Chapter 16
Germany

1.0 Introduction

Wind power will remain the greatest contributor to the expansion of renewable energy in the electricity sector for the foreseeable future. In 2008, wind power generation accounted for some 6.5% of Germany's gross electricity consumption, and is therefore already one of the main producers of electricity in Germany, ranking alongside conventional technologies. At the end of 2008, Germany had a total of 20,301 wind turbines installed with an output of around 23,902 MW (compared with 22,250 MW at the end of 2007). Despite the huge increases in many countries, 22% of installed output worldwide is still concentrated in Germany. Germany retained its leading international position in the construction of new turbines with 1,665 MW, putting it in third place behind the United States and China (Table 1).

R&D supported by the Federal Ministry for the Environment (BMU) experienced a considerable increase in 2008. R&D projects with a total financial volume of 40.1 million € have been launched (Figure 1).

Current research and development priorities include helping to cut the cost of producing and operating wind turbines, and hence the cost of generating wind power, as well as continuously improving the technological requirements for the eco-friendly expansion of wind power. In 2008, BMU approved a total of 32 projects, including some funding top-ups, with a total volume of nearly 40.1 million €. A total of 29.9 million € was also allocated to ongoing research projects in 2008.

The aims and priorities of wind power research are determined at regular BMU strategy meetings with experts. The most recent strategy meeting took place on 3 and 4 November 2008 in Berlin. The outcome of this meeting was reflected in the new BMU funding announcement on 20 November 2008, which lists the following main research priorities for the next few years:

- Contributing toward cost-reduction, increasing yields, and improving the availability of wind turbines
- Technologies for the expansion of offshore wind power (including research at the Alpha Ventus test site)
- Accompanying ecological research and technological optimization of wind turbines to reduce ecological impacts.

2.0 Progress Toward National Objectives

The German government acknowledges the importance of renewable energy, and in this regard national policy was generally continued. The EU target for Germany of 12.5% contribution to energy consumption by all renewable energies in 2010 was already exceeded in 2007 with 14.2%. Therefore new targets were set in 2007. By 2020, the government aims to increase the proportion of primary energy consumption generated from renewable energy sources to 16%, as compared with 5.6% in 2006.

Table 1 Key Statistics 2008: Germany	
Total installed wind generation	23,902 MW
New wind generation installed	1,665 MW
Total electrical output from wind	40.4 TWh
Wind generation as % of national electric demand	6.5%
Target:	30% of national electricity demand from RES in 2020.

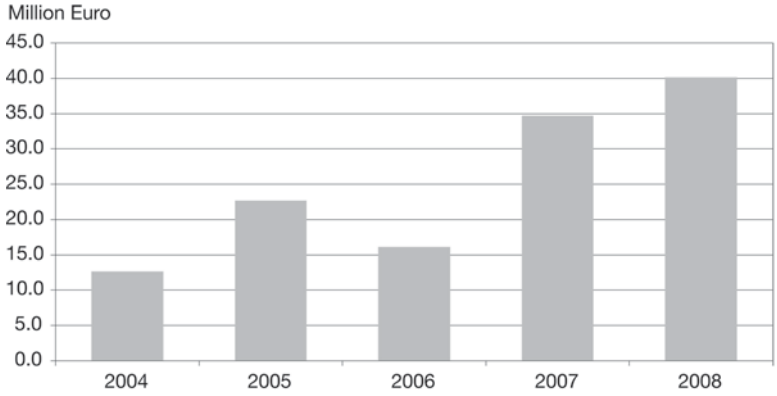

Figure 1 Development of funds for new R&D projects for wind energy research 2004 – 2008. Additional research into grid integration technologies related to wind energy has also been launched in 2008, with a financial volume of 14.6 million €.

The proportion of electricity consumption from renewable sources will be increased to at least 30%, and then will be continuously expanded (1).

Although offshore development in Germany is currently behind the strategic goal set by the government in 2002, medium- and long-term targets for offshore expansion in the German seas (1,500 MW by 2011; up to 25,000 MW by 2030) are still relevant. Important steps were taken with the Infrastructure Acceleration Act by improving the conditions for investors in offshore wind by obligating transmission system operators to pay for and install the grid connection from the onshore grid access point to the offshore wind farm toward meeting these targets. Another step is the revised Renewable Energy Sources Act (EEG) that was enacted by the parliament in July 2008. The beginning of the offshore construction of the first German offshore wind farm, alpha ventus, set a starting point for future offshore development.

3.0 Benefits to the National Economy

German wind turbine manufacturers and suppliers boast a global market share of more than one-third, thanks to sophisticated multi-megawatt turbines which have become well-established on the German market over a period of many years. In 2007, the German wind power industry generated some 7.6 billion € from turbines and components alone (data of 2008 will be available in July 2009). According to the Verband deutscher Maschinen- und Anlagenbauer (VDMA/German Engineering Federation), the export share is 83%. In 2008, more than 90,000 people in Germany were employed in the wind power sector.

A recent forecast by the Deutsches Windenergie-Institut (DEWI/German Wind Energy Institute) predicts that around 210,000 MW of wind power will be installed worldwide by 2014, which translates into an investment volume of around 130 billion €, with offshore technology and repowering playing a key role. As soon as offshore expansion picks up pace, the maritime industry anticipates a new boom. Seaports such as Bremerhaven and Cuxhaven have already prepared for this by investing in infrastructure. The aim is to advance wind power generation through research and development, to reinforce German industry's position in this expanding market and safeguard its future viability.

Cost ranges for turbines onshore and offshore in 2008 are summarized in Table 2.

Table 2 Estimated average turbine cost and total project cost for 2008		
	Turbine cost €/kW	Total installed cost €/kW
ONSHORE		
Rated Power 1.3 - 1.9 MW	1,026 – 1,160	1,345 – 1,479
Rated Power 2.0 - 3.0 MW	941 – 1,199	1,260 – 1,518
Rated Power > 3.0 MW	1,155 – 1,340	1,474 –1,659
OFFSHORE		
deep water, great coast distance	1,450 – 1,500	3,010 – 3,230
shallow water, low coast distance	1,350 – 1,450	2,625 – 2, 895
Data from Deutsche Windguard GmbH		

4.0 National Incentive Programs

An amendment of the Renewable Energy Sources Act was passed by the Parliament in July 2008 and came into force on 1 January 2009. The aim is to increase the share of renewable energy in the German electricity portfolio to at least 30% by 2020. This is intended to counteract the dramatic increase in energy and raw material prices (especially for steel and copper) and to promote the lagging offshore development in Germany.

4.1 Wind energy onshore

The amendment of the Renewable Energy Sources Act includes an initial remuneration of 0.092 €/kWh for at least 5 years and a maximum of 20 years, depending on the quality of the site according to the reference yield model. After the initial remuneration period, the tariff is 0.0502 €/kWh for a maximum of 20 years. Remuneration will be paid only for wind turbines with at least 60% yield of the defined reference. A reduction of 1% per year begins in 2010. For two cases there is a special extra payment of 0.005 €/kWh (until 2013) for repowering and for turbines fulfilling technical requirements for the improvement of grid integration (voltage and frequency regulation) and for the lighting system.

4.2 Wind energy offshore

Turbines put into operation by 31 December 2015 receive an initial remuneration of 0.15 €/kWh for 12 years. After that period, the basic tariff is 0.035 €/kWh until the maximum remuneration period (20 years plus year of commissioning) is reached. The initial remuneration will be prolonged for wind farms more than 12 nautical miles away from the coast and in waters deeper than 20 m. For wind turbines installed after 31 December 2015, the initial tariff will be 0.13 €/kWh for a period of 12 years. A reduction of 5% per year will start for new wind turbines after 2015. A new principle is that operators can sell the electricity produced directly to third parties on a "calendar-monthly" basis (without EEG-remuneration).

5.0 R, D&D Activities

5.1 Structure of research

The study "On the structure of wind power research in Germany" was commissioned by BMU and conducted by the Internationales Wirschaftsforum Regenerative Energien

(IWR/International Economic Forum Renewable Energies). German wind power research is characterized by a large number of decentralized institutions, which makes it different from other areas of energy research such as photovoltaics, as well as from the research structures in other countries. The authors recommend the establishment of powerful, internationally visible players in wind research. To this end, they recommend the expansion of regional priority areas, and identified the region around Bremen and Bremerhaven in the North of Germany and the Rhine/Ruhr region in the West as regional clusters.

The study has helped to stir up the wind power research scene, and ensure the continuing evolution of structures in wind power research. Of central importance in this connection is the foundation of the Fraunhofer-Institut für Windenergie und Energiesystemtechnik (FhG-IWES/Fraunhofer Institute for Wind Energy and Energy Systems Technology) on 1 January 2009. At the heart of the institute is the Fraunhofer Center für Windenergie und Meerestechnik (CWMT/Fraunhofer Centre for Wind Power and Offshore Technology) in Bremerhaven, with the rotor blade competence center funded by the BMU and Bremen. When the Institut für Solare Energieversorgungstechnik (ISET) is incorporated during the course of 2009, the FhG-IWES will gain a second branch in Kassel, drawing on many years of experience in wind power research. There are also plans to forge close co-operation links between the FhG-IWES and the universities of Hanover, Oldenburg, and Bremen.

The latter have joined forces to form the university wind energy research center ForWind. The establishment of two Fraunhofer project groups at the universities of Hanover and Oldenburg will help to forge close co-operation. Kassel University will also be co-operating with the IWES. Together, IWES and the participating universities cover almost the entire spectrum of wind power research. This constellation has created a top cluster for wind power research in Germany.

5.2 Projects

In 2008, BMU supported 123 on-going research projects in the wind power sector, with the development of offshore wind power a top priority. The 28 newly launched projects focus on the following priority areas:

- Completion of the RAVE research network in the test site Alpha Ventus with regard to foundations, grid integration, accompanying ecological research, and a central measurement project
- Developing new variants of foundations and supporting structures and new technologies for their production, including noise reduction in offshore expansion
- Improvement of the design of rotor blades using new materials
- Developing new multi-megawatt wind turbines and demonstrating them under near-shore conditions.

5.3. Offshore wind power

5.3.1 Alpha Ventus test site

The first German offshore wind farm Alpha Ventus is under construction 45 km North of the North Sea island of Bochum. The company DOTI GmbH, owned by the power utilities EWE, E.ON, and Vattenfall, will construct and operate 12 wind turbines from Multibrid and REpower, with a total installed capacity of 60 MW. The first structure for Alpha Ventus was the transformer substation, completed in 2008 with a height of 60 m and weighing more than 1,300 tons. The transformer substation is located around two km from the BMU research platform FINO 1. The submarine cable was also laid in 2008. Unfortunately, construction of the 12 wind turbines, originally scheduled to begin in August 2008, had to be postponed until 2009 due to unfavorable weather conditions. As a test and demonstration project, Alpha Ventus will

mark the start of the use of offshore wind power in Germany.

The research initiative RAVE was launched in May 2008 with a kick-off event in Berlin. At the event, research projects at the Alpha Ventus test site were presented to a large expert audience for the first time. The main priorities of RAVE are to explore wind as a "raw material," to investigate the technical requirements placed on wind turbines and their foundations, and to focus on grid integration and accompanying ecological research. The Bundesamt für Seeschiffahrt und Hydrographie (BSH/Federal Maritime and Hydrographic Agency) and the Deutsches Windenergieinstitut (DEWI/German Wind Energy Institute) are involved in measurement and data collection, while the RAVE projects are being coordinated by ISET in Kassel. By the end of 2008, BMU had approved 20 projects with a total of 33.7 million € for research at the test site.

By signing a co-operation agreement, researchers and industry have set themselves the joint target of deriving maximum knowledge and experience from operation of the offshore test site which will benefit future wind power use on the high seas. Further information is available at: http://rave.iset.uni-kassel.de/rave/pages/welcome

The BSH, as the authority for the licensing of offshore wind farms, has drawn up a standard analysis concept to provide a framework for the ecological analyses required for the licensing, construction, and operation of an offshore wind farm. The analysis concept is being used for the first time in the construction phase of the Alpha Ventus wind farm. In order to investigate whether the defined methods and specified standards are adequate, appropriate, and effective, the StUKplus project will formulate broad-based ecological research activities in order to evaluate the analysis concept. The work is being coordinated by the BSH and is dedicated to determining the potential impacts of the wind farm on various protected species (marine mammals, resting and migrating birds, fish, and biotic communities on the ocean floor). As such, they far exceed the requirements specified in the analysis concept. Based on the results, the BSH will optimize the analysis concept for the licensing of further wind farms. Evaluation of the analysis concept is the largest accompanying ecological research project to date. At the kick-off event in November 2008, some 70 experts from academia, research institutes, the wind industry, and policy and government authorities were told about the initial findings. (BMU funding total: 5 million €).

The BSH is managing and coordinating the measurement technology, as well as providing maintenance and support for measurements from all research projects. Installation of measuring equipment was completed on time in 2008. Over 200 sensors have been installed on the foundations of one of the wind turbines, and will provide information on power distribution, dynamics, position, water temperature patterns, and sediment deformations in the vicinity of the foundations. Once sited in the Alpha Ventus wind farm, the sensor-covered tripod foundation will be situated just 850 m from the FINO 1 research platform.

5.3.2 Technological development

In January 2008, the IWES/Fraunhofer-Institute for Wind Energy Research and Energy System Technology started work on construction of the rotor blade competence center in Bremerhaven. The first section of the test center to be completed has a hall for 70-m rotor blades. In the hall, measuring 17 m wide, 84 m long and 20 m high, these rotor blades can be subjected to in-depth analysis. To this end, they are screwed into a foundation made from 4,000 tons of steel-reinforced concrete, and subjected to months of vibrations, during the course of which the blade tips are deflected up to 17 m. The tests are accompanied by state-of-the-art measurements. The aim of the project is to ensure that the rotor blades are fit to withstand 20 years of offshore and

onshore use. Phase two of the complex, for rotor blade lengths of up to 90 m, as used in future offshore wind farms, is currently in the final planning stages. The test rigs are part of the BMU-funded project InnoBladeTeC, in which Fraunhofer-IWES is collaborating with industry to develop new test methods designed to prepare rotor blades for the extreme loads at sea. Measurements are carried out on whole rotor blades, and supplemented by test rigs to allow much cheaper component testing, as well as a climate controlled chamber which allows the simulation of offshore conditions. In 2008, a project extension was approved. In the future, the rotor blades will be simultaneously deflected both vertically and horizontally during the load tests. (total BMU funding: 11.1 million €).

5.3.3 Foundations

Several companies and research institutes are participating in the OGOWIN project (optimization of jacket foundation structures for offshore wind farms with regard to material consumption, assembly sequence, and new production techniques) to develop a modular system for the foundation structures of offshore wind farms. In February 2008, early results from the OGOWIN project were incorporated into the world's first jacket foundation with cast junctions for offshore wind farms, which WeserWind GmbH has constructed onshore in Bremerhaven as a test foundation. It supports a 5M type 5-MW turbine from REpower. The particular feature of this jacket is its cast junctions, which produce a highly efficient and stable structure. The project is led by WeserWind GmbH Offshore Construction Georgsmarienhütte, with the involvement of HOCHTIEF Construction AG, and EUROPIPE GmbH. Participating research institutions include IWES, the Institut für Statik und Dynamik at Leibniz University Hanover, and the Bundesanstalt für Materialforschung und –prüfung. (BMU funding total: 2.3 million €).

Over the next few years, demand for foundations for offshore wind farms will grow. With this in mind, WeserWind GmbH Offshore Construction Georgsmarienhütte, in collaboration with other companies and IWES, is launching a joint project to pave the way for high-quality and cost-effective mass production of offshore foundations. There are currently no production facilities in the world that are suitable for mass production of this type of steel structure weighing several hundred tons. In this project, the principles of production automation and quality management already used in automotive engineering, for example, are to be adapted for the production of offshore wind turbine foundations. (BMU funding total: 2.8 million €).

On 28 October 2008, the commissioning of the BARD multi-megawatt nearshore wind turbine took place. The BARD VM installed at this site has a rated output of 5 MW with a total height of 152 m and a rotor diameter of around 120 m. BARD VM used the innovative BARD "Tripile Foundation" for the first time with this project. It is comprised of three piles, each weighing 210 tons, with a supporting cross-section on top weighing around 49 tons which carries the tower. The nearshore facility was installed around 400 m from the shore near Hooksiel outer harbor, in a water depth of 2-8 m depending on the tide. As part of the project, BARD will be testing the entire production, construction, and operation logistics at the nearshore site. (BMU funding total: 1.9 million €).

The aim of the joint project "Foundations of offshore wind farms from filigree concrete structures with a particular focus on the fatigue behavior of high-strength concrete" by the Institute of Concrete Construction at Leibniz University Hanover and Ed. Züblin AG is to develop the most lightweight possible filigree structure of high-strength concrete (HPC) for the foundations of offshore wind turbines. Development focuses on the dynamic interaction between the foundation structure and

the turbine, with the foundation initially being designed for a 5-MW turbine.

Parallel to the development of the foundation structure, the research team will also concentrate on manufacturing techniques, transportation and assembly devices, as well as the necessary logistics for subsequent mass-production and installation of the foundation structure. Finally, the research team will look at devising the most cost-effective overall solution possible. (BMU funding total: 350,700 €).

Herrenknecht AG, market leader in the production of tunnel-boring machines, is carrying out a feasibility study to determine whether the Herrenknecht Vertical Shaft Machine (VSM) is suitable for use in the construction of offshore wind farms. Unlike pile driving, boreholes are less dependent on the local geology and can therefore offer benefits, for example, with regard to noise emission levels in the construction of turbines. Other project partners include IMS Ingenieurgesellschaft mbH from Hamburg and the Institut für Geotechnik (Geotechnical Institute) at Hamburg-Harburg Technical University. (BMU funding total: 77,000 €).

5.3.4 Construction and logistics

Experience acquired during 2008 with the construction of the FINO 3 research platform and the Alpha Ventus wind farm have highlighted the decisive role of technologies for the construction and installation of offshore turbines (such as construction ships, jack-up platforms, cranes, etc.). Without adequate installation technology adapted to the specific requirements of offshore wind turbines, it will be impossible to continue expanding offshore wind power at the planned rate. Priorities here include the efficient handling of transportation and assembly, and minimizing the influence of waves, currents, and wind on the construction process. During the operational phase, logistics are also needed to give year-round access for the maintenance and repair teams, if possible.

A project by Deutsche WindGuard GmbH aimed to make the operation of offshore wind farms more cost-effective by identifying the optimum service vehicle. The alternatives considered were a Small Waterplane Area Twin Hull (SWATH), catamaran, crew boat, and helicopter. These vehicles are designed to transport maintenance staff safely to the wind farm even in heavy swell. A subsequent cost analysis revealed that a SWATH is the most cost-efficient alternative, particularly for large offshore wind farms. For optimum operation, the combination of a SWATH craft plus a helicopter was identified as the optimum solution for offshore wind farms. The project team also drafted technical recommendations to optimise the SWATH in terms of its suitability for offshore use in the servicing of wind farms. (BMU funding total: 46,500 €).

The project developer PTS GmbH has designed a system allowing assembly personnel and spare parts to be transported safely onto the platforms of offshore wind turbines in a wide range of weather conditions. The Personnel Transfer System (PTS) consists of a crane mounted on the platform of the wind farm. Personnel and equipment can be suspended from a hook and lifted onto the platform from the ship. An adaptive control system ensures that the distance between the hook and the ship always remains the same, even in rough seas. This system allows almost year-round safe access to offshore wind farms. This increases accessibility and safety, and also helps to cut assembly and maintenance costs. PTS GmbH is a joint venture between Teupen Maschinenbau GmbH and ep4 offshore GmbH. In 2008, Teupen constructed and tested a prototype of the system. (BMU funding total: 158,000 €).

The Institut für Seeverkehrswirtschaft und Logistik (ISL/Institute of Shipping Economics and Logistics) undertook a study to investigate the extent to which modern, coordinated logistics concepts

and models from other industries may be transferred to the wind power sector. The study focuses on offshore logistics and the export market, and examines concrete case examples. The aim is to calculate logistics costs and illustrate potential cost-cutting measures. As logistics are estimated to account for between 15 and 20% of the costs in an offshore wind farm, this project could potentially make a decisive contribution toward improving the cost efficiency of offshore wind farms. (BMU funding total: 296,000 €).

Ed. Züblin AG is developing an innovative vertical lifting device for the final assembly of nacelles for offshore wind turbines weighing up to 500 tons. The proposed device lifts the nacelles from the transporter ship onto the tower. This will dispense with the use of expensive assembly units such as floating cranes and jack-up platforms, whose availability until now has been limited, at least for parts of the assembly process. The project is being carried out in collaboration with Berg-idl GmbH, Offenburg University and Karlsruhe University. (BMU funding total: 475,000 €).

In a theoretical study, F+Z-Baugesellschaft mbH defined the application conditions and requirements for a jack-up platform for the construction of offshore wind farms. In the follow-up project, completed in 2008, the company developed a specific, certified technical design for this purpose. The new type of jack-up platform will be capable of withstanding wave heights of up to 2.5 m, making it usable in at least 75% of all weather situations throughout the year. (BMU funding total: 93,000 €).

5.4 Onshore technological research

Although offshore wind power is currently the greatest technological challenge for wind power development, onshore technology still offers the largest expansion potential in global terms. Here, older wind farms are increasingly being replaced by more powerful technology (repowering) in order to make optimum use of the energetic and economic potential of wind power.

In February 2008, Deutsche WindGuard GmbH began operation of a wind tunnel center in Bremerhaven, capable of creating wind speeds of up to 250 km/h. Over a working section of 14 m, experiments are conducted on models and original wind turbine parts. The acoustically optimized wind tunnel is used to improve the aerodynamic components of wind turbines. In collaboration with the wind farm industry, the center will address scientific and technical issues, with a particular emphasis on the optimization of rotor blade profiles to improve the efficiency of wind farms, the acoustic optimization of rotor blade profiles to minimize sound emission, and the identification and optimization of load profiles on rotor blades. (BMU funding total: 753,000 €).

A project to make wind farms more compatible with the requirements of civil and military airspace, monitoring was concluded by EADS Deutschland GmbH (European Aeronautic Defence and Space Company). The project included the development of technologies for radar engineering which enable the detection and suppression of signals from wind farms that can potentially interfere with airspace monitoring. Recommendations for minimizing radar reflections from the turbines were drawn up as well. (BMU funding total: 1 million €).

PN Rotor GmbH is working on the development and construction of a partially automated surface coating for rotor blades. It is hoped that this will reduce wear and tear on the rotor blades during operation and minimize the work involved in surface treatment. Coating systems are being selected and tested in collaboration with suppliers. In a subsequent stage, the team will develop suitable automated application techniques and the edges of the rotor blade will be given special edge protection. The partially automated finish is to be used in the new rotor blade production plant at PN Rotor for the construction of large offshore rotor blades. (BMU funding total: 846,600 €).

UpWind is currently the largest wind power project funded by the European Union. Since 2006, some 40 companies and research institutions across Europe have been working on this project to develop models for key components of large wind turbines with outputs of up to 10 MW. The recently established IWES (formerly CWMT) is collaborating closely with the UpWind network as an associated partner in a research project funded by BMU. IWES is also developing new test methods for rotor blades. It is hoped that, rather than testing the vibration resistance of entire rotor blades, it will be possible instead to perform static and dynamic load tests on rotor blade spars.

At the same time, IWES is contributing to the materials database "OptiDAT" within the framework of UpWind, and helping to define a certification methodology for rotor blade materials. (BMU funding total: 597,200 €).

5.5 Research platforms

Since summer 2003, the research platform FINO 1 in the North Sea has collected data on wind, waves, currents, and bird migration. It has also played host to other ecological research projects. To date, the BSH has recorded around 150 incidences of data use by industry and research. FINO 1 is acquiring still greater significance thanks to the offshore test site Alpha Ventus, which is located just a few hundred meters away. Back in early 2002, the planners deliberately sited FINO 1 in the main approach to this pilot wind farm so that measurement data could be evaluated in combination with data from the turbines. FINO 1 is an important research tool for the 20 research projects in the Alpha Ventus test site now approved under the RAVE research initiative. One turbine each from the companies Multibrid GmbH and REpower Systems AG will be equipped with extensive research technology as part of RAVE. FINO 1 wind measurement data will then be used to determine the performance curves of the turbines and to perform load analyses.

The research platform FINO 2, located 45 km North of Rügen at the Baltic Sea, has been recording wind data and hosting ecological research projects since summer 2007. The wind measurements utilize the same regime as on FINO 1. Since 2008, the data has likewise been fed into the ODIN database of the BSH, where it is available for downloading alongside the FINO 1 data.

In late July 2008, offshore work began on construction of the FINO 3 research platform around 80 km North-West of the North Sea Island Sylt. To this end, a 55 m long steel pipe (monopile) was driven into the sea bed in water depths of 23 m. The surface of the monopile is fitted with a comprehensive array of sensors from Braunschweig University, which will later measure how the pile is embedded in the seabed. Researchers were anxious to discover how well the sensitive technology would survive the pile-driving process. Thanks to special protective covers, almost all sensor holders have remained fully functional, despite having been driven more than 20 m into the seabed.

In order to reduce noise emissions, the company Hydrotechnik Lübeck GmbH was commissioned by Forschungs- und Entwicklungszentrum FH Kiel GmbH to construct an air bubble curtain with a radius of 70 m around the construction site. Scientists at Hanover University and the Institut für technische und angewandte Physik GmbH (ITAP) investigated the effectiveness of this measure and recorded the sound pressure levels at various distances around the site. Initial data analysis suggests that the air bubble curtain achieved a total noise reduction of 12 decibels, with a 30 to 35 decibel reduction in the frequency range between 1 and 7 kilohertz. Biologists also spent several days studying the effectiveness of measures to protect porpoises. Initial results indicate that during construction, no porpoises entered the hazardous

zone around the site. Two weeks later, the number of porpoises had returned to pre-construction level.

5.6 Environmental research and optimization

The expansion of offshore wind power use is accompanied by a wide range of projects on ecological issues. The effects on birds, marine mammals, fish, and benthic organisms are investigated, and legal aspects are taken into account.

The research project "Marine mammals in the North and Baltic Seas" (MINOS+) was successfully completed in early 2008. This was a joint project between the Leibniz-Institut für Meereswissenschaften (IFM-GEOMAR/Leibniz Institute for Marine Sciences at Kiel University), Forschungs- und Technologiezentrum Westküste (Büsum), the Deutsches Meeresmuseum Stralsund (German Oceanographic Museum) and the Nationalparkamt (National Parks Office) Schleswig-Holsteinisches Wattenmeer. The project represents a milestone in accompanying environmental research. Firstly, it examined the habitats, migration routes, and distribution patterns of porpoises, seals, and seabirds, and secondly, analyzed the hearing sensitivity of porpoises and seals. This unique data record provides the basis for numerous new findings on the distribution, behavior, seasonality, and sensitivity of such species. The methods developed will be used in future marine monitoring and accompanying studies in Germany. The study has broadened the ecological knowledge of Germany's marine regions, and significantly improved our understanding of ecological correlations, creating a tenable scientific basis for the licensing of offshore wind farms. The data will be permanently stored in a database in the National Parks Office created specifically for this purpose. (BMU funding total: 3.4 million €).

The Institut für Vogelforschung "Vogelwarte Helgoland" (IfV/Institute for Bird Research) has already conducted numerous studies into potential impairments of migrating birds by offshore wind farms as part of its "Finobird" project. In order to be able to track the flight paths of sea birds and migratory birds more accurately, the "Finorad" project will convert a decommissioned weather balloon tracking radar from the German army to enable it to be used for ecological research purposes. With the help of this system, it will be possible to monitor even small birds over distances of many kilometres, and to derive information regarding the spectrum of species. The new radar will therefore set a new state of the art in ornithological offshore radar technology, which will help to intensify our knowledge of bird migration. Scientists hope this study will enable them to quantify the potential impacts of wind farms on bird migration. If the project is successful, there are plans to use the new technology for the first time in the vicinity of the offshore test site alpha ventus. (BMU funding amount: 175,000 €).

In a joint project, Leibniz University Hanover, Erlangen University, Enercon GmbH, and the Forschungsinstitut für Optronik und Mustererkennung (FOM/Research Institute for Optronics and Pattern Recognition) are developing methods to analyze and reduce the risk of bat collision with onshore wind farms. Based on predictions, practical methods will be derived aimed at reducing and avoiding possible bat strikes. (BMU funding total: 1.1 million €).

The Michael-Otto-Institut within the Naturschutzbund Deutschland (NABU/Nature and Biodiversity Conservation Union), BioConsult SH, and the Leibniz-Institut für Zoo- und Wildtierforschung (Leibniz Institute for Zoo and Wildlife Research) are exploring the reasons for possible collisions between birds of prey and wind turbines, with a special focus on red kites, sea eagles, and Montagu's harriers. In order to be able to systematically investigate the behavior of birds in various parts of Germany, the birds of prey are fitted with small satellite receivers, rather like navigation systems, and terrestrial VHF transmitters. In this way, flight movements in the vicinity of wind farms are logged, and compared with standardized behavior

records. The observations provide insight into potential avoidance and minimization measures. (BMU funding total: 802,000 €).

6.0 The Next Term

Improving the conditions for investors in offshore wind should stimulate activity in 2009. The first German offshore wind farm Alpha Ventus will begin operation in 2009 and increased research funding will provide interesting results in the next years.

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