build a dynamic model, including a control scheme, for an HVDC-based VSC transmission system for connecting wind farms to the grid (Figure 1).

Figure 1: Possible layout of an HVDC transmission system connecting wind farms to the grid



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The control system for each wind farm should:

- Maintain stable voltage and frequency on the wind farm grid
- Supply the wind farm with reactive power
- Meet the grid connection requirements using the local grid HVDC station (station B)
- Maintain stable voltage and frequency on the local grid in standalone mode

Challenges

Literature study: review existing methods for controlling HVDC systems

Create a model of the complete system.

Design a control scheme for the HVDC stations.

Design the wind farm controller.

Learn how the system is analysed for grid integration studies, including power quality, power control based on system operator demands, and low voltage ride-through.

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