

MEMO

24 May 2011

Case no.

Reference.: PCJ/HW/FGN

The wind turbine industry: a historical flagship

Introduction

The Danish tradition for wind turbines is deeply rooted in the past. However, in order to focus on the recent history that has formed the basis of the industry's current status and development, the time perspective of this memo is 1974 to the present day. This period has been chosen due to the significance of the first oil crisis in 1973. This crisis resulted in a number of international and national measures and plans, in order to resolve issues concerning energy prices.

This memo does not contain comparative economic analyses of the cost effectiveness of the wind turbine industry.

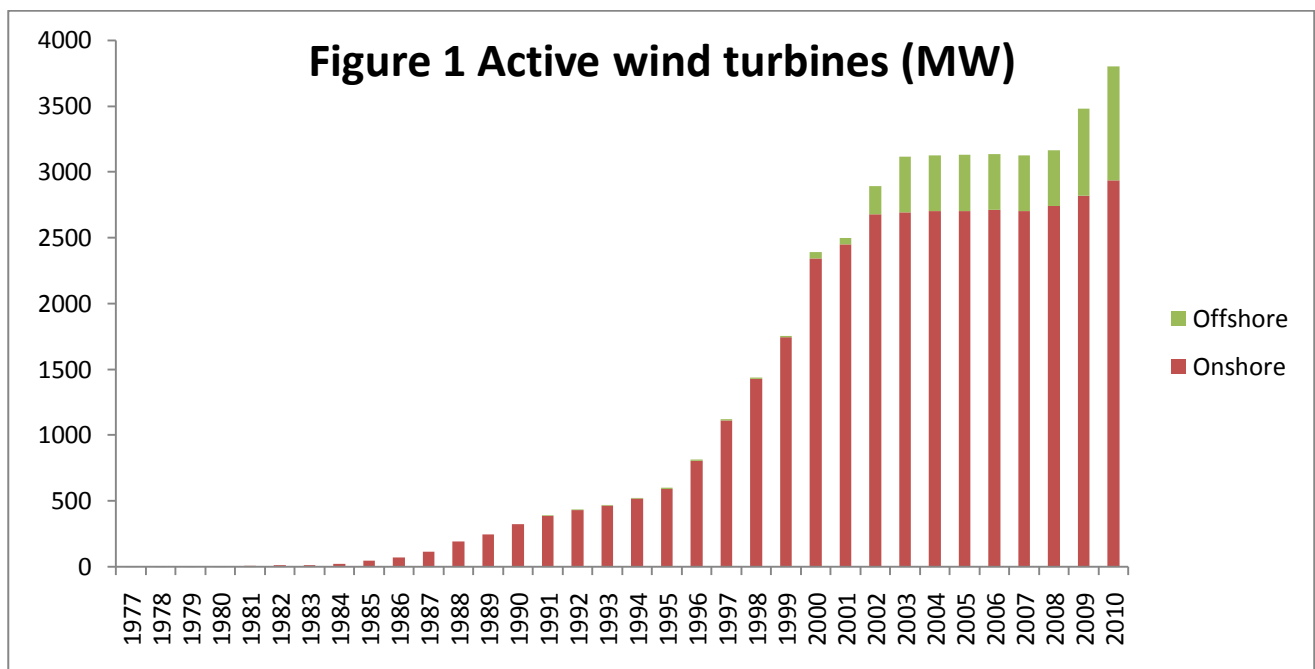
Milestones

In a historical perspective, the development of the wind turbine industry has been a success. The following milestones have been of particular importance in terms of influencing and promoting this development:

- The oil crisis in 1973 gave rise to an ambition to become independent of imported oil.
- Funds for research from 1976 and testing facilities from 1978.
- Exports to the Californian market in 1982/83. Early on, enterprises combined their production for both the domestic and international markets.
- Funding for wind turbines. Initially as capital installation subsidies and then from 1984, as funding for electricity production. Funding for electricity production has probably had the most influence on incentives for private individuals to erect wind turbines.
- The European Commission's acceptance of the (high) Danish subsidy rates under the regulations on state aid.
- Contracts/requirements for power companies to install wind turbines from 1985 have been crucial to the expansion rate.
- International political support for wind power from 1987 based on the Brundtland Report.
- Systematic planning process involving relevant parties.
- Initial development of the industry on the basis of a bottom-up process in which individuals and communities play a crucial part. This paved the way for the future wind turbine industry by providing a basis of knowledge, local acceptance etc.

Status of the wind turbine industry

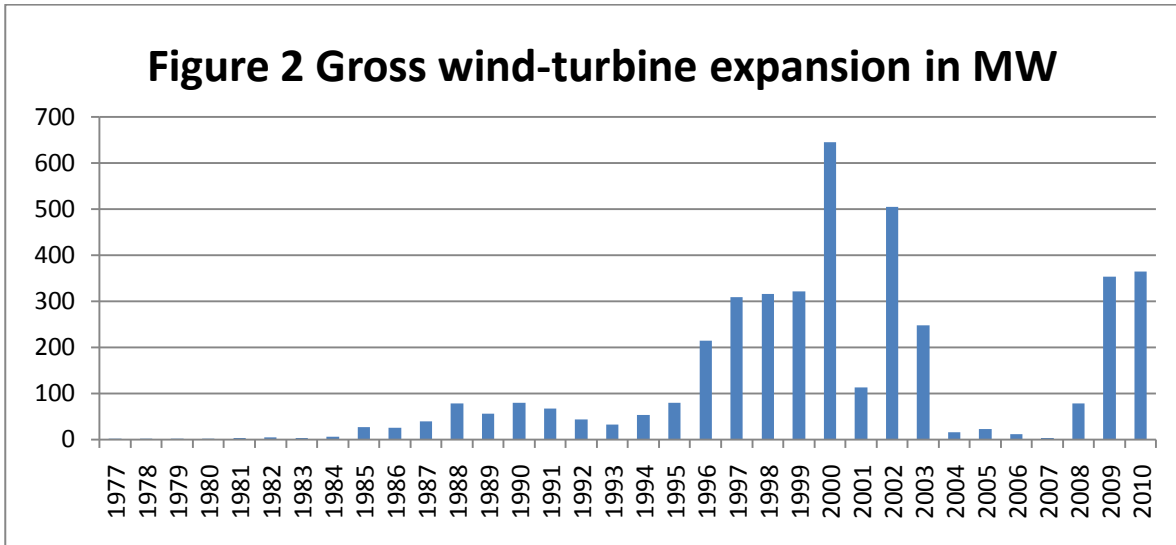
Many different indicators can be used to illustrate the development of the wind turbine industry. The number of active turbines, gross wind turbine expansion, the public service obligation (PSO), exports and employment will be described in the following.



Source: The Danish Energy Agency's Register of wind turbines, end of March 2011

All turbines connected to the grid are listed in the Register of wind turbines. The register shows that wind turbines totalling approximately 3,800 MW had been installed by the end of 2010. Development in number of existing active wind turbines broken down by year of grid connection is shown in figure 1.

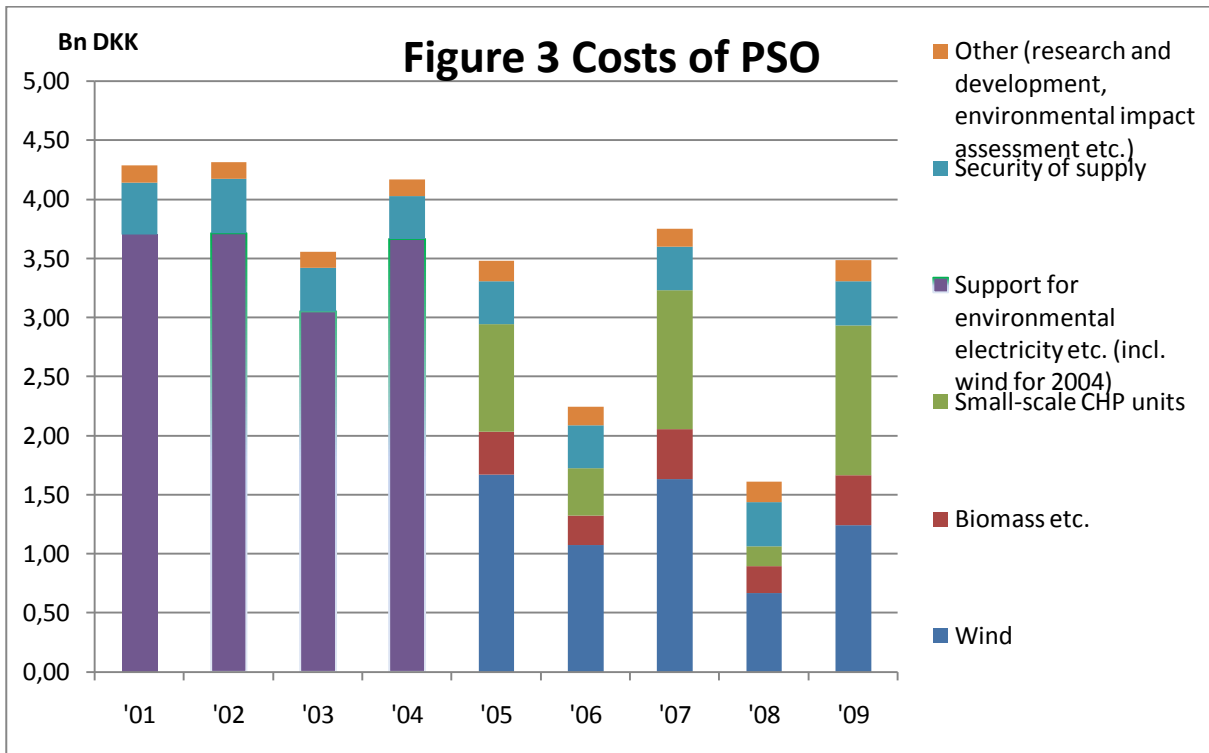
Gross wind-turbine expansion is shown in figure 2. Until 1995, a small number of turbines were installed annually with an output of approximately 80 MW. From 1996 to 2003, just under 2,700 MW were installed with a maximum in 2000 of approximately 650 MW. Very few wind turbines were installed from 2004 to 2008. This trend was reversed in 2009 to 2010 with installation of about 700 MW, of which 450 MW were offshore.



Source: The Danish Energy Agency's Register of wind turbines, end of March 2011

Note: Gross wind-turbine expansion means the number of wind turbines that are installed annually, with no adjustment for the number of turbines dismantled.

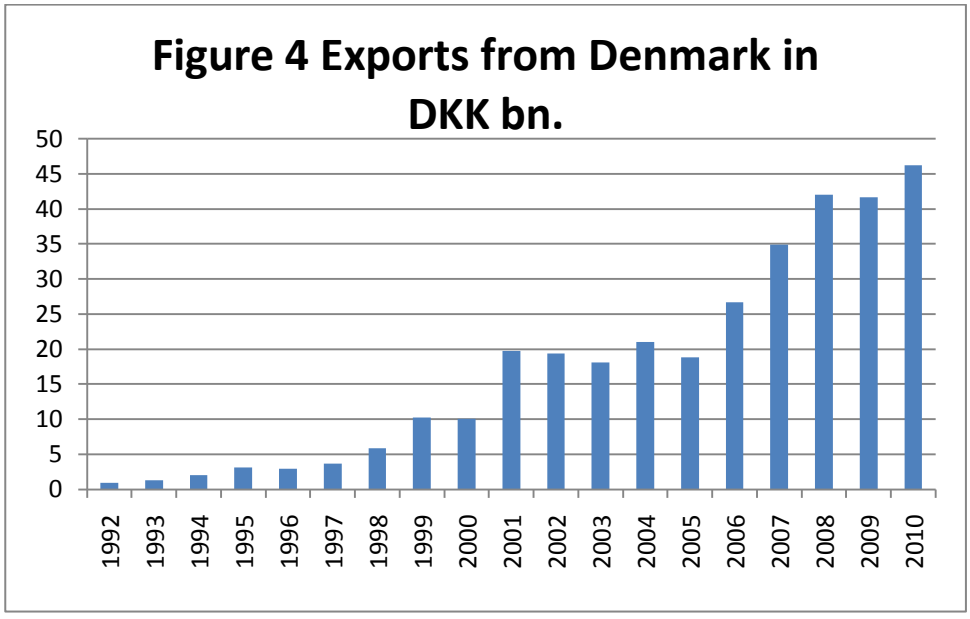
Funding for wind power was converted to a price supplement in 2001 - the PSO (Public Service Obligation). The PSO is paid by all electricity consumers. The costs of PSO are shown in figure 3. The price supplement for wind power in 2001 to 2004 has been included in the sum of funding for environmentally friendly electricity etc. The price supplement for wind power has not been included in subsequent years. From 2005 to 2009, the annual costs fluctuate significantly between about DKK 1.7 bn. in 2005 to about DKK 0.7 bn. in 2008. This fluctuation is particularly due to the development in the market price of electricity, which influences the funding element. Another significant factor is the differences in wind production each year, i.e. deviations from a normal wind year.



Source: Energy statistics 2010, the Danish Energy Agency

The Danish Wind Industry Association prepares statistics for the sector. According to the latest statement, (see figure 4), Danish wind turbine exports increased from 1992 to 2000 to approximately DKK 10 billion. From 2001 to 2005, exports amounted to approximately DKK 20 bn. per year. Subsequently, exports rose even more, to about DKK 46 bn. in 2010.

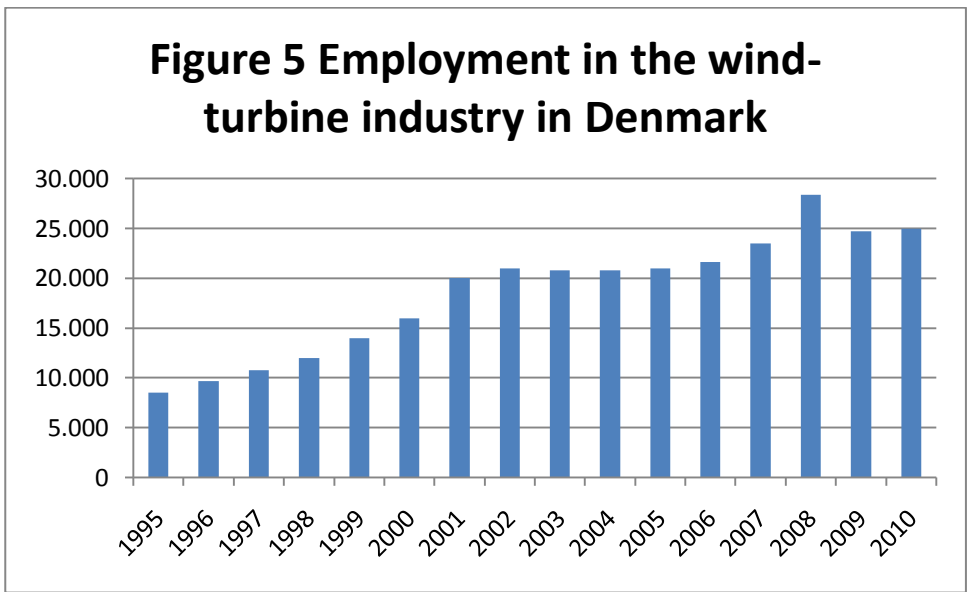
In collaboration with the Danish Energy Industries Federation and the Danish Enterprise and Construction Authority (DECA), the Danish Energy Agency publishes annual export figures for energy technology. From 2009 to 2010, exports of energy technology and equipment fell by 10.8% and in 2010 exports amounted to DKK 52.2 bn. Furthermore, a collaboration has been established to update and develop the analysis. Additionally, the Danish Energy Agency and the Danish Wind Industry Association are engaged in an ongoing dialogue concerning coordination of data compilation.



Source: The Danish Wind Industry Association

Note: According to The Danish Wind Industry Association, these figures have been calculated on the basis of a questionnaire survey.

The number of people employed in the wind turbine industry has also been calculated by the Danish Wind Industry Association in the industry statistics. From 1995 to 2002, employment rose from slightly less than 9,000 to about 21,000. On to 2006, employment only increased slightly. In 2008, employment peaked at about 28,000 people. Subsequently, this number fell to about 25,000 in the years 2009 and 2010.



Source: The Danish Wind Industry Association

Note: According to the Danish Wind Industry Association, these figures have been calculated on the basis of a questionnaire survey.

Development in the wind-turbine industry

The development of an industry can be characterised by either a top-down or bottom-up energy and economic policy development strategy. *Top-down strategy* is a technology development strategy with a strong scientific and technological knowledge base that has a strongly publicly funded research-base that enables a large stepwise upscaling of wind-turbine design to MW-size. The *bottom-up strategy* is a strategy for technology development based much more on existing engineering knowledge and/or production-related technological knowledge. This strategy entails very slow upscaling of turbine size.

In Denmark, the wind-turbine industry had both a top-down strategy and bottom-down strategy. In 1977, a budget of DKK 35 million in 1977-prices was allocated for a development programme for wind power. The fundamental task of the top-down process was the development of know-how on planning and construction of large wind turbines.

In parallel, there was a bottom-up process in which local contractors, small developers and grass roots constructed and installed small functional wind turbines for own use or on behalf of their friends. This development was based on empirical experience, learning processes and rules of thumb.

Work with wind turbines was not only taking place in Denmark at that time. The US, West Germany, the Netherlands and Belgium were also trying to develop the industry, either by using a top-down or bottom-up strategy.¹

In 1995, the Danish Institute of Governmental Research prepared a report on the societal value of wind power. In that connection, the Danish Institute of Governmental Research made the following assessment of the phases, the industry has gone through since 1974. (The following description, including table 1, is a translation of the report by the Danish Institute of Governmental Research.) Table 1 compiles the development phases that the wind turbine industry has gone through since the mid 1970s. The six phases are based on the industry's economic development. In phase 1 from 1974-79, the first entrepreneurs began to experiment with different turbine designs. The test station for small wind turbines was established in 1978 and with the approval scheme, the station became central in terms of proactive market funding, which set off phase 2 and the early industrialisation. During phase 2, enterprises more or less mastered the 55 kW turbine which, together with the subsidy, was the foundation of domestic production. The relatively well-functioning wind turbines became the basis for large exports to the Californian market, which opened in 1982/83 and escalated in phase 3 in 1984-85. During this period, the technological challenge was the requirement for a very speedy transition from series to mass production of a product that had not yet been fully developed. The organisational and market-related challenge was to manage this growth as well as learn how to succeed on the export market.

Phase 4 was characterised by a rapidly declining export market; an initially stagnant domestic market, which since increased; and a series of bankruptcies among wind turbine manufacturers. The weak market provided enterprises with the necessary calm - and for

¹ Dansk vindmølleindustri, Peter Karnøe. 1991

reconstructed companies capital as well - to focus on further product development. This was necessary because subsidies on the US market had been discontinued and subsidies on the Danish domestic market had been reduced significantly. The only solution for the industry was to produce wind turbines that were more cost-effective. Then, after two to three difficult years, economic development triumphed in phase 5. The domestic as well as the export markets flourished once again and in 1990, the industry saw revenues of about DKK 1 bn. - half of which was for exports.

Phase 6 is ongoing and is characterised by strong growth driven by export to emerging markets, which has followed the dependence on the US market.

Table 1. Periodical development of the Danish wind-turbine industry 1974-1994

Phases	Industrial phase
1. 1974-79 Entrepreneurs and Grass roots	Emergence
2. 1980-83 Early industrialisation	Development
3. 1984-85 Forced industrialisation	Expansion and hectic activity
4. 1986-88 Crises and decreasing exports	Technological consolidation, but economic crisis
5. 1989-92 Stable domestic growth and growth in exports	Economic and technological consolidation
6. 1993-94 Significant growth in exports 1)	Economic and technological consolidation

Source: Societal value of wind power, report by the Danish Institute of Governmental Research. December 1995

Note: 1) This note was written in 1995, at which time development in exports seemed to be significant.

Subsequent developments have shown that the export success had only just begun (ed.).

A proposal for a continuation of the phases by the Danish Institute of Governmental Research is shown in table 2. Table 2 shows the development of the wind power industry from 1995 to 2010 and summarises the results of the above figures.

Table 2. Development in the wind-turbine industry from 1995-2010

7. 1995-2003	Considerable growth in expansion
8. 2004-07	Expansion stops. Significant growth in exports
9. 2008-10	Expansion increases once again. Stabilisation of exports at high levels

Source: The Danish Energy Agency

Public funding and subsidies

Wind-turbine-generated electricity has been receiving support since 1976. From 1976 to 1989, in form of investment aid. Initially, subsidies accounted for 40% of the investment costs. However, the subsidies were gradually reduced up until 1989, when this type of subsidy was discontinued.

Until the early 1980s, the majority of wind turbines were small and connected to their own electrical installations. When consumers used their own wind turbine production, they saved money on electricity taxes, among other things. As wind turbines became larger and larger, and had to be connected to the public grid, the wind turbine manufacturers required that being exempt from payment of electricity tax should continue to apply when the wind turbines were supplying the grid. The Danish Ministry of Energy supported this equalisation of the tax exemption. Following immense pressure on the Danish Ministry of Taxation, a bill was introduced in 1983 and subsidies were subsequently provided for electricity produced by means of renewable energy, and which was supplied to the grid. Costs for these subsidies would amount to a couple of DKK million per year according to the notes of the bill.

After a couple of increases in the electricity tax, the subsidy was fixed at DKK 0.23/kWh plus VAT (a total of DKK 0.28/kWh). In connection with the implementation of the CO₂ tax-package in 1992, the subsidy was removed from the Electricity Tax Act and converted to a special subsidy of DKK 0.27/kWh, of which DKK 0.10/kWh was compensation for the CO₂ tax and the remainder was an extra subsidy for renewable energy.

In 1999, subsidies for production of renewable energy electricity reached about DKK 1.4 bn. The Danish Ministry of Finance put considerable pressure on the government to reduce these. Then in 1998, the government, led by the Danish Social Democratic Party and the Danish Social-Liberal Party, agreed on a new Finance Act for 1999 with the Liberal Party of Denmark, the Conservative People's Party and the Danish Centre Democrats. The new Act included the liberalisation of the electricity sector which would yield a budget improvement of DKK 2 bn.

In order to comply with the Finance Act, and as part of the Electricity Reform of 1999, subsidies for renewable energy were converted from a government subsidy to a PSO funding, which yielded savings of DKK 1.4 bn. The remaining DKK 0.6 bn. was collected by means of a special distribution tax on electricity consumption.

Simultaneously, the Electricity Reform established a phased reduction in subsidies for wind turbines. In 2002, it was agreed that subsidies for wind turbines should be reduced to DKK 0.10/kWh. This practically led to a stop in development, and in 2007 the government proposed to increase subsidies from DKK 0.10 to DKK 0.15/kWh. The wind-turbine industry wanted subsidies to be concentrated in the first 10 years of the wind turbine's service life for reasons of financing. Therefore, the result of the 2008 agreement was DKK 0.25/kWh for 22,000 peak-load hours, which corresponds to approximately DKK 0.15/kWh over the service life of a turbine.

This means that the settlement of electricity produced by wind turbines today primarily depends on when the wind turbine was connected to the grid, and how old it is. New onshore or offshore wind turbines that are not included in tendering procedures receive price supplements of DKK 0.25/kWh for 22,000 peak-load hours as well as allowances of DKK 0.023/kWh for balancing costs, etc. As for offshore wind turbines that are included in calls for tenders, the price supplement depends on the tender. Annex 1 contains a full list of existing settlement terms.

Throughout the period, complex negotiations have been held with the European Commission on the Danish rates for funding and subsidies. Negotiations were especially difficult in the mid 1990s, as Denmark was a pioneer within the wind turbine area and therefore became a "test case" for new, and tighter EU regulations for state aid for renewable energy.

Research, development and demonstration

To ensure continuous development in any industry, it is crucial to set aside funds for research, development and demonstration, and to enable testing of new products. Tables 3 and 4 show allocated funding for wind energy from 1976-2009.

Table 3 Funding from the Energy Research Programme (ERP) for wind power (DKK million in annual prices)

1976/77-1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
133	11	11	9	10	10	10	9	9	12	13	15	15	13	13

Source: The Danish Energy Agency

Note: In the 1990s, funding from the development programme for renewable energy, estimated at around DKK 15 mill. per year, was provided for the development of wind power in addition to the specified funding.

Table 4 Funds for wind power from the EUDP, ForskEL, the Danish Council for Strategic Research and the Danish National Advanced Technology Foundation (DKK million in annual prices)

2001	2002	2003	2004	2005	2006	2007	2008	2009
26	22	9	48	39	19	73	80	137

Source: The Danish Energy Agency

Note: ForskEL is an Energinet.dk funding programme.

Initiatives within the area:

- A test station for small wind turbines was established in 1978 as part of the overall research programme.
- The Nordic Folkecenter for Renewable Energy was established in 1983.
- The Energy Research Programme (ERP) was launched in 1976.
- The Council for Renewable Energy, including the development programme for renewable energy were established in 1991.
- The test station for large wind turbines, Høvsøre, was established in 2002.
- Megavind was established in 2006 and is based on the Danish Research Consortium for Wind Energy, which was established in 2002. Megavind promotes and initiates enhanced testing, demonstration and research strategy for wind power in Denmark.
- A new test station at Østerild, that was included in the energy agreement from 2008, is under construction.

International and national measures and plans etc.

The development of renewable energy, including the wind turbine industry, has been continuously affected by *international* policy measures. These measures mean that each country's policies are constantly being updated, which is likely to have a favourable impact on the commercial potential for the wind turbine industry abroad.

Internationally, the first trendsetting work was conducted by the Brundtland Commission, which was established by the UN in 1983. This resulted in the Brundtland Report in 1987. Then came the Rio Conference and the Rio Climate Convention in 1992. Furthermore, the Kyoto Protocol was signed in 1997 and came into force in 2005. After these three milestones, international focus has been on reaching agreements in areas where solutions for climate change can be combined with security of supply and the economic perspective.

Nationally, the following measures etc. have contributed to the development of the wind-turbine industry:

- The oil crisis in 1973 gave rise to an ambition to become independent of imported oil.
- The amendment of the Electricity Tax Act in 1984, resulted in subsidies for electricity produced by wind turbines and supplied to the grid. Subsidies were provided so that the electricity produced by renewable energy received a subsidy corresponding to the electricity tax. In 1992, this form of subsidy was converted into a direct state subsidy of DKK 0.27/kWh, and in 1999, the Electricity Reform transformed subsidies from state subsidies to the lower Public Service Obligation subsidy.
- In 1985, an agreement was made with power companies to install 100 MW wind turbines.
- The rule that electricity companies have a general obligation to develop or enhance the overall electricity grid, so that new wind turbines can always be connected. This was introduced on 9 March 1992 by an agreement between the government and the Social Democratic Party.
- In 1996, requirements to power companies to establish an additional 900 MW wind turbines up to 2005.
- In 1998, requirements to power companies to expand by 750 MW offshore wind turbines, each of approximately 150 MW before 2008.

- Electricity Reform: In 1999, the electricity market was liberalised and from 2001, the subsidies system was fundamentally changed. Subsidies are being paid by all electricity consumers as a price supplement (PSO).
- The energy agreement of 2004 includes a call for tenders concerning two offshore wind farms of 200 MW each with grid connection in 2007/2008.
- The energy agreement from 2008 includes a call for tenders with regard to an offshore wind farm of 400 MW for commissioning in 2012. In addition, the agreement determines the introduction of four new schemes: loss-of-value scheme, option to purchase scheme, guarantee scheme and the green scheme.

Planning

A key feature of the Danish wind turbine development model is the planning procedures that partly contribute to establishing wind turbines and partly to involving relevant stakeholders.

In the beginning of this period, the wind turbines being installed were small onshore turbines and the initiators were mainly local residents. In other words, it is very likely that finding suitable sites for the turbines was much easier than it is today. The size of turbines is ever increasing and the degree of local involvement is generally ever decreasing.

The following major planning measures have contributed to municipal planning efforts *onshore*:

In 1990, "Energy 2000 - an action plan for sustainable development" was introduced. This action plan became the basis for a development in the energy sector towards greater efficiency and less environmental impact. The plan follows up on the Brundtland Report.

In 1992, the Wind Turbine Location Committee recommended that municipalities drew up municipal plans for the expansion of wind turbines with a view to ensuring increased coordination between the parties involved. The Minister for the Environment urged the municipalities and counties to follow this recommendation.

In 1994, municipalities were ordered to decide, in their municipal plan or in an appendix to municipal planning documents, where and to what extent wind turbines could be installed.

Similar orders have also been given to municipalities later.

Today, planning of wind turbines up to 150 meters onshore is managed by municipalities. The rules for municipal planning ensure that the public, associations, authorities and other stakeholders are involved in the process.

Apart from household wind turbines and smaller turbines, wind turbines may only be installed in areas reserved for this purpose by means of municipal designation and guidelines. The municipality must therefore assess which areas are suitable for wind turbines. Through its planning, the municipal council must ensure that neighbouring residents, nature, landscape, historical and cultural values, agricultural interests as well as the ability to exploit the wind resource are all taken into consideration.

Scrappage schemes have been introduced twice, most recently by the energy agreement for 2004, in order to renovate old and outdated turbines.

The first *offshore* wind farm was established off Vindeby in 1991 and planning was subject to the rules on environmental impact assessment (EIA). This means that the relevant authorities were involved in the planning.

Today, the Danish Energy Agency is the planning authority for planning and installation of offshore wind turbines. To simplify project developers' preparation of new offshore wind turbine projects as much as possible, the Danish Energy Agency gathered together processing by the authorities in a "one-stop-shop", which means that a developer who wishes to establish an offshore wind turbine project, only has to contact one authority, the Danish Energy Agency, to get the necessary permits.

As a one-stop-shop, the Danish Energy Agency contacts other relevant authorities. The Danish Energy Agency also plans consultation of relevant stakeholders and provides the necessary permits.

In comparison with processing by authorities for offshore wind farms in other countries, the Danish model has proven to be a quick and cost-effective process, reducing operating costs of individual projects and benefiting the expansion of offshore wind farms.

The wind-turbine industry and foreign countries

So far, the Danish wind-turbine industry has had a leading position globally. The current export status is shown in figure 4. However, it is likely that foreign manufacturers will catch up with Danish manufacturers in coming years. A very important market is arising from international political agendas, see figure 8.

The EU Member States have committed themselves to meeting targets for conversion to renewable energy. This has resulted in a competition to attract manufacturers in order to ensure installation of turbines. However, the member states are also competing to become the hub for further wind turbine development with ensuing positive effects such as increased employment, growth and knowledge.

Figure 6 shows a comparison of conditions in Denmark, the Netherlands, Great Britain and Germany with regard to offshore wind turbines. Deloitte has conducted assessments based on interviews with prospective investors.

Figure 6 Attractiveness of national conditions for important elements for large offshore wind farms from an investor’s perspective

	Danish model	Dutch model	British model	German model
Political plans for expansion of offshore wind energy	<ul style="list-style-type: none"> No objectives or specific expansion plans 	<ul style="list-style-type: none"> Previous high ambitions have been postponed 	<ul style="list-style-type: none"> Ambitious and very specific plans for new capacity rolled out through successive tendering procedures 	<ul style="list-style-type: none"> Strategic long-term ambition for offshore wind capacity, but not any specific plans
(Tender) model for concessions	<ul style="list-style-type: none"> Single site auction The state defines the site Limited dialogue with tenderers as part of the latest tenders 	<ul style="list-style-type: none"> Multi-site/open selection auction Investor finds and proposes sites Dialogue with tenderers 	<ul style="list-style-type: none"> Multi-site tender process The state designates zones – investor finds and suggests sites within these zones Competitive-influenced dialogue 	<ul style="list-style-type: none"> Open-door procedure Investor finds and suggests sites
Criteria for winning the call for tender	<ul style="list-style-type: none"> Lowest settlement price offered 	<ul style="list-style-type: none"> Lowest tariff offered Site permit must be acquired beforehand 	<ul style="list-style-type: none"> Tender after negotiation Beauty contest (based on developer’s project proposal and capacity) 	<ul style="list-style-type: none"> First come, first served Permit must be acquired beforehand
Timeframe for use/establishment	<ul style="list-style-type: none"> Fixed and tight (establishment must be completed 2-3 years after assignment) 	<ul style="list-style-type: none"> Fixed, but moderate (construction must be initiated no later than 3 years after assignment) 	<ul style="list-style-type: none"> Fixed, but tolerant (2018 for tendering round III from 2008) 	<ul style="list-style-type: none"> Flexible and tolerant
Support settlement for electricity sales	<ul style="list-style-type: none"> Fixed settlement price defined by winning bid (10-15 years forwards) Full deduction of electricity revenues No settlement at negative market prices 	<ul style="list-style-type: none"> Fixed tariff defined by winning bid (15 years forwards) Supplement for distance to coast Partial deduction of electricity revenues Cap of total production to be subsidised 	<ul style="list-style-type: none"> Renewable obligation certificates (ROC) in addition to electricity price (until 2037) Extra credits for offshore wind 	<ul style="list-style-type: none"> Fixed standard tariff (at least 12 years forwards) Full deduction of electricity revenues Expansion of subsidised period for large distances to coast and depths
Additional incentives (penalties, sprinter bonus etc.)	<ul style="list-style-type: none"> Penalty for untimely termination of contract Penalty for transgression of deadline for grid connection 	<ul style="list-style-type: none"> Favourable tax depreciation rules for investments Penalty for untimely termination of contract Innovation bonus 	<ul style="list-style-type: none"> Exemption of electricity consumers from the Climate Change Levy Leasing tax for sites Application fee and guarantee 	<ul style="list-style-type: none"> Sprinter bonus (decreasing for commissioning after 2015)
Grid connection	<ul style="list-style-type: none"> Free connection; conducted, financed and underwritten by the state 	<ul style="list-style-type: none"> Investor pays costs for grid connection 	<ul style="list-style-type: none"> Investor manages and pays costs for grid connection Fees for the use of cables 	<ul style="list-style-type: none"> Free connection, the state conducts and finances (but only until 2015)
Environmental impact assessment	<ul style="list-style-type: none"> Carried out before the tender procedure Financed by the state 	<ul style="list-style-type: none"> Carried out before auction Financed by investor 	<ul style="list-style-type: none"> Carried out in continuation of tendering procedure Financing is shared between state and investor 	<ul style="list-style-type: none"> Carried out in connection with application Financed by investor
Authority procedures and planning	<ul style="list-style-type: none"> Streamlined one-stop-shop Detailed basis of planning 	<ul style="list-style-type: none"> Close to one-stop-shop Detailed basis of planning 	<ul style="list-style-type: none"> Individual permit procedures, but working on one-stop-shop Limited basis of planning 	<ul style="list-style-type: none"> Detailed basis of planning

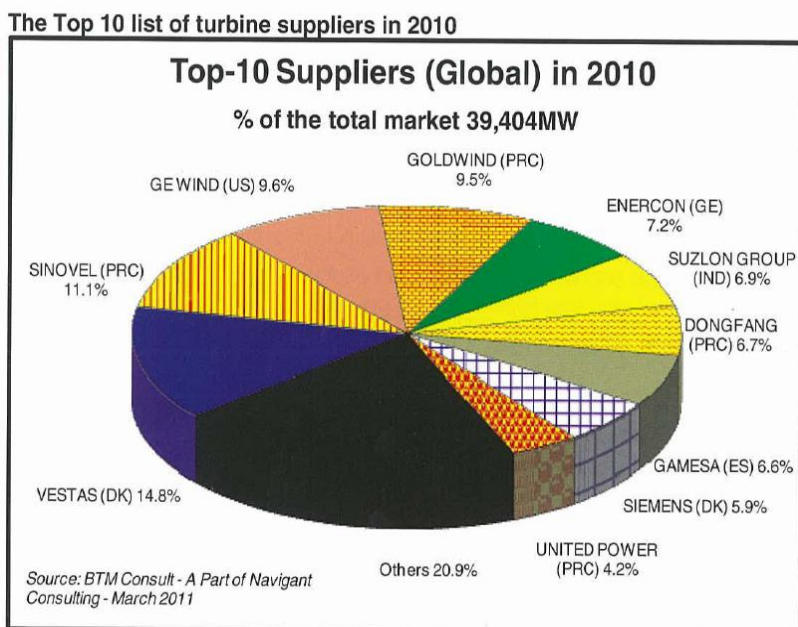
Source: Analysis of promotion of competitiveness in installation of large offshore wind farms in Denmark, Deloitte. April 2011

Note: The green colour indicates very attractive conditions, yellow indicates relatively neutral conditions and red indicates less attractive conditions.

Outlook for the future

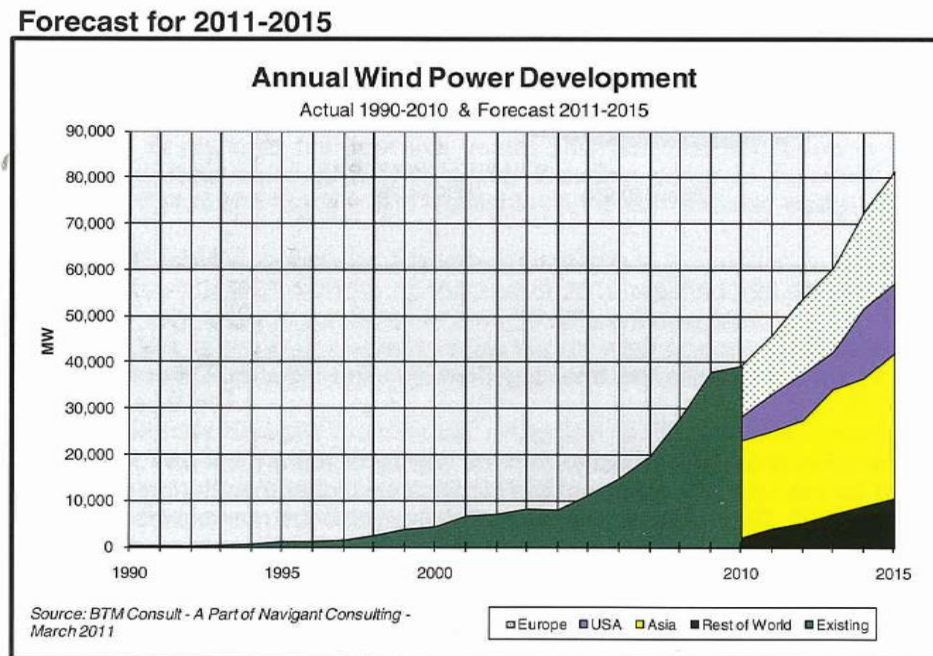
BTM Consult prepares an annual report entitled "World Market Update" on developments in the international wind turbine industry. According to the latest edition from 2010, 39,404 MW were installed globally in 2010, i.e. a total of 199,520 MW. Of these 39,404 MW, 27.9 percent were installed in Europe, 16.8 percent in America and 54.8 percent in Asia. Wind power is expected to provide 1.92 percent of the world's electricity in 2011. With regard to supply, Vestas remains in the leading position with a market share of 14.8 percent see figure 6. Four Chinese manufacturers are on the list of the top ten manufacturers: Sinovel, Goldwind, Dongfang and United power.

Figure 7



The following expectations for 2011 to 2015 and 2016 are included in the BTM report. Globally, the incentive to use wind power is very strong. In Asia, incentives especially include economic growth and the need for electricity. In Europe, focus is on combating global warming. In the US, focus is on global warming as well as on security of supply. Expectations for 2011 to 2015 are shown in figure 7.

Figure 8



Summary and conclusion

Seen from an historical perspective, the wind turbine industry has been successful. This success can be elucidated on the basis of various factors, such as the significant number of turbines (3,800 MW in 2010) installed in Denmark, which shows that a part of the transition to becoming independent of fossil fuels is being facilitated by wind power. In 2010, wind turbine production also contributed to Danish exports by DKK 46 bn. and to the employment of 25,000 people.

The initial development phases of the industry towards industrialisation have primarily been based on a bottom-up process; a process to which individuals and local communities have been of the utmost importance. During this period, wind turbines were small and the costs therefore limited. Due to local involvement, the planning process and funding of projects have been relatively manageable. The bottom-up process provided a foundation of knowledge, local acceptance, etc. for the later wind turbine industry.

Demand began to be significant in the domestic market in 1996. The industry was getting an increasingly solid base for development in the domestic market. Already in 1982/83, the wind turbine industry had been exporting to the Californian market for some years. Although the subsidies were discontinued on the US market after a few years, causing something of a crisis, enterprises managed to combine their production for the domestic market and abroad early on.

Local commitment and economic involvement in the community is likely to have contributed to the general acceptance of turbine installation in society. Politically, there has been national support for wind turbines from early on and funds were allocated for research from 1976. At the same time, wind turbines received subsidies, initially for capital installation and later as

subsidies for electricity production. Subsidies for electricity production, which were introduced in 1984, have been crucial to the economic incentive to install wind turbines. Another crucial factor for the professionalisation of the wind turbine industry and for the expansion rate was the agreements/requirements for power companies to install wind turbines, which were first introduced in 1985 and have since been reaffirmed on several occasions. In the 1990s, the main factors behind the increase in the expansion rate was declining interest rates and increasing efficiency of wind turbines.

Internationally, wind power has been supported politically since 1987 with a basis in the Brundtland Report and then by the Rio Climate Convention and the Kyoto Protocol. Subsequently, several global agreements have been concluded.

In the early 1990s, the planning process became even more organised, and municipalities were required to designate areas for location of wind turbines. The distribution of wind turbines in Denmark shows that the older turbines were generally placed without much consideration and without proper planning. Scrappage schemes were introduced in two phases to rectify this problem.

Production conditions for the industry can be assessed on the basis of competition and the economy, for example. Competition conditions have seen significant development since the beginning of this period. In the beginning, the industry was not an actual industrial sector. Gradually, there has been industrialisation and later a reduction in the number of producers. So far, the Danish manufacturers have been in the lead globally, and they have been able to withstand competition from foreign manufacturers.

The question is whether the lessons learned from the wind turbine industry can be transferred to other energy sectors/technologies. A structured process will require that a sector/technology can be selected for special preference as well as intense focus. As the basis of the wind turbine industry has been a bottom-up strategy, a top-down strategy must follow other development paths. Opinions differ on whether it is appropriate to use an actual pick-the-winner strategy, or rather to focus on the most general principle of ensuring good framework conditions.

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Annex 1

Settlement of electricity produced by wind turbines today primarily depends on when the wind turbine was connected to the grid, and how old it is, while ownership is irrelevant.

The rules for settlement are outlined in the following. These specifications are not exhaustive. See the Act and relevant executive orders for the more detailed rules.

With regard to turbines where owners do not have to sell electricity on market terms, Energinet.dk sells electricity production on the spot market. This mainly concerns production from the older wind turbines.

The sum of the market price and the price supplement has been applied as the settlement price in the tables. The market price means the spot price on Nord Pool in the area where the turbine is connected to the grid.

Wind turbines connected to the grid from 21 February 2008

The owner of the wind turbine is responsible for sales of production on the electricity market and for paying the costs of this.

A price supplement of DKK 0.25/kWh for 22,000 peak-load hours is provided as well as an allowance of DKK 0.023/kWh for balancing costs, etc.

Permits to install offshore wind turbines are given in accordance with a decision made by the Minister for Climate, Energy and Building on the basis of either a tender or an application.

Wind turbines connected to the grid from 1 January 2005 to 20 February 2008

The owner of the wind turbine is responsible for sales of production on the electricity market and for paying the costs of this.

A price supplement of DKK 0.10/kWh for 20 years is provided as well as an allowance of DKK 0.023/kWh for balancing costs, etc.

Permits to install offshore wind turbines are given on the basis of either a tender or an application.

Wind turbines connected to the grid 2003 to 2004

The owner of the wind turbine is responsible for sales of production on the electricity market and for paying the costs of this.

A price supplement of DKK 0.10/kWh for 20 years is provided. The price supplement is adjusted in proportion to the market price as the price supplement and the market price cannot exceed DKK 0.36/kWh.

In addition, allowances of DKK 0.023/kWh for balancing costs, etc. are provided.

Wind turbines connected to the grid 2000 to 2002

Transmission system operator (TSO) sells the electricity production on the spot market and a price supplement is provided which together with the market price ensures a settlement of DKK 0.43/kWh for 22,000 peak-load hours for wind turbines on shore and for 10 years for offshore turbines.

After expiry of peak-load hours, the owner of the wind turbine is responsible for sales of production on the electricity market and for paying the costs of this. At the same time a price supplement of up to DKK 0.10/kWh is provided until the turbine has been in operation for 20 years. The price supplement is adjusted in proportion to the market price as the price supplement and the market price cannot exceed DKK 0.36/kWh. In addition, allowances of DKK 0.023/kWh for balancing costs, etc. are provided.

Wind turbines purchased before the end of 1999 ("existing" wind turbines)

Transmission system operator (TSO) sells the electricity production on the spot market and a price supplement is provided which together with the market price ensures a settlement of DKK 0.60/kWh until the ration of peak-load hours has been used and then of DKK 0.43/kWh until the turbine has been in operation for 10 years. The ration of peak-load hours is 25,000 hours for wind turbines of 200 kW or lower, 15,000 hours for wind turbines of 201-599 kW and 12,000 hours for wind turbines of 600 kW and above.

If the turbine is over 10 years old, but has not yet used all of its peak-load hours, settlement is made by using the market price plus a price supplement of DKK 0.27/kWh with a cap on the sum of the market price supplement of DKK 0.60/kWh.

When the turbine is more than 10 years old, the owner of the wind turbine is responsible for sales of production on the electricity market and for paying the costs of this. At the same time a price supplement of up to DKK 0.10/kWh is provided until the turbine has been in operation for 20 years. The price supplement is adjusted in proportion to the market price, as the price supplement and the market price cannot exceed DKK 0.36/kWh. In addition, allowances of DKK 0.023/kWh for balancing costs, etc. are provided.

Household turbines

Household turbines are turbines of 25 kW or lower and they are connected to the grid in their own installation.

The enterprise responsible for the system sells the electricity production on the spot market and a price supplement is provided which together with the market price ensures a settlement of DKK 0.60/kWh regardless of grid connection date.

<p>Wind turbines financed by power companies</p>
<p>Wind turbines financed by power companies that have been installed by electricity supply companies as a result of an order/requirement or special agreements. The order expired at the issuance authorisations on 4 June 2002. It included all onshore wind turbines financed by power companies that had been connected to the grid before 4 June 2002 as well as the offshore wind farms at Horns Rev and Nysted.</p>
<p>Onshore or offshore wind turbines connected to the grid no later than 31 December 1999</p> <p>The owner of the wind turbine is responsible for sales of production on the electricity market and for paying the costs of this. A price supplement is not provided.</p>
<p>Onshore wind turbines connected to the grid from 1 January 2000</p> <p>The owner of the wind turbine is responsible for sales of production on the electricity market and for paying the costs of this.</p> <p>A price supplement is provided, which together with the market price represents DKK 0.33/kWh plus a price supplement of DKK 0.10/kWh. The price supplements are provided for a period of 10 years from the date of grid connection.</p> <p>When the turbine is more than 10 years old, a price supplement of up to DKK 0.10/kWh is provided until the turbine is 20 years old. The price supplement is adjusted in proportion to the market price, as the price supplement and the market price cannot exceed DKK 0.36/kWh.</p>
<p>Offshore wind turbines connected to the grid after 1 January 2000</p> <p>The owner of the wind turbine is responsible for sales of production on the electricity market and for paying the costs of this.</p> <p>A price supplement is provided, which together with the market price represents DKK 0.353/kWh plus a price supplement of DKK 0.10/kWh. The price supplements are provided for 42,000 peak-load hours. If the production is imposed with a feed-in charge, a price supplement is provided of up to DKK 0.007/kWh as compensation.</p>

<p>Additional price supplement for brand new wind turbines with scrapping certificates</p>
<p>Wind turbines connected to the grid from 1 April 2001 to 1 January 2004</p> <p>An additional price supplement is provided of DKK 0.17/kWh for 12,000 peak-load hours for the part of the production that is covered by a scrapping certificate from a turbine with an output of 150 kW or lower that has been dismantled in the period from 3 March 1999 to 31 December 2003.</p>
<p>Onshore wind turbines connected to the grid from 1 January 2005 to 20 February 2008</p> <p>An additional price supplement is provided of DKK 0.12/kWh for 12,000 peak-load hours for the part of the production that is covered by a scrapping certificate from a turbine with an output of 450 kW or lower that has been dismantled in the period from 15 December 2004 to 20 February 2008. The additional price supplement is adjusted in proportion to the market price as the sum of the additional price supplement of DKK 0.10/kWh and the market price</p>

may not exceed DKK 0.48/kWh.

Onshore wind turbines connected to the grid from 21 February 2008 to 31 December 2010

Based on a decision by the owner, additional price supplements are provided for the part of the production that is covered by a scrapping certificate from a turbine with an output of 450 kW or lower that has been dismantled in the period from 15 December 2004 to 15 February 2010 of

either:

DKK 0.12/kWh for 12,000 peak-load hours. The additional price supplement is adjusted in proportion to the market price as the sum of the additional price supplement and the market price may not exceed DKK 0.38/kWh.

or:

DKK 0.08/kWh for 12,000 peak-load hours