NordVind

Wind Power in the Nordic Region

Conditions for the expansion of wind power in the Nordic countries

NordVind

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The NordVind project group has prepared the present memo concerning the terms and conditions for the expansion of wind power in the four Nordic countries.

The memo highlights conditions surrounding political goals for the field of wind power, planning, processing by the authorities, financial terms, environmental conditions, popular acceptance, research and development, and so on. Through the course of this presentation, the memo provides an image of the opportunities and obstacles that exist for the expansion of wind power in Sweden, Norway, Finland and Denmark.

The memo has been compiled from the contributions of the individual countries. It should be viewed as a "living document", which will be amended and updated twice a year (in April and October) throughout the NordVind project group's work process, in step with – in particular – political developments in the countries in question. For this reason, it should not be seen as a final and definitive document.

Contents

1. Sweden

1.1 Installed and planned capacity

Currently installed wind power capacity in Sweden totals 2,476 MW, of which 2,342 MW is on land and 134 MW offshore. Sweden currently generates approximately 5 TWh of wind-powered electricity annually. In addition to this, permits have been granted for the establishment of around 2,800 MW of wind power which, for a variety of reasons, has not yet been completed. As regards the offshore installations for which permits have been granted but which have not yet been built, the reason for this is that Sweden does not currently have the financing to build offshore.

MW	**2011 (August)**	**Permit granted, not built**	**Total**
Onshore	2342	+ 935	3,277
Offshore	134	+ 1,715	1,849
Total (Onshore + Offshore)	**2,476**	**+ 2,650**	**5,126**

The values for "Permit granted, not built" are approximate.

1.2 Political goals

The electricity certificate system

The electricity certificate system is a market-based support system for the expansion of electricity generation from sources of renewable energy and peat in Sweden. The system comprises biofuels, wind power, some hydropower, solar energy, wave energy, geothermal energy and peat in CHP stations.

When the Swedish electricity certificate system was introduced in 2003, it was decided to increase the use of renewable energy by 10 TWh from the 2002 level by 2010. In June 2006, this target was raised to 17 TWh from the 2002 level by 2016. In June 2010, the Swedish Parliament decided to extend the electricity certificate system until 2035 and to increase the quota obligation, which is to be adapted to the new goal of 25 TWh. This is to contribute to providing Sweden with a more sustainable energy system.

National planning framework that is not an expansion target

In June 2009, Sweden adopted a national planning framework for wind power in the amount of 30 TWh by 2020. In this context, a "planning framework" means that societal planning is to be targeted at 30 TWH of wind power electricity, and that societal planning is not to hinder an expansion of wind power on that scale. However, the planning framework does not actually set an expansion target for wind power.

1.3 Planning and processing by the authorities

Planning procedures

Sweden's national planning framework for wind power – 30 TWH in 2020 – may be broken down into regional planning frameworks by the Swedish Energy Agency. In this way, every county administrative board can be given a regional planning framework to relate to. It is important to view the planning framework as a floor and not a ceiling, in the sense that the planning framework is the lowest level of planning for which to strive. It is, of course, fully acceptable to plan for appreciably more in many cases.

In May 2008, the Swedish Energy Agency decided to define 423 areas of national interest for wind energy in Sweden. Work to prepare an overview of wind energy sites of national interest is ongoing and scheduled for completion in the latter part of 2012.

The county administrative boards have prepared regional planning bases for the large-scale expansion of wind power.

In recent years, comprehensive municipal planning for wind power has been carried out in Sweden, primarily centred on onshore sites. The regional planning base forms the foundations for the planning work done by the local authorities. It is calculated that around 200 local authorities, municipal co-ordination functions and county administrative boards have been actively planning for wind power (there are 290 local authorities in Sweden). State support for wind power planning that has existed since 2007 has now been discontinued, however, and this has had an appreciable impact on the development of planning for wind power.

There is as yet no legislatively regulated offshore planning in the Swedish Economic Zone (SEEZ). A new authority, the Sea and Water Authority, was established on 1 July 2011 and has been given responsibility for offshore planning. A proposal for a new offshore planning law is expected to come into effect on 12 July 2012. A number of sites are considered interesting from the perspective of establishing wind power, of which several have been classed as “of national interest for wind energy”. A fundamental problem, however, is that it is still expensive to establish wind power offshore. It may therefore be interesting to track the development of floating wind power installations – in parallel with the development of wave-power installations. A trial wave-power installation has already been established off the west coast of Sweden and plans have been drawn up for the construction of a large commercial wave-power plant.

Permit testing

Wind power plants in Sweden have previously been subject to double testing: both environmental testing and construction permit testing. This has been considered a resource-intensive procedure resulting in a protracted testing process. A new and simpler testing scheme – without double testing for major installations, i.e. those that feature seven units or more, and/or units with a total height in excess of 150 metres – was introduced as of 1 August 2009. Environmental testing is now only required for major wind power plants in Sweden. No construction permit is required if an environmental permit has been granted, but notification must be submitted in accordance with the Swedish Planning and Building Act so that the technical property requirements can be tested. For an environmental permit to be granted, the local authority must have supported the application. This should result in less resource-intensive testing, while at the same time reducing the opportunities to appeal decisions. For minor wind power plants – i.e. those with fewer than seven units under 120 metres, or a single unit under 150 metres – it is sufficient to submit notification in accordance with the environmental code and a construction permit application to the local authority.

The municipal overview plan lays down guidelines for various decisions. The opportunities for local authorities to demand detailed plans (legally binding) for a wind power plant have been significantly reduced.

Connection of wind power plants to the electricity grid

In Sweden, there is a need to acquire improved knowledge about the capacity of the electricity grid in connection with planning for the wind power area. The county administrative boards have traditionally found it difficult to acquire this knowledge. For this reason, it is also difficult to assess how much wind power can be connected within a given area. This also applies to a large extent for local authorities. In Sweden, various power companies have responsibility for the regional and local electricity grids, while the state-owned utility Svenska Kraftnät (Swedish National Grid – SvK) is responsible for the overriding transmission grid (the national grid) – i.e. grid cables with voltages of 200 and 400 kilovolts (kV). It is extremely important for local authorities or wind power planners to contact the grid owner early in the process to discuss the opportunities for connecting wind power plants to the electricity grid. If this is not done, there is a major risk that the grid connection will delay

the entire project because connection to – and, if necessary, reinforcement of – the electricity grid takes a long time to plan and execute.

Skills and resource requirements

On account of the strongly increased ambitions for wind energy and the rise in expansion of wind power in Sweden, appreciable resources are required from the county administrative boards, local authorities, etc. with regard to planning and testing. Planning currently underway in the country is important for generating dialogue, participation and acceptance of wind power among the general public and other stakeholders. Using good local deployment to boost understanding of wind power may be one of the most important issues in the field of wind power.

Wind power co-ordinators

The Swedish government appointed four wind power co-ordinators in 2006. These co-ordinators are to support interaction between wind power project planners, authorities and other operators at regional and local levels. Their task is to contribute to creating conditions for a large-scale expansion of wind power, so that the politically defined goals and frameworks can be achieved. The wind power co-ordinators are to be able to act as driving forces in ongoing processes, assist in promoting wind power expansion and function as the problem-solving link between strategic planners, project planners and the government. The assignment of the wind power co-ordinators is primarily to support the establishment of major wind power projects. Sweden is divided into four regions with one wind power co-ordinator for each: Stefan Lundmark (North), Lars Thomsson (Central), Lennart Värmby (South-west) and Agne Hansson (South-east). All wind power co-ordinators have a background working in parliament, the government, the EU or similar.

The actual form that the work takes can vary between regions, but the co-ordinators should always function as a catalyst and “door opener” for wind power. The co-ordinators report directly to the Swedish Ministry of Enterprise, Energy and Communications with regard to the status of the work and issues that require special attention.

Electricity grid and connection of renewable energy

It is naturally extremely important that there is an electricity grid for the connection of wind power. For this reason, it is essential that when local authorities are planning for wind power, they contact the grid owner to discuss opportunities for the connection of wind power in the geographical area in question. Generally speaking, larger wind power plants are connected to the regional grid with voltage levels of 30–130 kilovolts (kV).

In April 2009, Svenska Kraftnät announced a government commission to design amended regulations and responsibility for electrical grid reinforcements of national importance and for the connection of major projection plants, with a view to reducing the financial threshold effects for the expansion of renewable energy production. The proposals in the report may come to have a significant positive effect on the connection of wind power. The work on the legislation required on the basis of the proposals is ongoing, but it is not yet known when the changes can come into effect.

1.4 Financial conditions

In Sweden, support for renewable energy production has previously been based on investment contributions to electricity generation from biomass, wind power and small-scale hydropower plants, and what is known as an "environmental bonus" for electricity generated by wind power. As early as 1 May 2003, the market-adapted system of electricity certificates was introduced to replace the previous subsidy system.

The intention of the electricity certificate system is to boost electricity generation from renewable sources of energy in Sweden by 25 TWh from 2002 to 2020. The system is based on electricity producers being allocated electricity certificates from the state for each MWh of renewable electricity they generate. The market – or demand – for electricity certificates arises through electricity providers and some electricity users being required by law to purchase certificates in relation to the volume of electricity they deliver/use, and the legislatively defined quota for the year in question. For 2010, 2011 and 2012, the quota is 17.9%. This means that 17.9 TWh of the electricity that all electricity providers sell must be renewable electricity. When an electricity certificate is cancelled, this means that it has been used and therefore cannot be sold or used again. The quotas in the system are fixed until 2035 and have been designed to promote a sufficient increase in renewable electricity production that matches the government's stated goals.

2010 became a record year for wind power in the Swedish electricity certificate system. Since the system was implemented in 2003, renewable electricity generation has increased by 11.5 TWh. A total of around 18 TWh of renewable electricity was generated in 2010 at approved sites in the electricity certificate system. A total of 350 new plants were registered in the system during the year, of which 300 were wind power plants. The table below illustrates the distribution of electricity production between different sources of energy:

Energy sources	Small-scale hydropower	Wind	Biofuels	Other	Total
Electricity production 2010 (MWh)	2.5	3.5	11.5	0.8	18

Renewable electricity production in the electricity certificate system (values have been rounded off).

Within a competitive market, the price of a certificate is defined by the interaction between access to and demand for the certificate. In 2010, the average price of a certificate was slightly under SEK 300, which translated into an average cost to electricity customers of SEK 0.05–0.06/kWh.

Shared electricity certificate system with Norway

Sweden and Norway have agreed to create a shared electricity certificate market. The ambition is to implement this shared market as of 1 January 2012. In March 2011, the Swedish government issued a "Proposal for a new law concerning the simplification of electricity certificate regulations and a shared electricity certificate market with Norway" for consideration. In April 2011, the Norwegian government submitted a proposal for an electricity certificate law to the Norwegian Parliament (Stortinget). According to the Swedish Energy Agency, a shared and expanded certificate market with Norway will boost renewable electricity production and have a positive effect on the area in general. The shared goal for the expansion of renewable electricity production between 2012 and 2020 amounts to 26.4 TWh.

1.5 Environmental effects and local deployment and acceptance

The environmental effects of wind power have been comprehensively examined by many countries in recent years. In Sweden, the area is being examined, for example, through a knowledge project entitled Vindval (Wind

Option) run by the Swedish Energy Agency and the Swedish EPA. There is still a lot of work to be done with regard to environmental effects and wind power – particularly as regards offshore plants. It is good to know that a large volume of aggregated experience is now available to study and apply to new installations. For details, visit www.vindval.se and read about what is happening in this area. The Vindval project will continue to study environmental effects for some time.

The noise from wind power plants can be divided into two categories: the mechanical noise from the gearbox, for example, and the aerodynamic noise from the blades. The mechanical noise is no longer much of a problem. What can, however, be considered annoying is the "swishing" aerodynamic noise that varies with the wind speed. Sweden has a standard value for noise impact of a maximum of 40 dB(A) at a wind speed of 8 m/s at a height of 10 metres. Experience from studies conducted within Vindval and other measurements taken close to operating wind power plants indicate that few people consider this level to be a disturbance.

The attitude of the population to wind power varies in Sweden. Surveys have shown that as many as 70–80% of respondents are positively disposed towards wind power. Traditionally, the authorities have focused on conservation interests in the fields of nature and culture, and not on sustainable development or conversion to renewable energy. With regard to physical planning, sustainable development is an extremely important starting point and is thus crucial both to conservation interests and interests in the development of renewable energy.

There is a need to increase focus on the general perception and understanding of the value of wind power, and for local deployment in connection with the establishment of wind power in the community. It is essential that people who are affected by wind farms are informed of the expansion plans at an early stage, and that they feel that they can participate actively in the issue of the development of renewable energy. It is also important that people receive objective information about the "big picture" from project planners and via the media, i.e. information about how wind power should be viewed in relation to electricity production as a whole, climate impact and other human influences on society. Environmental testing makes clear demands on providing the general public with comprehensible information and the opportunity to participate in the process. New technology entails improved opportunities for disseminating information more easily. In the comprehensive municipal planning work that is underway in Sweden, it is essential to increase the general public's participation and access to information.

1.6 Research, development, demonstration

Research programme

The research programme entitled Vindforsk etapp III (2009–2012) (Wind research, stage III) was launched in 2009. The programme is financed jointly and equally by the Swedish Energy Agency and the business community (www.vindenergi.org). Vindforsk primarily deals with technical research.

Wind power in cold climates

Under the auspices of the Vindforsk programme, research has been conducted into wind power in cold climates. This is not just an issue that affects the Nordic region – it concerns 25-30 countries worldwide. It is a matter of establishing whether wind power plants in extreme external conditions are affected by these conditions in various ways, with the result that they occasionally have to be shut down. This is a very important issue because there is appreciable potential for wind power in areas of Sweden (and other countries including Canada, Finland and Norway) where the climate is very cold. Within the research programme, ongoing activities are centred on the influence of the climate on technical/electrical equipment, ice formation on the rotor and measurement instruments, ice detection, de-icing, etc. One practical example in Norway is that a map has been prepared showing the risk of ice formation on wind power plants. An "ice map" of this kind is also being drawn up in Sweden.

In 2011, with the assistance of WSP in Sweden, the NordVind group has prepared a knowledge compilation concerning “Wind Power in cold climates”. In this, we attempt to describe what we know about the subject today and to summarise what else needs to be done.

The research within the Vindval project has generated knowledge about how wind power affects plants and animals in marine environments, how landscapes are affected and how people actually perceive wind power. Almost 20 projects launched since 2005 – centred on birds, bats, fish and structures – have now been concluded. You can view these reports online at www.energimyndigheten.se/vindval

Vindval stage II 2008–2012 is underway and currently centres on the environmental impact of wind power on the countryside, e.g. mountainous areas. It also involves research into the effects on reindeer. The programme is ongoing and reports are submitted on a regular basis. Under the Vindval project, synthesis studies are being performed with regard to birds, bats and the marine environment, along with acceptance issues and studies of mammals on land. The objective is to compile and present aggregated research results internationally and within Vindval. Many such results have already been published online at www.vindval.se

1.7 Relevant literature

- Relevant reports on this website
- The Swedish National Board of Housing, Building and Planning (Boverket) website www.boverket.se
- Boverket, February 2010, “Wind power offshore – weaknesses and opportunities in planning and project preparation”
- Boverket, January 2009: “The wind power manual – planning and testing wind power plants onshore and in coastal waters”
- Boverket, 2009, “Wind power and the landscape – analysing conditions and designing installations”
- The Swedish Energy Agency website www.energimyndigheten.se
- The Swedish Energy Agency’s Web handbook www.vindlov.se
- The Swedish Energy Agency, “The energy situation 2010”
- The Swedish Energy Agency, 2007 “Wind power – the permit process and the status of knowledge”
- The Swedish Energy Agency, “Concerning wind and wind power in forests”, ERR 2008:21
- The Swedish Energy Agency, 2008 “Wind power – constructing and connecting major wind power plants”, ET 2007:08 and ET 2007:32
- The Swedish Environmental Protection Agency website www.naturvardsverket.se
- The Swedish Environmental Protection Agency, Vindval, 2010: “Here’s what we know!”
- The Swedish Environmental Protection Agency, Vindval, 2008: “The environmental impact of wind power”
- The Swedish Environmental Protection Agency, Vindval, 2007: “Offshore wind energy and its impact on bird life”
- The Swedish Environmental Protection Agency, Vindval, 2008: “Studies of small fish at Lillgrund wind farm”

2. Norway

2.1 Installed and planned capacity

Wind power capacity currently installed in Norway totals approximately 440 MW. As of autumn 2011, five additional wind power projects were under development, with total installed capacity of around 400 MW. The first floating wind turbine in the world was installed off the Norwegian coast at Karmøy in Rogaland in autumn 2009. The project is entitled HyWind and the turbine in question had an installed capacity of 2.3 MW. In addition, licences have been granted for the establishment of a total of around 3,760 MW of wind power (October 2011), of which offshore wind power plants are to account for 373 MW. If all these projects are implemented, they will correspond to wind power production of 8-9 TWh/year. The current installed capacity has the potential to provide annual electricity production of around 1 TWh.

There are comprehensive plans for wind power plants in Norway, both onshore and offshore. In October 2011, there were plans for wind power plants with a combined installed capacity of more than 21,000 MW both on land and at sea.

2.2 Political goals

The Norwegian Water Resources and Energy Directorate (NVE) has previously estimated that an expansion of 5,000 MW represents the volume of wind power that can be established, given the existing grid structure and the grid construction that is to be expected in coming years. According to NVE, a construction plan on this scale would correspond to careful expansion, taking into account a broad perspective of other important interests such as reindeer farming, travel and the environment.

In December 2008, NVE worked with Enova SF to prepare a viability analysis for onshore wind power in Norway. The study reveals that in the period up to 2025, it will be possible to add between 5,800 and 7,150 MW of wind power to the Norwegian power grid. The Statnett grid development plan was used as the basis for this assessment.

The Norwegian government has assessed the EU Renewables Directive as being EEC-relevant. Norway is currently in negotiations with the EU concerning implementation of the directive.

In autumn 2010, Norway and Sweden reached agreement on the terms of a shared Norwegian-Swedish electricity certificate market. Legislation concerning electricity certificates was passed by the Norwegian Parliament (Stortinget) in spring 2011. The objective of this legislation is to contribute to increasing production of electrical energy from renewable sources. The legislation provides the necessary legal basis for a system of trade in electricity certificates between Norway and Sweden. The market is scheduled to commence on 1 January 2012.

2.3 Planning and processing by the authorities

Planning procedures

Through a set of guidelines, the government is encouraging the application of the Norwegian Planning and Building Act to create local (municipality) and regional (county) plans for the appropriate placement of wind power plants. These guidelines have three purposes:

- The municipalities and counties are to be encouraged to make an active assessment of suitable areas for wind power in their general plans.
- They are to state the considerations that are to be used as a basis for the assessment of new locations for wind power.

- They are to state how it will be possible actively to align the processing of wind power cases in accordance with the Norwegian Energy Act and the Norwegian Planning and Building Act.

Some county authorities have already agreed to prepare such plans. The wind power guidelines from the Ministry of the Environment and the Ministry of Petroleum and Energy state that the application processing of initiated projects does not need to wait for the completion of regional plans.

Approval procedures

There are two key permit acts in Norway with regard to wind power. Parties seeking to construct wind power plants have to apply for a licence pursuant to the Energy Act (licence = permit) and an area permit/clarification in accordance with the Planning and Building Act (preparation of an area development plan or exemption). The Norwegian Water Resources and Energy Directorate (NVE) is the authority that processes cases under the Energy Act, while the local authorities have responsibility for processing area development plans. The new guidelines prepare the ground for co-ordination of municipal and state approval procedures.

A new Planning and Building Act has now come into effect. Wind power plants are still subject to the terms of the act, but development plans no longer need to be prepared for such installations. The act also states that the granting of licences can serve as a national plan.

For all large wind farms (total installation of more than 10 MW), the project owner is required to prepare a consequence assessment for the farm and the associated grid connection, access roads, etc. NVE is the authority responsible for processing consequence assessments for wind power plants, and is to establish the report programmes that the project owner is required to follow. A report programme lays down the requirements for the content and scope of the reports that have to be prepared.

As regards offshore, the same legislation applies up to a sea boundary. In addition, an application must be submitted – and approval received – according to the Norwegian Harbours and Coastal Waters Act, which is administrated by the Norwegian Coastal Administration. The provisions of the Energy Act and the Planning and Building Act do not apply outside the sea boundary. New legislation has been prepared concerning renewable energy production offshore. This legislation lays down the legal framework for granting licences and otherwise regulating conditions linked to the planning, construction, operation and decommissioning of installations for renewable energy generation, and for installations for the conversion and transfer of electrical energy generated offshore. The legislation suggests opening up areas with a view to awarding licences for renewable energy production.

NVE has chaired a directorate group that has mapped out areas for the future establishment of wind power in Norwegian waters. In addition to NVE, this group comprised representatives from the Norwegian Petroleum Directorate, the Norwegian Directorate of Fisheries, the Norwegian Coastal Administration and the Norwegian Directorate for Nature Management. The completed work was submitted to the Norwegian Ministry of Petroleum and Energy on 15 October 2010. The reports are published online at www.havvind.no. A strategic environmental assessment (SEA) is to be performed on the areas selected in 2011/2012. The plan is also to present an updated strategy for offshore wind power to the Norwegian Parliament in 2012.

In NVE's experience, almost all wind power licences are today appealed to the Norwegian Ministry of Petroleum and Energy. This means that all wind power issues will be decided politically. There are many cases awaiting political clarification from the ministry, and the decisions are certain to affect future cases with regard to important themes such as national defence and landscape considerations.

Connection conditions

The transmission grid is poor in many regions in Norway, and many of these regions are of particular relevance to wind power. For this reason, competition for available capacity is tough in many places. Thus far, it seems that major grid reinforcements (national grid) will be required if some areas of Norway are to experience comprehensive wind power construction. NVE is currently processing a great many plans for the reinforcement of both regional and national grids.

The regional grid companies are obliged to make unused capacity available for new electricity production, but they may make technical demands on the equipment and connection of the turbines. Otherwise, it is the responsibility of the project owner to plan and construct the necessary grid, up to the connection point in the existing distribution, regional or national grid.

Some wind power companies think that the regulations for connection to the grid (i.e. the technical specifications prepared by Statnett) are too strict and costly.

2.4 Financial terms

Over the past 10 years, a variety of subsidy schemes have been applied for renewable energy – including wind power – in Norway. To date, financial support for wind power in Norway has been based on investment subsidy intended to ensure that the project in question was actually completed. Subsidy could be applied for after the release of funds and identification of the projects that were competing for the subsidy funds available. The subsidy scheme was administrated by the State-owned company Enova.

The government has now decided to introduce a shared market for electricity certificates with Sweden, and the intention is for the certificate market to be operative as of 1 January 2012.

2.5 Environmental conditions and public acceptance

Unspoiled natural areas

Norway is planning relatively large wind power installations that are to be located in areas with few/no previous technical interventions (i.e. unspoiled areas). This will therefore come into conflict with a national objective of preserving unspoiled areas of nature/wilderness.

Bird life

Both the general public and the media in Norway have focused heavily on the problem of bird collisions, as the bodies of 38 white-tailed eagles killed by collisions with turbines have already been found on Smøla, the site of the largest wind farm (150 MW) in Norway.

Reindeer farming

In Norway, tame reindeer are farmed on around half of the surface area of the country (north from Central Norway/Trøndelag). As such, this is an activity that demands a great deal of space – in the same way as wind power is an area-intensive form of energy production. The reindeer farming sector and Sami interest organisations are expressing concern about the impact of a major expansion of wind power on reindeer farming and, as a result, on Sami culture.

Public acceptance

Involvement in the issue of wind power is increasing strongly in Norway – with opposing voices predominant. However, many local authorities and local communities are positively disposed to the establishment of wind power plants. Questionnaire surveys performed among the Norwegian population reveal a clearly positive desire to expand wind power in Norway. Negative attitudes are largely to be found among various groups who oppose the establishment of wind power in Norway. Their primary arguments are that the expansion of wind

power will result in major negative impact on the countryside and that this, in turn, will adversely affect popular enjoyment of the coastal areas. In addition, some groups are voicing concern about the potentially negative effect on Norway as a tourist destination if wind power plants become more widespread. There has also been some mention of noise and the effects on health of low-frequency noise, for example.

The Armed Forces

The Norwegian Armed Forces are concerned about the consequences wind power may have on their electronic infrastructure (radar, radio lines and intelligence).

2.6 Research, development, demonstration

Programmes

Research and development work is being carried out in the fields of technological development and the environmental effects of wind power production. Many R&D activities are financed through grants from the Research Council of Norway, although some are financed fully or in part by support from public sector authorities or energy companies.

Major research projects have been launched with the aim, for example, of examining more closely the effects of wind power on reindeer farming and bird life.

Through the climate settlement, it was also decided to set up research centres for eco-friendly energy. A total of eight such centres have already been established with the assignment of implementing a concentrated, focused and long-term research initiative at top international level to find solutions to challenges identified in the field of energy and the environment. For additional information, see www.forskningsraadet.no.

2.7 Climate

Strong winds and tough climatic conditions have, in some cases, necessitated the replacement and reinforcement of a number of components in conventional wind turbines developed for Central European conditions.

In Norway, a number of wind power installations are being planned and built in areas where there is a significant risk of icing. The elevated areas along the coast of Norway and in northern regions of the country are subject to the influx of large volumes of moist air from the west, which significantly increase the risk of icing. The problem of icing could lead to loss of production at a wind power plant, and several companies have their own programmes for finding solutions to this problem.

NVE has also commissioned the preparation of a map that indicates the icing conditions that wind power producers may face in all areas of mainland Norway. This “icing map” can be downloaded from the NVE website, which also features maps of Norway’s wind resources.

2.8 Relevant literature

- www.nve.no
- NVE's and Enova's "Opportunity study for onshore wind power 2015 and 2025"
- The Norwegian Ministry of the Environment and the Norwegian Ministry of Petroleum and Energy 2007. Guidelines for the planning and location of wind power plants.
- NVE 1998, Wind power – an introduction.
- The Norwegian Climate and Pollution Agency 2004, Guidelines for dealing with noise in area planning (T-1442).

3. Finland

3.1 Installed and planned capacity

Currently installed wind power capacity in Finland amounts to around 200 MW, primarily onshore. Some wind power plants have been constructed approx. 1.5 km from the mainland (on breakwaters, cliffs, etc.)

Planned projects:

Onshore: less than 3,000 MW
Offshore: approx. 3,000 MW

MW	**2010**	**Total**
Onshore	50	195
Offshore	2	2
Total (Onshore + Offshore)	**52**	**197**

3.2 Political goals

On 6 November 2008, the Finnish government (Statsrådet) approved a new, long-term **climate and energy strategy,** which deals with climate and energy policy measures in detail up to 2020 and lays down guidelines for the same up to 2050. The ambition is to increase total installed wind power capacity to around 2,000 MW by 2020 at the latest, by which time total annual energy production from wind power is expected to amount to approx. 6 TWh.

Climate and energy strategy:
http://www.tem.fi/files/20586/Dnr_1382_klimat och_energistrategi_3.11.2008.pdf

Legislation to **support production of electricity from renewable sources of energy** came into effect in its entirety on 25 March 2011. This legislation was introduced in part from the beginning of the year, but permission from the European Commission was required for the application of state support in accordance with the subsidy system.

The legislation contains provisions concerning the subsidy that is to be paid for electricity generated by wind power plants and biogas plants (feed-in tariff) with a view to covering the difference between the production costs and the market price of electricity. Electricity producers are to be parties on the electricity market and receive the market price for the electricity they generated when this is sold.

Subsidy is only granted to new wind power plants with electricity output of at least 500 kilovolt amperes and biogas plants with electricity output of at least 200 kilovolt amperes. The power plants to which subsidy is granted must be located in Finland or within Finnish territorial waters, and they must be connected to an electricity grid within Finland's territory. The subsidy is to be financed via the national budget.

Legislation concerning subsidy for the production of electricity from renewable sources of energy:

http://www.finlex.fi/sv/laki/alkup/2010/20101396

Finnish Government regulations concerning subsidy for the production of electricity from renewable sources of energy:

http://www.finlex.fi/sv/laki/ajantasa/2010/20101397

Work to update Finland's **wind atlas**, which has already been commenced, lays the foundations for an appreciable expansion of wind power and more relevant positioning of wind power plants.

Finland's wind atlas:

http://www.windatlas.fi/se/index.html

3.3 Planning and processing by the authorities

The amendment to the Finnish Land Use and Building Act regarding the construction of wind power plants came into effect on 1 April 2011. The intention behind the amendment is to make it possible to use the general plan to a greater extent as a planning instrument when deciding issues concerning the placement of wind power expansion sites.

The amendment to the law makes it possible to use the general plan as a direct basis for construction legislation for wind power plants. A precondition for using a general plan in this manner is that, with the "wind power general plan" adapted to the legislative change, it is possible to sufficiently manage the construction of wind power plants in an area with due consideration to, for example, the environmental value of the area and other land use. In such cases, the granting of construction permits requires neither a detailed plan nor a decision about planning requirements.

Law concerning the amendment of the Land Use and Building Act:

http://www.finlex.fi/sv/laki/alkup/2011/20110134

The Finnish Ministry of the Environment granted local authorities and countryside associations a total of EUR 1.5 million in state subsidy for the preparation of plans to manage the expansion of wind power. The subsidy is initially intended for use in managing holistic wind power establishment in local authorities and countryside areas. The subsidy was also granted for 2012.

Planning procedures

The best wind conditions in Finland are to be found by the coast, in offshore areas and in the mountain areas in Lapland. Of these, the coastal and offshore areas are the most important. Wind power production demands areas with sufficient wind speeds, areas relatively close to the electricity grid, and areas where other technical, financial and environmental conditions are in place. Suitable areas are to be found, for example, on the coast and in the archipelago, but they are rare. Islands and islets reduce the average wind speed, and wind power in these areas is otherwise in competition with other forms of land use such as built-up residential areas, Ministry of Defence areas, and measures to protect natural diversity and cultural heritage. The areas of land with wind

power potential are often too small for the establishment of major wind farms. This means that if wind energy is to be exploited on a large scale, the installations will have to be sited offshore.

Guidelines concerning the expansion of wind power are currently being drawn up by the Ministry of the Environment. These guidelines will cover planning, consequence assessment and permit procedures associated with wind power expansion.

Solutions regarding plans and permits required in different situations to allow the exploitation of wind power are primarily dependent on where the power plants are placed, and the consequences of this. Planning thus plays a key role concerning the promotion of wind power production, because it is planning that links together the different perspectives. It is also planning that defines how wind power production is to develop over the coming decades.

The objective of landscape planning is to manage the expansion of wind power as a whole. In accordance with the nationwide objectives for area use, wind power plants are initially to be concentrated in installations that comprise multiple power plants. In the landscape plans, all wind farms are to be presented and processed as comprehensively as possible. Landscape plans thus far have primarily defined areas for wind power plants along the coast, in the mountains and offshore. Before the landscape plans for wind power plants come into effect in more inland areas, wind power expansion can be proposed through municipal planning.

Depending on the size or location of the project, a wind power plant and a wind farm can be built on the basis of a detailed plan and/or permit solutions. In this context, either an actual detailed plan or a general plan including a provision concerning the granting of a building permit on the basis of the same (wind power general plan) can serve as a "detailed plan". A wind power general plan is suitable for situations in which there is no need for co-ordination with the other land use that requires planning at detailed plan level. A decision about planning requirements is often sufficient for constructing a wind power installation, particularly in areas that have already been designated as suitable for wind power expansion in the general plan. A wind power plant can be built with just a construction permit, but only if establishing the plant does not entail any significant environmental consequences. Fundamentally, the establishment of major wind farms must still be based on at least one decision concerning planning requirements. The construction of individual wind power plants should be avoided, particularly in areas that are valuable from the perspective of the environment and the landscape.

Approval procedures

Wind power projects must be approved in relation to the Finnish Land Use and Building Act. In practice, the processing of wind power projects is often equated with that of buildings that require building permits, and average processing time is two months. Approval responsibility rests with the local authorities, with the exception of coastal areas, which are the responsibility of the regional environmental centres.

As a result of the Finnish Environmental Protection Act, the establishment of wind power projects may require environmental approval if there are permanent or holiday residences in the area.

The environmental consequences of major wind power plants are assessed in the MKB procedure. Changes to the regulations concerning the procedure for an environmental consequence assessment (MKB), which involves the MKB procedure being applied to major wind power projects, came into effect on 1 June 2011. The size limitation for such projects has been set to at least ten separate wind power plants or a total capacity of at least 30 megawatts.

Finnish Government regulations:

http://www.ymparisto.fi/download.asp?contentid=126703&lan=fi

Connection conditions

As with other electricity production installations, wind power plants are guaranteed connection to the grid.

3.4 Environmental conditions and popular acceptance

The effects of establishing a wind power plant are assessed jointly by the planning and approval authorities. In addition, the environmental consequences of significant wind power projects are assessed in connection with the EIA (Environmental Impact Analysis) process and the Environmental Protection Act. It is important to include area planning within general project planning at the earliest stage possible. During the project planning phase, it is essential not only to consider technical and financial factors, but also to elucidate decisions that apply to land use and its significance to the project.

In Finland, opinions vary concerning the consequences of wind power and the importance of these (e.g. collision risk for birds). Discussions about the consequences of wind power are often not based on facts.

There are many residences in the archipelago, and the visual impact of wind power plants is far-reaching in the mountains. In addition, conflicts with local businesses may arise. The general acceptance of wind power varies from one area to the next. There is less opposition in areas where wind turbines have already been erected. In many cases, the most significant consequences have to do with the landscape. The importance of the impact of a wind power plant on the landscape depends on how visible the plant is and on the features of the landscape itself.

As regards cost, the largest and most suitable areas in Finland are offshore – where it is more expensive to establish wind turbines than on land.

Programmes

There are as yet no research programmes specifically centred on wind power, but research into wind power is integrated into the broader environmental/climate change-related research programme (Tekes).

3.5 Relevant literature

- Application of environmental legislation on the construction of wind power plants. Working Group Consideration, the Environment in Finland 548. Ministry of the Environment. 2002.
- Areas in Kvarken and Bottenviken that are suitable for wind power production, Ministry of the Environment, Central Österbotten Association, Österbotten Association, North Österbotten Association, Lapland Association. The Environment in Finland 666sv. Ministry of the Environment. 2004
- The impact of wind power plants on birds. The Environment in Finland 721. Ministry of the Environment. 2004.
- Wind power plants and the landscape. Nature Environment in Finland 5/2006. Ministry of the Environment. 2006.
- The generation and dissemination of noise from wind power plants. The Environment in Finland 4/2007. Ministry of the Environment. 2007.

4. Denmark

4.1 Installed and planned capacity

At the end of March 2011, Denmark had 3,807 MW of installed wind power capacity: 2,939 MW onshore and 868 MW offshore. In 2010, wind power production covered approximately 22% of electricity consumption in the country.

MW	**March 2011**
Onshore	2,939
Offshore	868
Total (Onshore + Offshore)	**3,807**

The majority of the installed wind power capacity was established during the period from the mid-1990s to 2003. The figure below illustrates the development of installed wind power capacity in Denmark and the proportion of the total electricity supply covered by wind power.

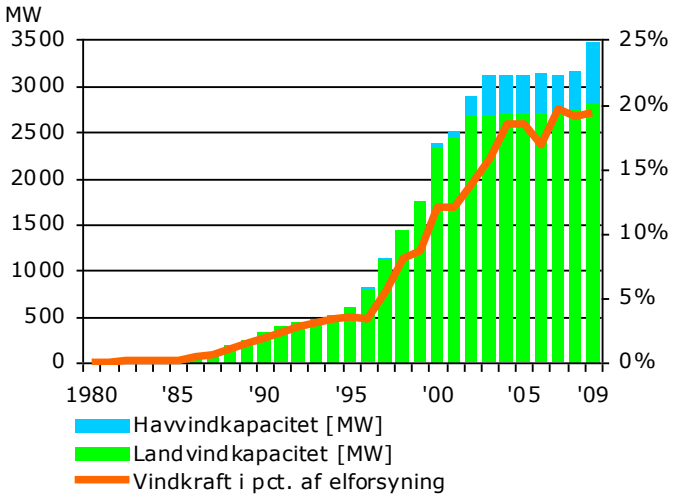

Figure 1: Wind power capacity and share of energy supply, ultimo 2010. Source: The Danish Energy Agency: Energy Statistics 2010.

With the initiatives that have been taken in recent political agreements, wind turbine capacity is set to rise once more – particularly through the establishment of additional offshore wind farms.

4.2 Political goals

On 21 February 2008, the previous Danish government entered into a broad energy agreement with the other parties in parliament, with the exception of the Red-Green Alliance (Enhedslisten). The agreement applies to the period 2008–2011 and one of its aims is to ensure that renewable energy covers 20% of gross energy consumption in 2011. Another aim is to contribute to achieving Denmark's target of 30% renewable energy in

2020, in accordance with the EU Directive concerning renewable energy. With regard to wind power, the agreement entails introduction of the following measures:

- Subsidy for new onshore and offshore wind turbines outside the state tender system is to be raised to DKK 0.25/kWh plus DKK 0.023 for balancing costs over and above the market price on Nordpool.
- Planning for 75 MW onshore wind power in both 2010 and 2011.
- "Green scheme" to reinforce landscape values in local areas. The scheme is to be financed through PSO income.
- An obligation to offer 20% of the investment for local co-ownership through the right to purchase for wind turbine neighbours.
- "Guarantee fund" of DKK 10 million to support the financing of preliminary studies, etc., by local wind turbine co-operatives. The fund is to be financed by the wind turbine owners.
- Compensation scheme to cover loss of property value among neighbours of new wind turbines.
- Tender for 400 MW of offshore capacity for commissioning in 2012.

The specific design of the new measures is presented in detail in the new renewable energy legislation, which also collates previous legislation in the area. The new act came into effect on 1 January 2009.

Several new studies have focused on the options for assimilating larger volumes of wind power. This applies, for example, to the studies conducted by Energinet.dk, the Danish Board of Technology and the Danish Wind Industry Association, which published analysis centred on quantifying the advantages and drawbacks of expanding wind power production in Denmark such that it can cover 50 per cent of Danish electricity consumption by 2025.[1]

Denmark elected a new centre/left government in October 2011. One of the ambitions of the new government is for the Danish supply of electricity and heat to become independent of fossil fuels, with wind power covering half of the country's energy consumption by 2020.

The government is to initiate negotiations with the other parties in parliament on the subject of a new energy agreement in November 2011. It is expected that the agreement will form the basis for the continued expansion of wind power in Denmark.

4.3. Planning and processing by the authorities

Planning procedures

Onshore

The local authorities are responsible for designating areas for the erection of onshore wind turbines.

In February 2007, the government's planning committee presented a range of recommendations concerning long-term wind turbine planning on land. The committee recommended, for example, that in connection with the municipal plan audit in 2009, the local authorities should incorporate an overall plan for the long-term

[1] A discussion of the Danish Board of Technology's scenario work is presented online at www.tekno.dk

The Danish Wind Industry Association analysis was conducted by Ea Energianalyse, and the report is published online at www.eaea.dk

expansion of wind power. This plan should designate sites for the erection of turbines measuring 100-150 metres in height, and assess the total estimated capacity in the designated areas. This was backed by a wide range of recommendations for the landscape-related aspects of wind power expansion, including a recommendation to concentrate turbines in groups wherever possible.

On the recommendation of the committee, the Danish Ministry of the Environment held a workshop for the local authorities in May 2007 centred on the planning of wind power on land. The workshop was held jointly by the Ministry of the Environment, the Danish Energy Agency and Local Government Denmark, with the participation of the Danish Wind Industry Association.

On the basis of the 2007 workshop, a number of dialogue forums were set up, which the local and state authorities use to promote information, the exchange of experience and the build-up of competence in the local authorities. The Ministry of the Environment has subsequently held annual workshops on wind turbine planning.

In June 2009, the Ministry of the Environment published a revised Wind Turbine Circular, which set down guidelines for the physical planning of wind turbine areas. The revised circular takes into account aspects such as the new municipal structure and the fact that wind turbines are now taller than they were previously.

On 28 May 2010, the Danish government, the Social Democrats, the Danish People's Party and the Socialist People's Party entered into an agreement to establish a Danish national test centre for large wind turbines in Østerild.[2]. At the same time, the parties involved agreed that the establishment of a national test centre is to be seen as part of a future-oriented holistic solution for the placement of test turbines up to 2020 when, in addition to the test centre, there are to be potential areas for the testing of large turbines up to heights of 250 m, prototype turbines and zero-series turbines.

Both private and public areas across Denmark have been screened on the basis of a set of objective criteria that areas for prototype turbines and zero-series turbines are to fulfil.

In spring 2011, the Danish Nature Agency prepared a report containing environmental assessments of the seven sites that are potentially suitable for the erection of prototype turbines. The report on the environmental assessment of 24 potentially suitable areas for zero-series turbines was published in autumn 2011.[3]

On 25 April 2008, the Danish Ministry of the Environment and Local Government Denmark entered into an agreement concerning local authority planning for wind turbines up to 2011. The Wind Turbine Secretariat of the Ministry of the Environment, which is tasked with assisting local authorities in promoting wind turbine planning, was set up under the Ministry of the Environment as a part of the agreement with Local Government Denmark concerning the establishment of a planning basis for wind turbines before 2011.

In September 2010 and in collaboration with the Danish Wind Industry Association and the Danish Wind Turbine Owners' Association, the Danish Ministry of the Environment and Local Government Denmark concluded a study of the progress being made in the local authorities' planning for onshore wind turbines. The study revealed that many local authorities are making good progress on their planning, and that in municipal plans and concrete proposals which have already been adopted for the placement of wind turbines, opportunities have been created for the installation of around 1,000 new MW-class turbines on land.

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[2] Act no. 647 of 15 June 2010 concerning a test centre for large wind turbines at Østerild. See :http://www.naturstyrelsen.dk/Planlaegning/Planlaegning_i_det_aabne_land/Testcenter/Lovarbejdet/

Additional information concerning the Danish test centre at Østerild:

[3]http://www.naturstyrelsen.dk/Planlaegning/Planlaegning_i_det_aabne_land/Testcenter/

Additional information about the Danish Nature Agency's identification of areas for test turbines is published online at: http://www.naturstyrelsen.dk/Planlaegning/Planlaegning_i_det_aabne_land/Testmoeller

The Danish EPA is revising the statutory order concerning noise from wind turbines to introduce binding limits for low-frequency noise.

The Danish Minister of the Environment has set up a working group tasked with establishing whether the local authorities' planning tools are sufficient to contribute to assuring the government's goals for the expansion of onshore wind turbines.

Offshore wind turbines

The Danish state has sovereignty over Denmark's territorial waters and the exclusive economic zone. Thus far, 12 offshore wind farms have been built in Danish coastal waters. On the request of the Ministry of Energy and the Environment, an "Offshore turbine action plan for Danish coastal waters" was prepared in 1997. The report identified the likely potential for large-scale expansion with 4,000 MW of offshore turbines, and highlighted a number of suitable main areas for first-stage demonstration projects. In 1998, on the basis of the recommendations in the Offshore Turbine Action Plan, the Danish government directed the electricity companies at that time to establish five large-scale offshore demonstration projects with a combined capacity of 750 MW. Two demonstration projects at Horns Rev and Nysted-Rødsand were brought online in 2002/2003.

In the wake of the liberalisation of the electricity sector and the division of the old energy companies into separate production and transmission units, the previous government withdrew the last three of the five original administrative orders for offshore wind turbine expansion in 2002. These referred to the offshore projects at Læsø, Gedser and Omø – totalling 450 MW.

The energy-political agreements in 2004 included tenders for two new offshore wind farms of 200 MW each at Horns Rev (Horns Rev 2) and Rødsand (Rødsand 2). Horns Rev 2 was commissioned in 2009 and Rødsand 2 in 2010.

A government committee has updated the Offshore Turbine Action Plan from 1997. In April 2007, the committee published its report entitled "Future offshore turbine locations 2025". The committee has assessed societal interests with regard to grid transmission conditions, navigation, nature, landscape, raw material extraction, etc. In addition, the committee has elucidated the technical, financial and planning-related options for bringing the electricity produced ashore, and has described scenarios for the technological development of the wind turbines. This has created a professional basis for planning the expansion of offshore wind power so that it can be co-ordinated with the expansion of the transmission grid. Having balanced all these considerations, the committee unanimously identified seven main areas with a total surface area of more than 1,000 km^2. This provides sufficient space for the establishment of up to 23 offshore wind farms – each with 200 MW of installed capacity. "Future offshore turbine locations 2025" was updated in 2011.

The map below shows the locations of the existing offshore wind farms in Danish coastal waters, as well as the committee's suggestions for future sites:

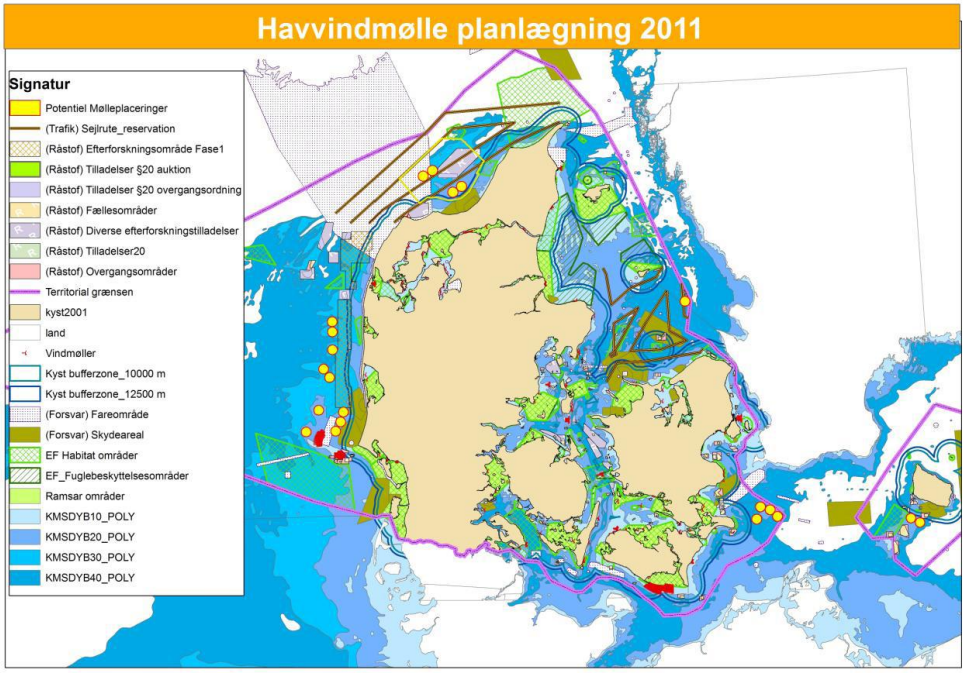

Figure 2: Existing offshore wind farms and possible locations for new farms in Danish coastal waters. The Danish Energy Agency, April 2011: "Large-scale offshore wind farms in Denmark"

The energy-political agreement of 21 February 2008 contains a decision to establish 400 MW of offshore turbines for commissioning in 2012. A chief contractor has been appointed following a tender process, and it is expected that the farm will be established at Anholt before the end of 2013.

Approval procedures

Applications for the installation of wind turbines are to be approved by local, regional or state authorities in line with the description below. The chief contractor is to prepare an EIA (Environmental Impact Analysis) which is to assess the environmental consequences of the installation on the basis of a set of specific requirements. In addition, it is to show how any negative environmental consequences can be reduced, and to state other placement options. The EIA report is to be followed by a public hearing process that includes the general public, the authorities and relevant organisations before the project is approved by the authority in question.

Offshore

There are two models for the installation of offshore wind turbines in Denmark. Large-scale offshore wind farms can be established on the basis of a tender process, or applications to install offshore wind farms can be submitted according to what is known as the "open door procedure". Turbines established according to the "open door procedure" receive the same settlement as onshore turbines.

Permission to install wind turbines offshore is granted by the Danish Energy Agency, which is thus also responsible for approving the EIA report. This report is to cover aspects such as wind conditions, sea currents, seabed conditions and the impact on the marine environment. It is also to contain a description of the environmental consequences for flora and fauna, the seabed, water, air, climate conditions, archaeological conditions, effects on the landscape and coastal safety. Permits from the Danish Energy Agency are required for both preliminary studies and the actual commissioning. This procedure also applies to state tenders for offshore wind farms.

Connection conditions

For all turbines, it is the grid company or transmission company that sets the voltage level.

The proportion of the connection fee that the turbine owner is to pay can vary. In the case of onshore wind turbines, the grid company is obliged to run the grid to the boundary of the area for which the local plan was prepared. For offshore farms covered by state tender processes, Energinet.dk is to establish transformer platforms and cables from the farm to the mainland on the basis of a ministerial order. Finally, for offshore turbines established according to the "open door procedure", the grid company is obliged to purchase the production from the coastline, which means that the turbine owner is to cover the costs for the sea cables.

More detailed technical requirements for the connection of wind turbines to the grid are published on the system supervisor's website: www.energinet.dk. There are technical regulations for wind farms connected to the grid with voltages in excess of 100 kV, and corresponding regulations for wind turbines that are connected to the grid with voltages below 100 kV.

The large Danish offshore wind farms – Horns Rev 1 and 2, Nysted and Rødsand 2 – are all connected directly to the transmission grid. These farms are, among other things, intended to fulfil requirements for uninterrupted operation in the event of short-circuit faults in the transmission system (ride-through). This requirement has contributed to the development of the capacity of wind turbines to deliver system services.

As mentioned previously in the section concerning planning procedures, a government committee has elucidated technical, financial and planning-related opportunities for the offshore expansion of wind power. This includes the options for and costs related to bringing the electricity produced ashore.

Achievement of the energy-political goals for increased expansion of wind power requires expansion of the transmission grid. For this reason, in April 2008, a committee featuring representatives from Energinet.dk, the Danish Ministry of Climate, Energy and Building, the Danish Ministry of Finance, the Danish Ministry of the Environment, Local Government Denmark, the Danish Energy Association and others completed a technical report on the future expansion and cable installation of the Danish electricity system. On the basis of this report, a political decision was taken on 4 November 2008 concerning new guidelines for cable installation and the expansion of the electricity system. These guidelines are published online on the Danish Energy Agency website:

http://www.ens.dk/da-DK/UndergrundOgForsyning/ElOgVarmeForsyning/Elforsyning/Eltransport/Sider/Forside.aspx

4.4 Financial conditions

In Denmark, financial subsidy is paid to new wind turbines as a supplement to the market price. In addition, a tender process with special tariffs has been prepared in connection with the establishment of new large-scale offshore wind farms.

The settlement terms for wind power depend on when the turbine in question is purchased and erected. In general terms, it can be said that newer turbines receive payment on market terms, while older turbines are covered by a transition scheme whereby the old price supplement is still in effect.

The energy-political agreement of 21 February 2008 resulted in an increase of the subsidy paid to new wind turbines of DKK 0.25/kWh for 22,000 full load hours + DKK 0.023/kWh in balancing costs, which amounts to DKK 0.273/kWh. This is backed by an extra supplement of DKK 0.08/kWh for 12,000 full load hours for turbines covered by the scrapping arrangement. Over and above settlement with the wind turbine owner, the sum of DKK 0.004/kWh is to be paid into a "green fund", which is administrated by Energinet.dk. The new settlement prices, which are laid down in the new renewable energy legislation, came into effect on 1 April 2009 following notification of the EU Commission, and were backdated to 21 February 2008.

Special settlement regulations apply to large-scale offshore wind farms established on the basis of tenders. These farms receive a fixed settlement during a period corresponding to approximately 50,000 full load hours. After this period, state subsidy is discontinued and the production is sold at market prices. Settlement on tender has been set to DKK 0.518/kWh for Horns Rev 2, DKK 0.629/kWh for Rødsand 2, and DKK 1.051 kW/h for Anholt Offshore Wind Farm.

4.5 Environmental conditions and popular acceptance

Wind turbines enjoy extensive public backing in Denmark. In a survey of the population conducted in March 2008 by Green's Analysis Institute[4], 91% of respondents stated that they were in favour of a continued expansion of wind power. However, there is growing local opposition to the establishment of new, larger wind turbines – and particularly to high voltage cables in association with the connection of new offshore wind farms. This can be seen as an expression of a NIMBY (Not In My Back Yard) tendency, which translates into support for the concept of wind turbines in general, but opposition to their being located "on my doorstep".

As regards offshore wind turbines, results from the recently concluded environmental monitoring programme at the Nysted and Horns Rev wind farms turned out more positive than expected with regard to the impact on flora and fauna. The studies centred on aspects such as seabed flora and fauna, fish, marine mammals, birds and public acceptance. One of the results reveals that public acceptance of offshore wind turbines is in excess of 80%. The table below presents the key results from the programme:

[4] Source: http://www.windpower.org/danskernemener.htm

	HORNS REV HAVMØLLEPARK	NYSTED HAVMØLLEPARK
Bundfauna og -flora	• Vindmøllefundamenter og erosionsbeskyttelse har skabt kunstige levesteder for dyre- og plantelivet, hvilket har øget diversiteten og biomassen i området.	• På grund af områdets lave saltholdighed og mangel på rovdyr er der udviklet monokulturer af blåmuslinger på vindmøllefundamenter og erosionsbeskyttelse.
Fisk	• Introduktionen af nye levesteder kan få positive effekter på fiskesamfundene efter fuld udvikling af de kunstige rev. • Ingen sammenhæng mellem styrken af det elektromagnetiske felt og de undersøgte fiskearters bevægelsesmønstre.	
Havpattedyr	• Sæler blev kun påvirket af ramningen af fundamenter. Både til havs og på land var sælerne generelt set upåvirkede af opførelsen såvel som driften af havmølleparken.	
	• Antallet af marsvin faldt en smule under anlægsarbejderne, men steg igen efter idriftsættelsen.	• Antallet af marsvin faldt markant under anlægsarbejderne og er efter to års drift kun langsomt ved at vende tilbage.
Fugle	• Fugle undgår generelt havmølleparkerne og nogle arter er fortrængt fra tidligere fødesøgningsområder. • Risikoen for at kollidere med vindmøllerne er lillle. • Effekterne på populationsniveau er ubetydelige.	
Holdninger	• Mere end 80 pct. af respondenterne fra lokalområderne er "positive" eller "meget positive" overfor havmølleparkerne. • Hovedparten mener, at havmølleparkernes virkning på fugle og det marine miljø er neutral. • Næsten to tredjedele mener, at havmølleparkernes effekt på landskabet er "neutral" eller ligefrem "positiv". • Mere end 40 pct. foretrækker at fremtidige havmølleparker flyttes uden for synsvidde. • Der er en væsentlig forskel på villigheden til at betale for placering af vindmøller på afstande hvor den visuelle forstyrrelse er relativ lille, dvs. op til 18 km fra kysten. Ved Horns Rev var der ingen ekstra villighed til at betale for at få møllerne uden for synsvidde ved at øge afstanden fra 18 til 50 km fra kysten.	

Figure 3: Experience from the Horns Rev and Nysted offshore wind farms. Danish Energy Agency 2006: "Offshore wind farms and the environment – experience from Horns Rev and Nysted"

In addition, four bird counts were performed in spring 2007, which revealed the presence of common scoters between the turbines at the Horns Rev offshore wind farm. A dramatic change in the distribution of the common scoter has occurred within the area examined in the period 1999–2007 in that, several years after the establishment of the offshore wind farm, the common scoter has returned to the area. The report concludes that common scoters can actually settle in recently established offshore wind farms.

A report on a limited follow-up on the environmental demonstration project is being prepared and the results are being published online on the Danish Energy Agency website: http://www.ens.dk/da-DK/UndergrundOgForsyning/VedvarendeEnergi/Vindkraft/Havvindmoeller/Miljoepaavirkninger/Sider/Forside.aspx

4.6 Research, development, demonstration

To date, Danish research into wind energy has been prepared and conducted in dialogue with the public sector authorities, the research community and the industry. Special areas of strength within Danish wind energy research include wind turbine aerodynamics, aerolastic dynamics, wind resources and wind atlases, loads and safety, and wind energy finance.

Research and development conducted in recent years has resulted in significant cost reductions and has helped improve the competitiveness of wind power in relation to conventional technologies. This is attributable in

particular to design optimisation, improved knowledge about wind conditions and the batch production of numerous turbines of the same type. It has transpired, for example, that the quickest cost reductions can be achieved by making the turbines larger. Recent studies show that wind power is now so competitive that its associated costs are approaching those of conventional electricity generation.

The areas of initiative for public sector support for future wind energy research in Denmark have been largely centred on supplementing actual technological development, with topics including the interaction between wind energy and the electricity system and cost reduction. In addition, special emphasis is placed on problem issues related to the offshore sector.

There are a number of public support programmes for research, development and demonstration of renewable energy technologies in Denmark. The most important are:

- **The Energy Technology Development and Demonstration Programme (EUDP**) (approx. DKK 400 million in 2011) – administrated by the Danish Energy Agency. EUDP provides subsidies to projects with the potential to "contribute to achieving the energy-political goals concerning supply reliability, the global climate and environment and cost efficiency, while simultaneously stimulating the commercial potential of the area to the benefit of growth and employment" and, finally, to contribute to Danish independence from fossil fuels. To a greater extent than previous programmes, EUDP is to prioritise subsidy for demonstration projects and thus narrow the gap between research and demonstration.

- **The PSO scheme for eco-friendly electricity production technologies** (DKK 130 million in 2011) – administrated by the Energinet.dk, the electricity company with responsibility for the system. The scheme provides subsidy for research, development and demonstration in the context of eco-friendly electricity production technologies.

- **The Council for Strategic Research pool for energy and the environment** (approx. DKK 300 million in 2008) – administrated by the Programme Committee for energy and the environment, whose secretariat is based at The Danish Agency for Science, Technology and Innovation. This provides subsidy for research into renewable energy and sustainable energy production.

You can find out more about the research programmes on the Danish Energy Agency website at www.ens.dk.

In 2006, the Megavind partnership was founded on the basis of a report from the government on the promotion of environmentally efficient technology. Megavind is to act as a catalyst for a stronger testing, demonstration and research strategy for wind power in Denmark. The partnership comprises representatives from the industry, research institutions and authorities, and its overriding purpose is to reinforce Danish innovation in the field of wind power by creating a cohesive strategy for innovation and research. Megavind's recommendations will function as a point of reference for strategic research into wind power over the coming years, and will thus become the applicable research strategy for wind power in Denmark. You can read more about Megavind on the Danish Wind Industry Association website at www.windpower.org.

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