GERMANY

MARKET OVERVIEW

Germany is the world's third-largest market for wind. In 2012, the country installed 2 415 MW of wind capacity, bringing its cumulative total to 31 308 MW. According to the National Renewable Energy Action Plan, the percentage of energy from renewable sources in the gross final energy consumption will rise from 6.5% in 2005 to 18% in 2020, and could even be surpassed to reach an aspirational target of 19.6% (Bundesministerium für Umwelt, Naturschutz Und Reaktorsicherheit (BMU), 2011a). By 2020, renewable energy will represent at least 35% of the gross electricity consumption of Germany (BMU, 2011b).

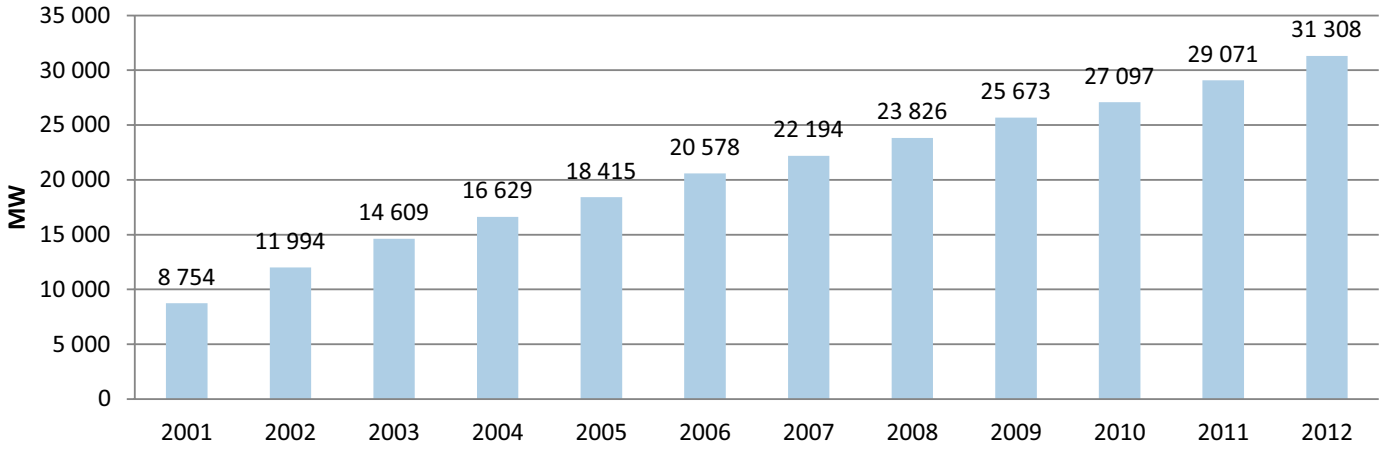

Figure 8: Cumulative Wind Installation (MW) of Germany (GWEC, 2013)

HISTORY AND EVOLUTION OF POLICY AND REGULATORY FRAMEWORK FOR WIND ENERGY

The discussions on sustainable electricity generation started with the two oil crises of 1973 and 1979, which stressed on the need for reducing dependence on energy imports. The initial discussions however focused on using more coal and nuclear.

Phase 1:

Support for technology demonstration and limited market growth (1979-1990)

A tariff for renewables based electricity generation was introduced in 1979 to stimulate market demand. It encouraged distribution companies to purchase locally produced renewable electricity at a price equivalent to the avoided costs. The system was similar to the Public Utility Regulatory Policies Act (PURPA) rules in the US (see page 136 for further details). Since the estimated avoided costs were low, the proposed price was also low and this initiative had no significant impact.

Until the end of the 1980s, Germany's electricity supply system was dominated by very large utilities relying on coal and nuclear generation. Small and decentralised forms of generation were at a disadvantage. However, during the late 1980s a series of events shaped the future regulatory framework for renewables.

In 1986, the Chernobyl accident had a profound impact on public opinion and subsequently on energy policies. Between 1987 and 1990, a series of proposals for institutional change were formulated, which included a feed-in law for the electricity produced from renewable sources. These proposals were supported by several government-funded R&D projects.

Phase 2:

Market creation and introduction of the Electricity Feed-In Act (1991-1999)

The first Electricity Feed-In Act (EFL), which came into effect in 1991, regulated the purchase and price of electricity generated by hydropower, wind energy, solar energy, landfill gas, sewage gas, and biomass.

The EFL guaranteed connection to the grid and proposed a Renewable Energy Feed-In Tariff (REFIT) to renewable energy generators. It also helped develop a national wind industrial base. For wind energy, the feed-in tariff was set at 90% of the average electricity utility rate per kWh[51]. Together with the 100/250 MW programme and subsidies from various state programmes, the EFL provided considerable financial incentives to investors in renewable energy projects (Sijm, 2002).

The rapid penetration of wind energy by the turn of the century can be attributed to the EFL, as can the obligation for power companies to purchase renewable energy from producers at fixed rates (Runci, 2005).

In addition, the government encouraged rural development by changing the Building Code in 1996. The code distinguishes between urban and non-urban areas and gives certain buildings in non-urban areas a special status. For these buildings, a construction permit should be granted, unless it infringes public interest. Since January 1997, wind power plants have been considered as having this special status.

In 1997, the EFL was incorporated into the Act on the Reform of the Energy Sector, which transposed the European Renewable Energy Directive into national law[52]. In 1999, when EFL reform started, Germany's national wind turbine industry had grown to be the second-largest in the world.

Phase 3:

Market consolidation and Renewable Energy Sources Act (2000 -2012)

The seminal Renewable Energy Sources Act (Das Erneuerbare-Energien-Gesetz or EEG) came into force in 2000. This Act, which provided the main stimulus for the national wind market, established a feed-in tariff for each kWh produced, and awarded priority connection to the grid for power generation based on renewable energy.

A two-component tariff was designed for wind energy, with an initial fixed tariff for a period of five years, and a second period of 15 years with a tariff level modulated by the local wind conditions[53]. A strong element of the EEG was the obligation for power utility companies to purchase renewable energy at set tariffs over a period of 20 years.

From 2002 onwards, new installations received lower tariffs. Different elements such as technology learning were considered to set an annual tariff degression[54]. The degression rate for new wind contracts was fixed at 2% per year, and later revised to 1%. This provided wind turbine manufacturers with an incentive to systematically reduce production costs and offer more efficient products each year. By defining the tariffs for different technologies based on the yield/generation costs of each plant, the stepped tariffs mirrored the learning curve of the technology. They capped the producer's profits, and lowered costs to consumers (WWF Finland, 2008).

In 2002 the government published a strategy paper on offshore wind energy (Die Bundesregierung 2002), which marked the beginning of the development of the national offshore wind sector. Its objective was to establish large-scale wind power capacities offshore to increase the share of renewable electricity in the energy mix. The renewable energy targets of the European Renewable Energy Directive reflected the German offshore policy.

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[50] For example if consumers had paid, on average, EUR 0.10/kWh (approximately USD 0.2/kWh) in 1991, a farmer setting up a wind turbine received EUR 0.09 (approximately USD 0.17) for every kWh fed into the grid in 1993. For electricity produced from other eligible sources of renewable energy, the corresponding feed-in tariffs were set at lower rates of either 80% or 65% of the average consumer price, depending on the output capacity of these sources.

[51] This reform ensured that the feed-in rates would remain unchanged. The removal of policy uncertainty resulted not only in further expansion of the market for wind turbines, but also in the entry of larger firms into the wind turbine industry as well as into the business of financing, building and operating wind farms.

[52] Wind installations on very good sites (reference yield of 150%) receive tariffs for only five years. This period could be extended for turbines on sites with lesser wind conditions. In total, tariffs were paid for 20 years. No compensation was granted for turbines with a reference energy yield of less than 60%, to discourage installation of wind turbines on unfavourable sites.

[53] This "degression" rate varied with technology. The degression was intended to reflect the learning curve, as costs lower with increased production volumes. The degression mechanism was chosen in part as a means of gradually eliminating the premium paid to renewables relative to the market price.

Due to existing environmental protection laws for Germany's coastal regions, the offshore developments were limited to the Exclusive Economic Zone. The offshore sites were situated at least 12 nautical miles from the coast, which required putting up structures in deeper waters than the Danish projects for example (20-30 m depth instead of 5-10 m). This challenge to locate deeper sites further from the coast than as the state-of-art projects of that time did inspire the German wind industry to develop turbines that could withstand more difficult environmental conditions.

At the same time the government established and financed R&D programmes for offshore wind[55]. After the 2008 financial crisis, concerns regarding finance and insurance, as well as technical challenges, contributed to a lower expansion rate of the offshore installations than initially planned.

The EEG was amended in January 2009. It included an increased initial tariff for both onshore[56] and offshore wind energy. The tariff system was designed to respond to market dynamics[57] and the level of technology maturity. The new EEG required grid operators not only to expand the grid, but also to optimise its management. Failure to comply with these requirements could lead to claims for damages by any renewable power producer willing, but unable to connect to the grid.

In September of 2010, the government adopted the "Energy Concept", which includes long-term climate and energy targets[58]. As a response to the nuclear disaster in Fukushima in 2011, Germany decided on the gradual phasing-out of nuclear power by 2022, greater energy efficiency and an accelerated growth of renewable energies (BMU, 2011b). These decisions supplemented and accelerated the implementation of the measures set out in the "Energy Concept".

The continued and rapid expansion of renewable energies will be a central element for the future national electricity market. Greater coordination will be needed between renewable energy generation and conventional power plants, both for market and system integration.

The EEG was subsequently amended in January 2012 (BMU, 2012a). The main amendments included an increase in the tariff degression rate from 1% to 1.5% for onshore wind and a "repowering bonus", which improves the economic conditions of the repowering projects.

For offshore wind, several elements were revised:

- Integration of a "sprinter premium" (EUR 0.02/kWh / USD 0.03/kWh), added to the initial tariff, increasing it from EUR 0.13/kWh to EUR 0.15/kWh (USD 0.18kWh to USD 0.2/kWh)
- A tariff degression delayed from 2015 to 2018, as the offshore expansion has been delayed. In return, the tariff degression rate is increased from 5% to 7%.
- Launch of a EUR 5 billion (USD 6.8 billion) credit programme by the national development bank (KfW) in order to secure financing for about 10 wind farms at market interest rates[59].
- Development of a master plan for offshore grid connection, preferably by the Federal Maritime and Hydrographic Agency.

The offshore wind energy capacity increased to 108 MW in 2011, and is expected to reach 3 GW by 2015. To date, the national maritime authority and the federal states have licensed 24 projects, bringing the overall capacity close to 7 GW. The costs for connecting offshore wind farms to the mainland grid are supported by the transmission system operators, which started to plan for connection lines to clusters of offshore projects. Three 400 MW high-voltage direct current (HVDC) lines have been completed.

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[55] Stiftung Offshore Windenergie (German Offshore Wind Energy Foundation) was created in 2005 and is the owner of the test site Alpha Ventus. The Foundation supports the expansion of offshore wind energy use in Germany and acts as a communication platform for politics, the offshore wind industry, and the R&D community. The Foundation is involved in public relations and mediation activities to overcome barriers to offshore wind, and improves public acceptance for offshore wind energy. The Foundation supported Alpha Ventus, the first German offshore wind farm, officially commissioned in April 2010. The government is still supporting the initiative in 2012 (Power Cluster, n.d.).

[56] EUR 0.092/kWh (USD 0.133/kWh), up from EUR 0.087/kWh (USD 0.13/kWh).

[57] An annual degression of 1% applies for new installations. In January 2010, the initial tariff for onshore wind was EUR 0.0902/kWh (USD 0.13/kWh). The tariff for offshore wind energy was increased to EUR 0.13/kWh (USD 0.18/kWh) plus an additional "sprinter bonus" of EUR 0.02/kWh (USD 0.03/kWh) for projects which start operation before the end of 2015. The initial EUR 0.15/kWh (USD 0.21/kWh) was to be paid for a period of 12 years, and then decreased to EUR 0.035/kwh (USD 0.05/kWh). The period is prolonged if the offshore site is located in deep waters and at a long distance from the coast. Offshore tariffs will annually decrease by 5% for new installations starting in 2015.A bonus for improved grid compatibility of EUR 0.005/kWh (USD 0.007/kWh) was also introduced, and the special tariff (repowering bonus) was kept for replacing turbines that are ten years or older, if the project doubles in rated capacity. In 2010, 56 MW was repowered and replaced by 183 GW of new turbines.

SUPPORT FOR R&D AND TECHNOLOGY DEMONSTRATION

The initial development of the German wind industry relied strongly on the government-funded R&D programme. In the period from 1977 to 1989, about 40 R&D projects were granted to industrial firms and academic organisations for the development or testing of small (e.g., 10 kW) to medium-sized (e.g., 200–400 kW) wind turbines (Jacobsson and Lauber, 2006).

In the 1980s, a set of demonstration programmes became part of the national R&D policy. Some 14 wind turbine suppliers were funded to produce 124 wind turbines between 1983 and 1991. This programme represented an important part of the national market for small wind turbines at that time. The total installed capacity reached 20 MW by the end of 1989 (Jacobsson and Lauber, 2006).

In 1989, the Ministry of Research initiated a demonstration and market creation programme for wind power. Initially, it aimed at installing 100 MW of wind power capacity. Due to the success of the first programme, the Ministry expanded the objective to 250 MW in 1991.

The programme mainly involved a guaranteed payment of EUR 0.04/kWh (USD 0.08/kWh) for the electricity produced, which was subsequently reduced to EUR 0.03/kWh (USD 0.06/kWh).

Long-term R&D support has been continuously available for the wind power sector in the country. Recent highlights include:

- The 2010 opening of the Alpha Ventus offshore test site, complementing the research initiative called "Research at Alpha Ventus" (RAVE). This offshore test site aims to acquire fundamental technical and environmental information for the future expansion of offshore wind energy (Lang, 2012a).
- Continued funding for the operation of three research platforms – FINO 1, 2 and 3 – in the North and the Baltic seas. These platforms provide data to industry and research institutions.
- Fraunhofer Institute for Wind Energy and Energy System Technology (IWES) coordinates 45 research institutions and companies, which are involved in wind energy research. Currently an important topic of research is the foundations and support structures for an offshore wind turbine, which account for about a third of its capital costs.
- In 2011, the BMU[60] approved 74 projects with a total funding amount of EUR 77 million (USD 99.9 million). In 2010, the BMU approved 37 projects with a total funding of EUR 53 million (USD 75.3 million).

CURRENT CHALLENGES

The Federal Building Code continues to be a key regulation impacting on wind power development. Under this law, wind energy plants are categorised as "privileged projects" and local authorities are required to designate specific priority or preferential zones for wind projects. The developments can also be restricted in specific areas (exclusion zones). In several regions, restrictions inhibit the turbines from installing at the best height for their operation, where they could yield the maximum amount of energy (GWEC, 2010). In 2010, the Federal government and some states started to reconsider the authorisation conditions to allow continuous development onshore, and have entered into discussions with local and regional planning authorities.

Another key challenge for integrating renewable energy generation is the expansion of the grid, including underground cabling in critical areas in order to increase public acceptance. In 2010, the equivalent of 150 GWh of wind power was lost because grid operators had disconnected the wind turbines due to overproduction, which had increased by 69% compared to 2009 (Sewohl, 2012).

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[58] The German "Energy Concept" includes official targets for Renewable Energy: "Renewable energies are to achieve an 18% share of gross final energy consumption by 2020, a 30% share by 2030, 45% by 2040 and 60% by 2050. By 2020 renewables are to have a share of at least 35% in gross electricity consumption, a 50% share by 2030, 65% by 2040 and 80% by 2050." (BMU, 2011b).

[59] The KfW special programme for offshore wind was also designed to help increasing competition in the offshore sector. Until recently only four of the large utilities could bear the investment risk. The special programme will give small- and medium-sized companies and municipal utilities access to loans via KfW.

[60] BMU has signed a Joint Declaration on Cooperation in the Field of Research on Offshore Wind Energy Deployment with the energy ministries of Denmark, Norway and Sweden to facilitate an exchange of knowledge about offshore wind energy, and has continued its work within the International Energy Agency's Implementing Agreement on Wind Energy Research (IEA Wind). As a rule, most of the projects have a term of three years. In 2011, EUR 44 million (USD 57 million) was allocated to on-going projects (2010: EUR 37 million or USD 52.5 million) (BMU, 2012b).

The EEG specifies that grid operators have to pay for the power when wind turbines are disconnected from the grid (called curtailment). In the short- to medium-term, energy losses from curtailment are likely to increase. A difficult element will be to ensure the social acceptance of the projects for transmission and distribution lines that are required by the growing amount of wind energy.

The overall grid transport capacity in Germany can also be improved through soft measures such as temperature conductors, load flow management and other "smart grid" options. The upfront costs for integrating higher shares of wind energy may need to be considered in the broader perspective of the integration of the European electricity market. Additional storage capacities and HVDC interconnectors would need to be planned. In the current economic conditions these developments are likely to face financing constraints, thereby affecting the pace of integration plans for renewable energy.

Repowering will play a large role in the future, and is estimated to have the potential to double the amount of onshore wind capacity and to triple the country's energy yield with significantly fewer turbines deployed. By 2015, almost 6 GW of installed capacity will be older than 15 years[61] and ready for repowering.

CONCLUSION

The current position of Germany in the global wind market can primarily be attributed to decades of progressive and targeted legislation. By the early 1980s, a growing environmental movement influenced the energy debate in the German Parliament and the energy policy of the federal government.

Geographically dispersed wind farms, largely developed by small enterprises and cooperatives, have characterised wind development in the country. Historically, private citizens and mostly cooperative programmes owned the majority of the wind turbines. The involvement of a large number of small investors has contributed to a broad public support for wind energy projects, and has significantly reduced the "not in my backyard" problem that has been encountered in other large markets. Another supporting factor was the interest of farmers, who helped develop the financing market for early wind projects by providing their land as collateral for development costs. Most of the early jobs created by the wind energy sector were in small- and medium-sized enterprises and in regions that were rural or economically less developed. This helped to create a positive view of the technology and its socio-economic benefits.

[61] Repowering a turbine is only economical after 15 or more years of operation.

Germany's renewable energy polices and wind energy market since the late 1990s had a positive impact on the global renewable energy debate. The rapid progress made in achieving the national renewable energy targets had a large impact on other national markets. The policies in place translated the idea of a sustainable and clean energy supply into concrete developments. This development is emblematic, since it has been accomplished by the world's fifth-largest energy consumer.

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ANALYSIS ON ENABLING CONDITIONS FOR WIND ENERGY

Effective rule of law; and transparency in administrative and permitting processes	The legislation is clearly defined and has been enforced in a timely and targeted manner. Clear guidance is provided through the building codes, while siting and permitting laws are available for all landscapes.
A clear and effective pricing structure	A feed-in tariff has been available since 1991. Its subsequent revisions have allowed long-term certainty in the stability of the national market for both the local wind industry and its investors.
Provisions for access to the grid (incentives and penalties for grid operators)	Clear guidance is available to utilities, electricity generators and consumers on the role and duties of the grid operators. However, cooperation of regional grid companies in expanding the inland grid capacity and the offshore connections is not optimal. Issues related to grid integration are causing delays and adding risk to future projects.
An industrial development strategy	Focused and early support for R&D programmes was available for wind energy, as well as early support for demonstration projects both onshore and offshore. However the offshore development has run into delays.
A functioning finance sector	Wind projects have received long-term support from the National Development Bank (KfW) and the regional finance sector. Europe's current economic conditions and the impact of Basel 3 regulations[62] could influence the ability of German lenders to finance large projects (especially offshore) in the short- to medium-term.
Expression of political commitment from government (e.g., targets)	According to the National Renewable Energy Action Plan, the percentage of energy from renewable sources in the gross final energy consumption will rise from 6.5% in 2005 to 18% in 2020, and could even be surpassed to reach an aspirational target of 19.6%. Targets up to 2030 would be welcome, in order to provide long-term certainty for both the offshore and onshore developments.
A government and/or industry-led strategy for public & community buy-in	As a result of the national commitment to renewable energy, the country has seen a tremendous increase in renewable energy production since the 1980s as well as job creation and industrial development.

[62] Requiring higher shares of equity.

An employment development strategy	At an early stage, the regional governments provided regulatory and financial support for small- and medium-sized enterprises to build and operate wind turbines and farms. By 2011, Germany had created more than 100 000 jobs in the wind industry.
NOTE	**In Germany most of the early jobs created by the wind energy sector were in small- and medium-sized enterprises, often in rural or less developed regions. This helped create a positive view of the technology and highlighted its socio-economic benefits.**

REFERENCES

- BMU (Bundesministerium für Umwelt, Naturschutz Und Reaktorsicherheit) (2011a), "Cornerstones of the EEG amendment and other innovations for renewable energy", *www.erneuerbare-energien.de/erneuerbare_energien/doc/47469.php#3.*
- BMU (2011b), "The Energy Concept and its accelerated implementation", *www.bmu.de/english/transformation_of_the_energy_system/resolutions_and_measures/doc/48054.php.*
- BMU (2012a), "Act on granting priority to renewable energy sources: Renewable Energy Sources Act – EEG", BMU, Berlin, *www.erneuerbare-energien.de/files/english/pdf/application/pdf/eeg_2012_en_bf.pdf.*
- BMU (2012b), "Wind Energy", *www.erneuerbare-energien.de/english/renewable_energy/doc/42660.php*
- GWEC (2013), "Annual Market Update 2012", *Global Wind Report,* GWEC, Brussels.
- Jacobsson, S. and Lauber V. (2006), "The Politics and Policy of Energy System Transformation—Explaining the German Diffusion of Renewable Energy Technology", *Energy Policy*, Vol. 34, No.3, Elsevier, pp. 256-276.
- Lang, M. (2012a), "Alpha Ventus Offshore Wind Farm Exceeds Projected Yield", German Energy Blog, *www.germanenergyblog.de/?p=8812*
- Power cluster (n.d.), "German Offshore Wind Energy Foundation", *www.power-cluster.net/AboutPOWERcluster/ ProjectPartners German Offshore WindEnergyFoundation/tabid/626/Default.aspx*
- Runci, P. (2005), "Renewable Energy Policy in Germany", *Pacific Northwest National Laboratory Technical Lab Report PNWD-3526*, Joint Global Change Research Institute, University of Maryland, Maryland.
- Sewohl, A. (2012), "Wind Power Losses from Grid Disconnections up by as much as 69 Percent", BWE (German Wind Energy Association), *www.wind-energie.de/en/infocenter/articles/wind-power-losses-grid-disconnections-much-69-percent*
- Sijm, J.P.M. (2002), "The Performance of Feed-In Tariffs to Promote Renewable Electricity in European Countries", *www.ecn.nl/docs/library/report/2002/c02083.pdf.*
- WWF (World Wildlife Fund) Finland (2008), *Smart Climate Solutions: Seven International Success Stories,* Gaia Consulting Oy, Helsinki.