



## IEA WIND TASK 28

# SOCIAL ACCEPTANCE OF WIND ENERGY PROJECTS "Winning Hearts and Minds" STATE-OF-THE-ART REPORT Country report of Denmark

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<b>Abstract / Summary</b> .....	<b>2</b>
<b>Framing the issue</b> .....	<b>2</b>
0. Introduction.....	2
1. The challenges of energy and climate policy.....	3
2. Public involvement and Social Acceptance goes hand in hand.....	4
<b>National Wind Energy Policy Objectives</b> .....	<b>5</b>
3. Various measures supports the implementation of wind energy projects.....	5
4. The loss-of -value scheme.....	6
5. The option -to -purchase scheme.....	7
6. The green scheme.....	8
7. The guarantee scheme.....	9
8. The Danish Wind Turbine Secretariat.....	10
9. Financial support for wind turbine electricity.....	12
<b>Attitudes and Variables Influencing Social Acceptance</b> .....	<b>13</b>
10. Shadow, Reflection, Light, Noise.....	13
11. Local ownership.....	15
12. Attitudes.....	17
References.....	20

## Abstract / Summary

Wind Turbines are not new phenomena in Danish landscape. The new development is that the capacity of wind turbines is increasing and still expected to increase during the next decades. Along the up scaling of wind capacity from the many small and often private owned turbines to the large wind power plants owned by larger companies and suppliers, certain challenges belonging to the social acceptance is relevant.

Several initiatives have been taken to support the implantation of more and larger wind power in Denmark, hereby initiatives to strengthen the private ownership and to support and assist the local process for planning and implementation.

Danish experiences can serve as a demonstration for the implementation of large amounts of wind power on shore and off shore.

Generally the Danish population is very positive to wind power also in the local area. The good planning and implementation process through all links in the chain is very important.

## Framing the issue<sup>1</sup>

### 0. Introduction

#### Introduction by the Operating Agent of IEA Wind Task 28

In 2009, many governments and organizations set new targets for CO<sub>2</sub> reductions, renewable energies in general, as well as specific targets for wind energy deployment. All these targets require many single projects to be carried out both onshore and offshore that necessitate hundreds of siting decisions and therefore hundreds of communities accepting a wind project nearby.

Research and projects are ongoing in many countries on how acceptance could be fostered, but we need to look beyond national borders to learn from each other and to complement each other's approaches. While Denmark has one of the longest traditions of co-operatively owned wind farms, Japan may bring its expertise in generating additional benefits for the communities hosting the turbines. While Ireland and Canada know about the effects of wind parks on tourism, Norway has conducted actual research on communication between society and science, e.g. concerning bird risks with wind farms.

In the framework of the IEA Wind Implementing Agreement, Task 28 collects and disseminates the current knowledge on how to increase acceptance of wind energy projects with the aim of facilitating implementation of wind energy and climate targets.

Ten countries have officially committed to Task 28 and have provided an input for cross-national comparison and discussion by writing a national report such as the one on hand. The Finish report has been incorporated into the international State-of-the-Art Report by IEA Wind Task 28, available also on [www.socialacceptance.ch](http://www.socialacceptance.ch).

#### Wind power – a challenging solution

The Danish climate makes wind power one of the most obvious renewable energy sources because the wind conditions are more favourable for electricity production than in most other European countries. Added to this, since the up a strong technological and research competence within wind power, and wind turbines end of the 1970s Denmark has been building have undergone such considerable technological advances that wind has become one of the most competitive renewable energy sources. In 2008 the combined global market share of the two largest Danish wind turbine manufacturers was just over 27%.

Wind turbines erected onshore are often highly visible in the landscape. This is particularly true of the latest MW wind turbines, which have rotating blades that reach more than 125 meters high. Although new wind turbines have been designed to minimize noise nuisance, the turbines can still be both seen and heard in the immediate

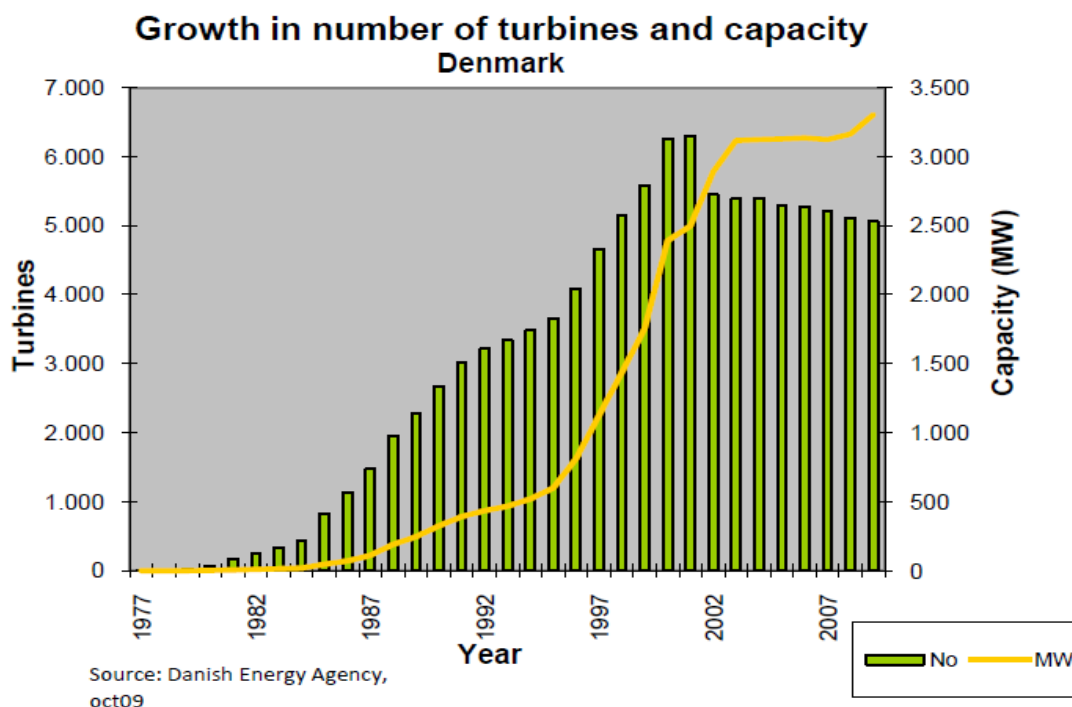
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<sup>1</sup> A substantial part of this report are inserted from the report 'Wind Turbines in Denmark', from Danish Energy Agency (<http://ens.netboghandel.dk/PUBL.asp?page=publ&objno=16336708>)

surroundings, which means that restrictions on distance to neighbours are imposed and the municipalities are obliged to consider the landscape in the planning that underpins the siting of new wind turbines. As a result of the ambitious objective for renewable energy, the Danish Government is seeking to promote the erection of new, more efficient wind turbines both offshore and onshore.

## 1. The challenges of energy and climate policy

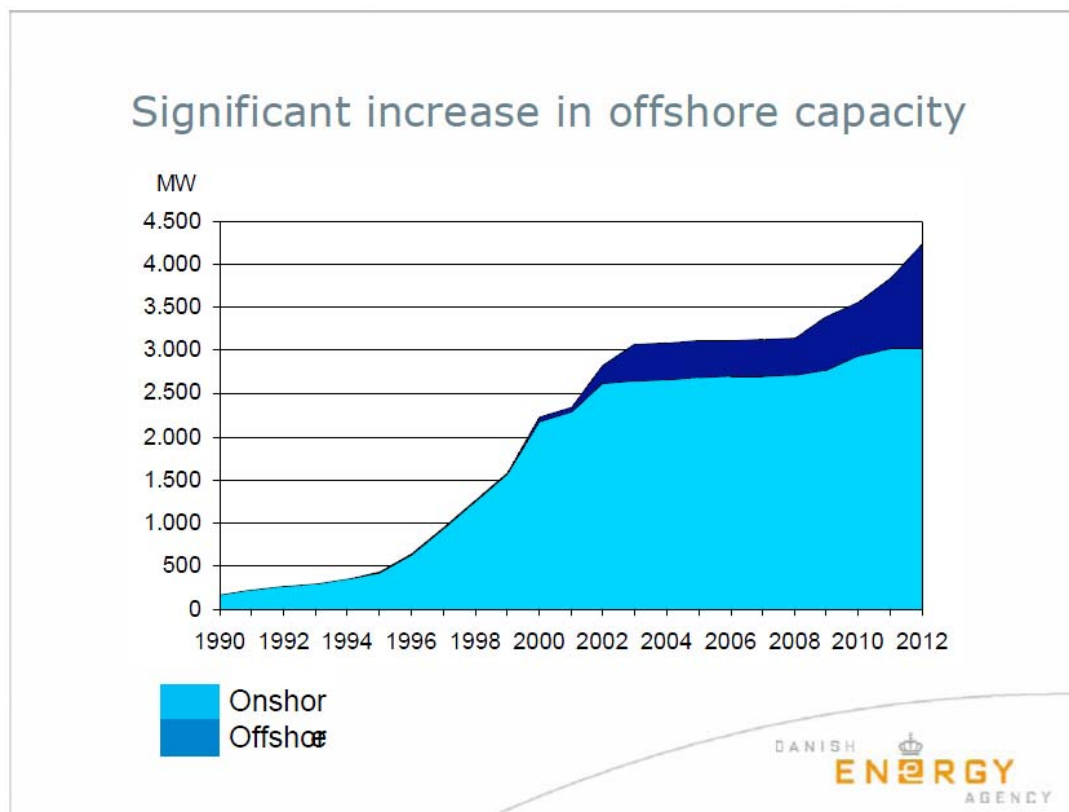
Since the first oil crisis in 1973 Denmark has transformed its energy supply and developed its own production of oil, natural gas and renewable energy. At the same time, energy has been greatly optimized so that, in spite of considerable economic growth during this period, there has only been a marginal increase in energy consumption. Denmark is therefore better prepared for international energy crises than most other countries, regardless of whether the challenges relate to supply or price. Furthermore, Danish emissions of the greenhouse gases covered by the Kyoto Protocol were reduced by around 8% in the period 1990-2008.



In spite of these results, Danish society is still facing major challenges in its energy and climate policies.

Denmark is expected, with its existing fields and finds, to be a net exporter of oil and natural gas for about 10 more years, although technological advances and any new finds may bring further production and extend this period. But there is a need to build up alternative sustainable energy production.

In *A visionary Danish energy policy 2025* the Danish Government presented a vision for the long-term phasing-out of fossil fuels such as coal, oil and gas, and appointed the Climate Commission to set out specific directions for how this can be done. A phasing-out of fossil fuels will strengthen long-term supply reliability and contribute to a reduction in CO<sub>2</sub> emissions.



## 2. Public involvement and Social Acceptance goes hand in hand

The development of wind power in Denmark has been characterised by strong public involvement. It was small machinery manufacturers that created the established wind turbine industry, and only after the consolidation of the industry through the 1990s did it become dominated by large, partly internationally owned and listed companies. Similarly, on the customer side numerous joint-owned wind turbines were established in the period 1984- 94. Around two thousand of the 5,200 Danish wind turbines are still owned by local wind turbine owners' associations. These are mostly older, smaller wind turbines because the majority of wind turbines erected since 1995 are owned by individuals, energy companies and other commercial wind power companies.

The progression towards fewer joint-owned and relatively large wind turbines has made it difficult to maintain local support for new wind power projects. But to ensure continued development of wind power, it is essential to have backing in the local community.

The *Energy Policy Agreement of 21 February 2008* therefore stipulated that a range of new initiatives should be undertaken to promote local acceptance and option to purchase wind turbines shares of new wind power projects.

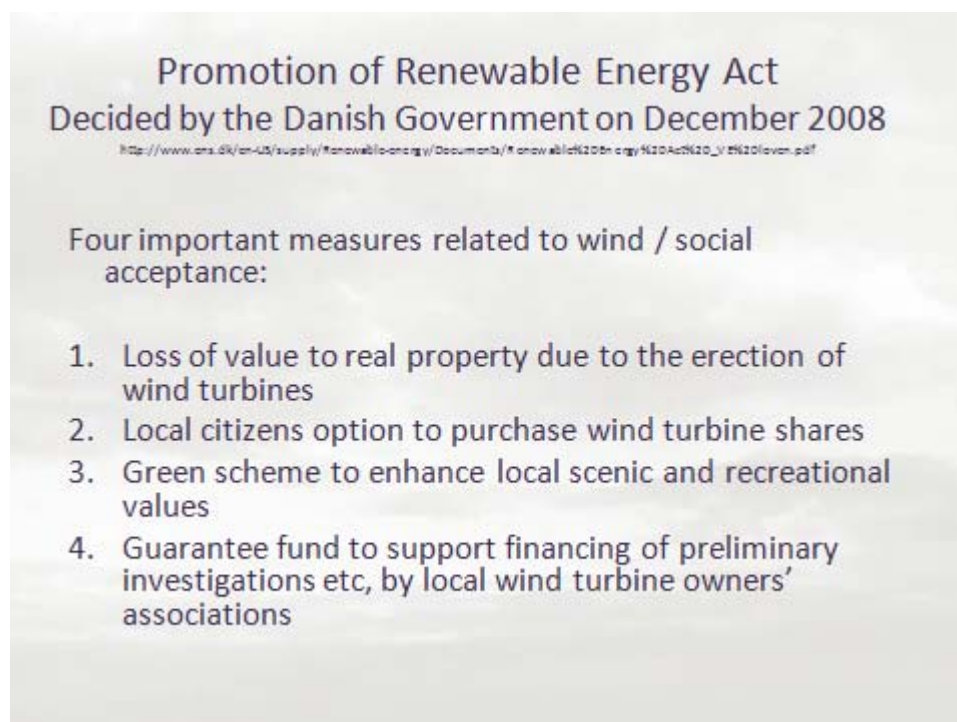
## National Wind Energy Policy Objectives

### 3. Various measures supports the implementation of wind energy projects

A visionary Danish energy policy 2025 was published in January 2007. It was followed by the *Energy Policy agreement of 21 February 2008* between the Danish Government and all of the parliamentary parties with the exception of the Red-Green Alliance. This Agreement sets out ambitious goals for the development of renewable energy and for energy savings. A specific goal is that, compared to 2006, gross energy consumption should be reduced by 2% by 2011 and by 4% by 2020. Furthermore, renewable energy should cover at least 20% of Denmark's gross energy consumption in 2011.

In order to achieve these goals, the *Energy Policy Agreement of 21 February 2008* contains a number of resolutions on, among other things, improving the feed-in tariff for electricity from new wind turbines, biomass incineration, biomass gasification, and biogas. Funding was allocated to promote the introduction to the market of newly developed renewable energy technologies such as solar cells, thermal gasification of biomass, and wave power, and government support for the research, development and demonstration of energy technologies will be increased to DKK 1 billion in 2010.

The Agreement also contains a range of initiatives aimed at promoting local acceptance of and commitment to new onshore wind turbine projects. Neighbours will be entitled to seek compensation for loss of property value due to the erection of wind turbines. A local option to purchase has been introduced for new wind turbine projects. Local wind turbine owners' associations can apply for a guarantee covering their financing of essential preliminary investigations. And municipalities where new wind turbine projects are established will have access to subsidies from a green scheme for new wind turbine projects.



**Promotion of Renewable Energy Act**  
Decided by the Danish Government on December 2008

<http://www.ens.dk/en-US/supply/renewable-energy/Documents/renewable-energy/Act%20v%202008.pdf>

Four important measures related to wind / social acceptance:

1. Loss of value to real property due to the erection of wind turbines
2. Local citizens option to purchase wind turbine shares
3. Green scheme to enhance local scenic and recreational values
4. Guarantee fund to support financing of preliminary investigations etc, by local wind turbine owners' associations

The *agreement of 21 February 2008* also includes initiatives to further promote the development of wind power. A follow-up to the 2004 scrapping scheme for old wind turbines was agreed. And it was also decided that the Danish Minister for the Environment should conclude an agreement on behalf of the Danish Government with Local Government Denmark with a view to facilitating local wind turbine planning.

In April 2008 the Minister duly signed just such an agreement with Local Government Denmark setting out the goals for local planning of onshore wind turbines. In connection with this, the Danish Ministry of the Environment's **Wind Turbine Secretariat** was established to assist the municipalities with their planning.

Finally, the supporting parliamentary parties agreed that 400 MW of new offshore wind turbine capacity should be established and operational by the end of 2012 and guidelines for different actors in the field.

**The various measures:**

#### 4. The loss-of -value scheme

*1 Loss of value to real property due to the erection of wind turbines*

"Any person who , upon erection of one or more wind turbines, causes the loss of value to real property, shall bear the costs of this.."

- Offshore turbines and turbines less than 25 meters are not included
- The valuation authority shall decide the size of the loss of value on the basic of an individual assessment / or the erector of the wind turbine and the owner of the real property may choose an agreement about the size of the amount

Any party erecting new wind turbines with a height of 25 meters or more, including offshore wind turbines erected without a government tender procedure, must pay for any loss of value on real property if the erection of the wind turbines results in a loss of at least 1% of the property value. In order to give neighbours the opportunity to assess the consequences of the wind turbine project, the erector must draw up information material on the project and invite the neighbours to a public information meeting. The material must include a list of the properties lying within a distance of up to six times the wind turbines total height.

Energinet.dk, which must approve the information material, can require that the material should also include a visualization of the project. The meeting must be convened with a reasonable period of notice by means of an announcement in local newspapers and must take place at the latest four weeks before the municipal planning process ends.

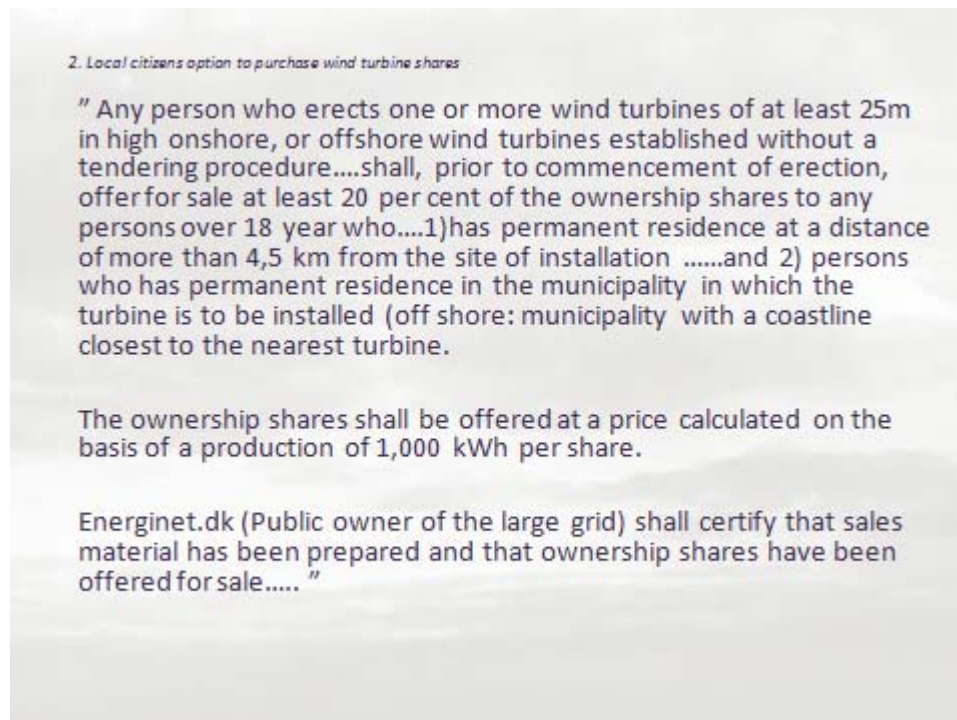
Property owners, who believe, based on the information material and the information meeting, that the erection of the wind turbines will reduce the value of their property must notify the loss of value to Energinet.dk within four weeks of the meeting. If a property owner lives further away than six times the wind turbine's total height, the owner must pay a fee to Energinet.dk of DKK 4,000. Neighbours who live closer to the wind turbine project are not required to pay this fee. The fee is repaid if the property owner is granted the right to compensation for loss of value.

The wind turbine erector may enter into a voluntary agreement concerning compensation for loss of value with property owners who have notified their claims to Energinet.dk. If this is not done within four weeks, Energinet.dk will submit the owners' claims to a valuation authority. The Danish Minister for Climate and Energy has appointed five valuation authorities consisting of a lawyer and an expert in assessing real property value. The valuation authority will decide, on the basis of a specific assessment, the extent to which property owners' claims can be accommodated.

If the property owner's claim for compensation is upheld, the wind turbine erector will pay the valuation authority's costs. If the property owner's claim is rejected, Energinet.dk pays the case costs not covered by any fee of DKK 4,000. This cost is recouped from the electricity consumers as a PSO contribution.

Decisions of the valuation authority cannot be contested with another administrative body but may be brought before the courts as civil proceedings by the owner of the property against the wind turbine erector.

## 5. The option -to -purchase scheme



Erectors of wind turbines with a total height of at least 25 meters, including offshore wind turbines erected without a governmental tender, shall offer for sale at least 20% of the wind turbine project to the local population. Anyone over 18 years of age with his/her permanent residence according to the National Register of Persons at a distance of maximum 4.5 kilometres from the site of installation or in the municipality where the wind turbine is erected has the option to purchase. If there is local interest in purchasing more than 20%, people who live closer than 4.5 kilometres from the project have first priority on a share of ownership, but the distribution of shares should ensure the broadest possible ownership base.

In order to give local citizens an adequate decision making platform, wind turbine erectors must provide information on the nature and financial conditions of the project. This must be done through sales material containing as a minimum the articles of association of the company that will be erecting the wind turbine, a detailed construction and operating budget, including the financing for the project, the liability per share, and the price of the shares on offer. The sales material must be quality-assured by a state-authorized public accountant. Energinet.dk must approve the sales material as a condition for the wind turbine erector obtaining the price supplement provided for in the *Danish Promotion of Renewable Energy Act*.

The wind turbine erector must run through the sales material at an information meeting convened with a reasonable period of notice by announcement in a local newspaper. Following the information meeting, local citizens have a period of four weeks to make a purchase offer.

In the case of both the loss-of-value and option-to-purchase schemes, transitional regulations exempting wind turbines where the municipality has published a supplement to the municipal plan with an associated EIA or announced that the project does not require an EIA apply until 1 March 2009. The wind turbine project must also be connected to the grid before 1 September 2010.

## 6. The green scheme

3. Green scheme to enhance local scenic and recreational values

" ..a green scheme which may grant subsidies to initiatives undertaken to promote local acceptance of the installation of new onshore wind turbines connected to the grid on 21st February 2008 or later.....

A municipal council may apply Energinet.dk for ...a subsidy from the green scheme...Energinet.dk may give a commitment for a subsidy for expenses paid by the municipal council for

- 1) construction work to enhance scenic or recreational values in the municipality, and
- 2) cultural and information activities in local associations etc, in order to promote acceptance of the use of renewable energy sources in the municipality."

In order to further promote the local council's commitment to wind turbine planning and local acceptance of new wind turbine projects, the *Danish Promotion of Renewable Energy Act* has introduced a green scheme for the financing of projects that enhance the scenery and recreational opportunities in the municipality.

Energinet.dk, which administers the scheme, pays DKK 0.004 per kWh for the first 22,000 full-load hours from wind turbine projects that are connected to the grid on 21 February 2008 or later. The money for the green scheme is recouped from electricity consumers as a PSO contribution. The money is lodged in a special account for the given municipality; the amount of money depends on how many wind turbines and of what size are connected to the grid in the municipality. A wind turbine of 2 MW generates a total sum of DKK 176,000.

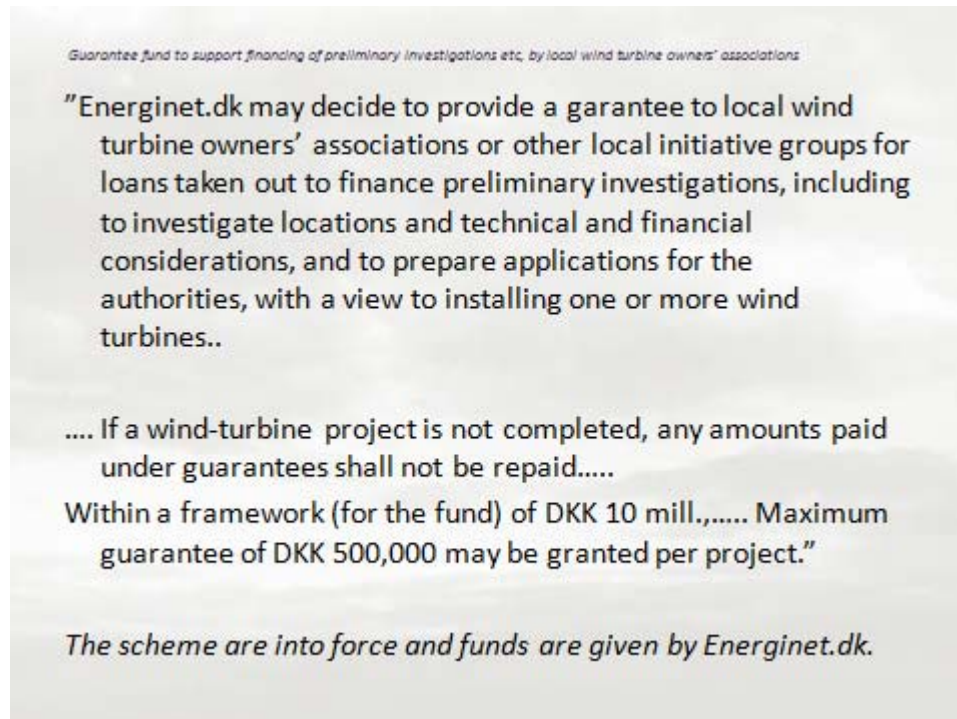
In order to promote local involvement in new wind turbine projects, during processing of the project the municipality may apply to Energinet.dk for a subsidy for certain development works or activities that draw on the full amount so that citizens become aware of the benefits that are obtained from the wind turbine erection. However, the subsidy can only be paid once the wind turbine project is connected to the grid. If several wind turbine projects are implemented in a municipality, the subsidies can be used for one combined project. In order for the money to be paid, the municipality must demonstrate to Energinet.dk that the money will be used in accordance with the application.

The green scheme may wholly or partly finance development works for enhancing scenic or recreational values in the municipality. A subsidy may also be granted for municipal cultural activities and informational activities in local associations, etc., aimed at promoting acceptance of the use of renewable energy sources in the municipality.



The municipalities may not raise complaints about Energinet.dk's handling of subsidies within the green scheme, but they can refer Energinet.dk's calculation of the municipality's share of the green scheme to the Energy Board of Appeal.

## 7. The guarantee scheme



In order to give local wind turbine owners' associations and other initiative groups the opportunity to initiate preliminary investigations, etc., for wind turbine projects, Energinet.dk has set up a guarantee fund of DKK 10 million that will make it easier for local initiatives to obtain commercial loans for financing preliminary investigations and keep the initiative takers financially indemnified if the project cannot be realised. The money for the guarantee fund is recouped from electricity consumers as a PSO contribution.

A local initiative may apply to Energinet.dk for a guarantee to take out a loan of maximum DKK 500,000. There are conditions that the wind turbine owners' association or initiative group must have at least 10 members, the majority of whom have a permanent residence in the municipality, and that the project prepared involves onshore wind turbines with a total height of at least 25 metres or offshore wind turbines that are established without a government tender.

The guarantee can be given for activities that may be regarded as a natural and necessary part of a preliminary investigation into establishing one or more wind turbines. This might be an investigation of the siting of wind turbines, including technical and financial assessments of alternative sitings, technical assistance with applications to authorities, etc. However, it is a condition that at the time of application the project is financially viable in the opinion of Energinet.dk. Guarantees can be awarded for a maximum total sum of DKK 10 million. If this limit has been reached, new applications are placed on a waiting list. The guarantee shall lapse when the wind turbines are connected to the grid or if the local group sells its project to another party.

Energinet.dk's decisions concerning the guarantee fund may be contested with the Energy Board of Appeal.

## 8. The Danish Wind Turbine Secretariat

The Danish Ministry of the Environment's **Wind Turbine Secretariat** was established to assist the municipalities with their planning. The secretariat was established in November 2008, and the impact from the secretariat to the planning process in the municipalities seems to be very successful. The model are now to be considered to include the local use of other local renewable resources.

By- og Landskabsstyrelsen

### The Danish Wind Turbine Secretariat Background and organisation

The Danish Wind Turbine Secretariat was established  
November 17, 2008

- An offer from the state to the municipalities. Free for the municipalities to use.
- A part of an agreement between the national government and "Local Government Denmark", with the target of new areas for 150 MW wind power before 2011



By- og Landskabsstyrelsen

### The Danish Wind Turbine Secretariat Services

**Assists the municipalities who are interested doing the wind turbine planning:**

- Locating potential areas
- Giving process advices
- Providing examples from other municipalities
- Assisting with dialogue with politicians
- Assisting with dialogue with authorities

- The municipalities still has the responsibility, and do the political priorities
- The Wind Turbine Secretariat is not doing authority work



By- og Landskabsstyrelsen

### The Danish Wind Turbine Secretariat Typical cooperation process

1. Interest from municipality
2. First screening for potential areas
3. First meeting and discussion of potential areas and process
4. Agreement
5. Specific screening on chosen areas from first screening
6. Second meeting and discussion
7. Presentation paper
8. ...




By- og Landskabsstyrelsen

### The Danish Wind Turbine Secretariat Typical questions

The municipalities can ask for a closer cooperation, but can also just ask questions, i.e.:

- Demands for distances
- Process
- Examples
- Possibilities for dispensation
- New legislation
- Small wind turbines
- Rulings
- Dialogue with authorities
- etc.



Contact:

The Danish Wind Turbine Secretariat  
vind@mim.dk  
www.vind.mim.dk  
Tel.: +45 72 54 82 44

## 9. Financial support for wind turbine electricity

Right from the late 1970s, there has been financial support for electricity produced by wind turbines. In the early years, this support took the form of both installation grants and electricity production subsidies. Since the beginning of the 1990s, the support has taken the form of a guaranteed feed-in tariff or a supplement to the market price. The support is offered as compensation for wind turbine owners because electricity production from wind turbines still cannot compete financially with conventional production at power plants using coal, natural gas or oil.

The current supplement to the market price is paid by Energinet.dk, which recoups the sum as a public service obligation (PSO). The amount is indicated on electricity bills. In recent years, when the average market price in the Nordic spot market has been fluctuating between DKK 0.20 and 0.35 per kWh, the PSO tariff has been around DKK 0.10 per kWh. As well as wind turbines, which receive around half of these PSO contributions for environmentally friendly electricity production, the contributions are also spent on supporting decentralised CHP plants, electricity production from biomass, solar power, etc.

### Price supplements for on shore wind turbines

The price supplement for electricity produced by wind turbines is regulated in the *Danish Promotion of Renewable Energy Act* in accordance with the *Energy Policy Agreement of 21 February 2008*. Here, a broad political majority in the Danish Parliament agreed to increase the supplement to make it more attractive to erect onshore wind turbines. The electricity produced is supplied to the electricity supply grid, and the turbine owner sells the actual electricity on the market under market conditions. A DKK 0.25 supplement to the market price is paid for electricity produced by wind turbines connected to the grid on or after 21 February 2008. The price supplement applies for the first 22,000 full-load hours. Furthermore, a supplement of DKK 0.023 per kWh is paid to cover balancing costs throughout the turbine's lifetime. In the case of wind turbines that were connected to the grid before 21 February 2008, there are special regulations that depend on the date of connection and the size.

Household wind turbines and small turbines, i.e. wind turbines with an output of less than 25 kW that are connected in a household's own consumption installation receive a price supplement which, together with the current market price, amounts to DKK 0.60 per kWh. If a wind turbine erector has earned or purchased scrapping certificates from older wind turbines with an output of 450 kW or less and dismantles the turbines in the period 15 December 2004 to 15 December 2010, the erector may receive a scrapping price supplement of DKK 0.08 per kWh, which is added to the general price supplement of DKK 0.25 per kWh. The scrapping price supplement is paid for the first 12,000 full-load hours at double the dismantled wind turbines' output. The supplement is conditional on the wind turbine being connected to the grid by 31 December 2010.

### Price supplements for off shore wind turbines

The price supplement for electricity produced by offshore wind farms established as part of a government tender is determined as part of the given tender. The winners of the tenders to date have been the bidders that could offer the lowest feed-in tariff. In the two government tenders carried out so far, the feed-in tariff for Horns Rev II, which is owned by DONG Energy, was set at DKK 0.518 per kWh for 10 TWh, corresponding to around 50,000 full-load hours, and the feed-in tariff for Rødsand II, which is owned by E.ON AB, was set at DKK 0.629 per kWh for 10 TWh, corresponding to around 50,000 full-load hours. Wind turbines established under an open-door procedure receive the same price supplement as new onshore wind turbines, i.e. DKK 0.25 per kWh for 22,000 full-load hours plus DKK 0.023 per kWh for the full lifetime of the turbine.

As mentioned, the Danish Ministry of the Environment's Wind Turbine Secretariat was established to assist the municipalities with their planning. The decision was taken along the 2008 Minister- agreement with Local Government in Denmark setting out the goals for local planning of onshore wind turbines.

## Attitudes and Variables Influencing Social Acceptance

### 10. Shadow, Reflection, Light, Noise

#### Impact on the immediate surroundings

The planning and environmental legislation sets out requirements to ensure that a wind turbine project will not cause major damage or nuisance to its surroundings, including noise and spacing requirements. It is also assumed that as a rule an environmental impact assessment (EIA) will be carried out as part of the detailed planning for specific projects. As well as describing the environmental impacts, this ensures, among other things, that the legislative requirements are observed.

The overall impact of wind turbines on their immediate environment includes visual impact, noise, shadow, the effects of lighting, impacts on nature, etc. The nature of these impacts depends on how the wind turbine is positioned in the landscape, the type of landscape, the wind turbines' size, and proximity to the wind turbine. In order to minimise the overall impact, when planning the siting of wind turbines the municipalities should seek to limit these nuisances, including ensuring that noise and spacing requirements are observed. Similarly, wind turbine manufacturers are continuously working to optimise turbine design so that they not only produce optimally but also reduce the impact on their surroundings as much as possible.

#### Shadow

A wind turbine casts shadows when the sun is shining. In windy, sunny weather, an area of the turbine's surroundings will be affected by rotating shadows from the blades. In Denmark the area lying to the south of the wind turbine will never be affected by shadow from the blades. Nuisance from shadow, which takes the form of a rapid change between direct light and short "flickers" of shadow, depends on where the wind turbine is standing from the perspective of the neighbour, the distance between the wind turbine and the neighbour, the wind turbines' hub height, and the length of the blades.

The critical times for shadow occur mainly in the early morning and late evening, with long shadows at a greater distance from the wind turbines than the neighbour distance requirement of four times the total height of the wind turbine. The impact of shadow is calculated as the total number of hours annually that a neighbour is subjected to shadow and will vary with seasonal changes in the weather. The assessment of the anticipated number of annual hours of shadow is therefore calculated based on the anticipated normal distribution of operating hours and sunshine hours during the course of the year.

It is recommended that the calculated normal distribution of shadow hours for neighbours not exceeds 10 hours a year. By taking these issues into consideration in the planning of wind turbine sitings, the periods during which shadow actually occurs can be limited. If a full assessment shows that the most suitable siting entails that the recommended maximum of 10 hours' shadow cannot be observed, the owner of the wind turbine may alternatively be required to shut down the wind turbine in critical periods. The wind turbines can be fitted with meters so that the operation can be halted if the sun shines during critical periods; this can reduce operating losses.

#### Reflection

As wind turbine blades must have a smooth surface to be able to produce optimally and repel dirt, the blades can produce reflective flashes. As part of the type-approval of wind turbines, the reflective qualities of the blades are stated. Typically, the reflective effect of the blades will be halved during the wind turbine's first year of operation, and in their planning the municipalities can set requirements for anti-reflective treatment of the blades. Normally, the blades from the manufacturer will be surface-coated to obtain a low gloss. Usually the gloss value will be less than 30, which is regarded as sufficiently low for reflections from the wind turbine not to be a problem.

#### Light - Marking of wind turbines in relation to air traffic

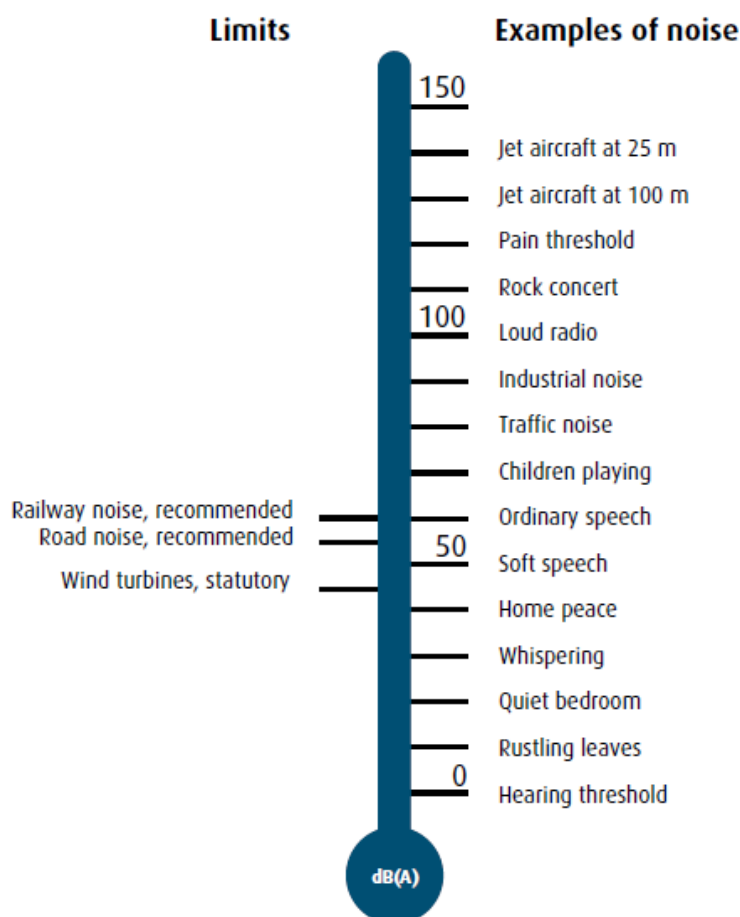
In order that installations should not compromise the safety of air traffic, any obstacles – including wind turbines – with a total height of more than 100 metres must be approved by Civil Aviation Administration-Denmark (CAA - Denmark). Around state-approved airports and airfields, aircraft are protected against obstructions using the approved obstacle limitation surfaces. The approach plan's height restrictions are registered with easements or notified in the municipal plans.

All wind turbines with a total height of minimum 150 metres must be provided with high intensity, white flashing lights. The exact regulations are set out in the *BL 3-10 Regulations for Civil Aviation* based on applicable international standards and recommendations. The basis for the regulations is a desire for obstructions to air traffic to be visible at a suitable distance so that the pilot can take the necessary operational actions in time. In the case of wind turbines of 100-150 metres in height, which will typically be pertinent in connection with projects under the scrapping scheme and new onshore wind turbines, CAA -Denmark will carry out a specific assessment of the need for marking, including taking into consideration Danish Defence's assessments of military flights in the area. Under normal circumstances, the marking of the wind turbines with low-intensity fixed red obstruction lights on the nacelle plus painting the wind turbine white will be sufficient.

Where special air safety factors apply, marking with medium-intensity flashing obstruction lights will be necessary in addition to painting the wind turbine white. It would be appropriate for requirements for air traffic marking to be clarified with CAA -Denmark before an EIA, where one is required, is drawn up. Previous attempts to counteract light nuisance from TV-station transmitting masts have shown that it is not possible to effectively shield surrounding houses against obstruction lights. Any shielding must be carried out taking into consideration that obstruction lights must be observable by the pilot from all directions in the horizontal plane.

### Noise

Wind turbines emit a relatively weak but characteristic noise. The noise emanates from the operation of the turbine's gear and generator as well as from the movement of the blades through the air. In relation to generated output, modern wind turbines emit considerably less noise than the earliest wind turbines from the 1970s and 1980s. In particular, the mechanical noise from the turbine's gear and generator are significantly reduced in comparison with earlier models. In modern wind turbines, the machine house is soundproofed, the generator and gear are suspended in rubber elements, and the nacelle's cabin is tight-closing and fitted with sound locks that dampen airborne noise. Blade design has developed so that the noise from the movement of the blades through the air is minimised.



In order for a wind turbine to be certified for erection in Denmark, it must satisfy a number of requirements set out in the *Danish Ministry of the Environment Order on noise from wind turbines* (no. 1518 of 14 December 2006). Among other things, a noise survey must be carried out and the noise level calculated at the premises of immediate neighbours. Sound is measured in decibels (dB). The human ear can just detect a change in sound intensity of 1-2 dB. If the sound intensity increases by 6-10 dB, it will be heard as a doubling of the sound intensity. Similarly, a reduction of 6-10 dB will be heard as a halving of the sound intensity. The intensity of the sound is generally measured using a method that mimics the ear's sensitivity and is stated by the measuring unit decibel-A, dB(A).

In accordance with the Danish Ministry of the Environment's Order, the noise in the open land immediately outside the neighbour's house and in open spaces up to 15 metres from the house may not exceed 44 dB(A) at a wind speed of 8 metres per second. This corresponds roughly to the noise of soft speech. In more densely built up areas, summer home areas and noise-sensitive recreational areas, the noise may not exceed 39 dB(A). The limits are lower

for lower wind speeds. The municipalities monitor compliance with these noise limits.

The relatively weak noise from wind turbines also includes some low-frequency noise, i.e. deep sound with a low frequency. Low frequency noise is where a significant proportion of the sound energy is found in the frequency range below around 160 Hertz (Hz). Hertz is a designation for the number of oscillations per second. None of the noise surveys that have been carried out suggest that there are special problems with low-frequency noise from wind turbines. In the assessment of the Danish Environmental Protection Agency, wind turbines that observe the limits for ordinary noise do not give low-frequency noise higher than the recommended limit. In order to shed further light on the issues of low-frequency noise, thereby giving municipalities and players in the wind power industry a more reliable basis for evaluating new wind turbine projects, DELTA – Danish Electronics, Light and Acoustics – has headed up a research project that has been mapping the issues of low-frequency noise from modern wind turbines since 2006. The project is expected to be completed in spring 2010.

Infrasound is sound with a frequency lower than 20 Hz and thus constitutes the “deepest” part of the low frequency range. Previously it was thought that infrasound could not be detected by the human ear, but infrasound can actually be heard if it is strong enough, and even weak infrasound is regarded as a nuisance. The threshold for hearing infrasound has been well researched, and the Danish Environmental Protection Agency recommends a limit that is 10 dB lower than the hearing threshold. The infrasound emitted by modern wind turbines is of no consequence for the surroundings and is much weaker than the Danish Environmental Protection Agency’s recommended limit.

## 11. Local ownership

### Cooperatives – a local and democratic ownership to wind turbines <sup>2</sup>

One of the characteristics of the Danish wind energy sector is the cooperatives or guilds. Many of the wind turbines erected in the 1980s and early 1990s were and still are owned by local cooperatives/guilds. The first wind turbine guild or cooperative was established in 1980 near Aarhus in Jutland, and it soon proved to be the pioneering model for future development. At that time, the wind turbine 'guilds' from all over the country were often the grass roots activists, working hard to get permission to have their turbines erected and also participating in public debate.

Since then, single-person ownership has superseded the importance of the cooperatives and now utilities and large energy companies play an increasing role in the establishment and ownership of wind turbines in Denmark, especially when it comes to large-scale wind farms. However, cooperative ownership is still an important factor, and new legislation from January 2009 is aimed at stimulating the local engagement and ownership in new wind energy projects. The new Danish act on renewable energy imposes an obligation on all new wind energy projects to offer minimum 20 per cent ownership to local people, e.g. cooperatives.

### The background for cooperatives

The overall concept of cooperatives can briefly be described as an autonomous association of persons united voluntarily to meet their common economic or social needs through a jointly-owned and democratically-controlled enterprise. A cooperative may also be defined as a business owned and controlled equally by the people who use its services or who work at it. In 1844, local weavers and other artisans in Rochdale, England, set up a society to open their own store selling food items they could not otherwise afford. This is often referred to as the first successful cooperative enterprise, used as a model for modern co-ops.

The first co-op store in Denmark was opened in 1866, and the first cooperative dairy was started in 1882 in Western Jutland. Later followed cooperative slaughterhouses and feedstuff wholesale societies. The foundation of a large number of cooperatives can be considered as one of the most important commercial developments in the history of Denmark.

In the 1970s, many cooperative undertakings disappeared from the villages of Denmark. Some of these are still formally organised as cooperative undertakings, but they have been merged into large units or companies, which are often operating both nationally and internationally. Although the number of cooperative undertakings have fallen, the idea of joining hands, establishing local associations or working groups, is still a widespread phenomenon in Denmark in order to start new businesses or local associations in relation cultural or social activities. On that basis the wind turbine cooperative or guilds were formed.

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<sup>2</sup> This chapter is an insert of an article from the home page of the Danish Wind Turbine Owners' Association, <http://www.dkvind.dk/eng/index.htm>, August 2009

### Cooperatives in practice

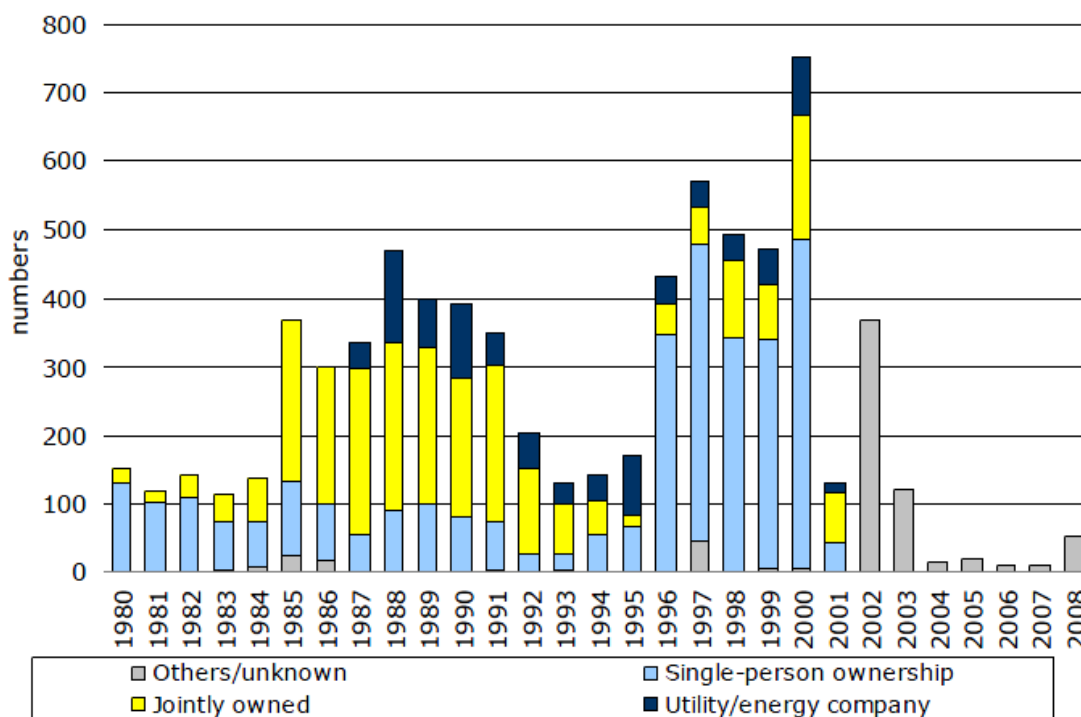
Wind turbine cooperatives in Denmark are normally partnerships, which in daily practice function as cooperatives. For legal reasons they are forced to establish formal partnerships due to the fact that in Denmark the interest on the loan for the wind turbine is tax deductible from the private income of the individuals in a partnership, not in a cooperative.

Jointly owned wind turbines in Denmark are organised as partnerships with joint and several liability. In practice, the risk of joint and several liabilities is minimised in that the partnership is unable to contract debt. This is ensured in the bylaws, which maintain that the partnership cannot contract debt, and that the turbines must be adequately insured.

As a partner you own a part of the wind turbine corresponding to the number of shares you buy. Often one share is calculated corresponding to the yearly production of 1000 kWh from that particular wind turbine.

Private individuals and cooperatives have played an important role in the development of the Danish wind energy sector. On a rough estimate, approx. 15 per cent of the Danish wind turbines today are owned by cooperatives.

**Ownership of Danish wind turbines**



As the number of small turbines (e.g. < 600 kW) will decrease over time, the number of cooperatives might also decrease. On the other hand, the new Danish act on renewable energy with its obligation to offer shares to a possible local ownership could give the cooperatives a revival.

### Advantages of cooperatives

Local acceptance of a wind turbine project is necessary. Public resistance against wind turbines in the landscape have been and still are and one of the largest barriers to the development of wind power. Opinion polls show a wide support in the population in favor of wind power in general. However, uncertainties and lack of information in the planning phase of future wind power projects often give raise to local scepticism.



The experience from a number of wind energy projects in Denmark shows that public involvement in the planning phase and co-ownership increases the acceptance. Adding to this, two private offshore projects shows that cooperative development and ownership is an option also in larger-scale projects. The Middelgrunden Offshore Wind Farm (40 MW) close to Copenhagen was developed through cooperation between the municipality, an energy company and not least a number of private individuals. Middelgrunden is the world's largest cooperatively owned wind farm with more than 8000 members of the cooperative. The Samsø project off the east coast of Jutland (23 MW) was developed by a cooperative with local people on the island of Samsø and the municipality as members.

Strengths of a cooperative:

- Active and committed members
- Dialogue and political contacts with many stakeholders through a widespread network
- Large public support
- Direct contact to local authorities

A possible weakness of a cooperative might be the financially weak starting point but this can be overcome by cooperation with municipalities, utilities or other investors.

Local ownership creates local dialogue and acceptance. Through dialogues with different interest groups a widespread understanding for the chosen location and layout of the farm can be generated. Potential conflicts can be avoided by taking direct contact to local stakeholders at an early stage in the development of the project, eg contact and dialogues with local farmers, fishermen, enterprises or inhabitants in villages close to the site.

With local investment in power generation it is the local people who – at least to some point – take the decision on the planning and implementation of power supply, bringing more responsibility to the local level. Experiences from many wind energy projects in Denmark have shown that often there are more complaints when unknown investors install the wind power than when the local population does.

Local production and engagement in wind energy projects make sustainable development understandable. Cooperatives engaged in the development and building of local wind turbines is a concrete example of how private people can contribute to the development of an environmentally-friendly and sustainable energy production.

## 12. Attitudes

Although the newly introduced loss of value scheme indicates negative impacts of living near to a wind turbine, the recent surveys are very supportive to wind turbines – also in the neighbourhood.

3 investigations are presented below:

### **a. Attitudes towards on-land and offshore wind power development in Denmark; choice of development strategy, by Jacob Ladenburg, Renewable Energy 33 (2008) 111–118, March 2007**

'Abstract

Wind power generation is expected to increase significantly in the near future. Owing to the increasingly limited possibilities for using on-land turbines, offshore wind generation is a potential alternative. However, wind turbines located offshore are still associated with visual disamenities potentially making offshore location a less attractive alternative to on-land wind power generation. The present paper analyses attitudes towards both on-land and offshore wind power development using a probit model. It also discusses the elicited determinants of attitude in relation to developing wind power on-land or offshore. Compared to other papers on attitude, the paper is unique in the sense that the Danish population has considerable experience with the different impacts associated with wind turbines compared to most of the other countries investing in wind power generation. This is particularly evident with regards to offshore development. **The paper establishes that whilst offshore wind farms are preferred to on-land development, the results also imply that on land development is still a feasible alternative. In that relation, differences in wind power generation costs and the substitution of smaller on-land turbines with fewer but larger turbines might make on-land development even more attractive.** On a more detailed level, younger respondents are more positive towards wind power than older respondents. Interestingly, respondents living close to either on-land or offshore wind turbines did not display a more negative attitude towards wind power generation when compared to respondents who were not living close to wind turbines.'

**b. Visual impact assessment of offshore wind farms and prior experience, by Jacob Ladenburg, Applied Energy, June 2008**

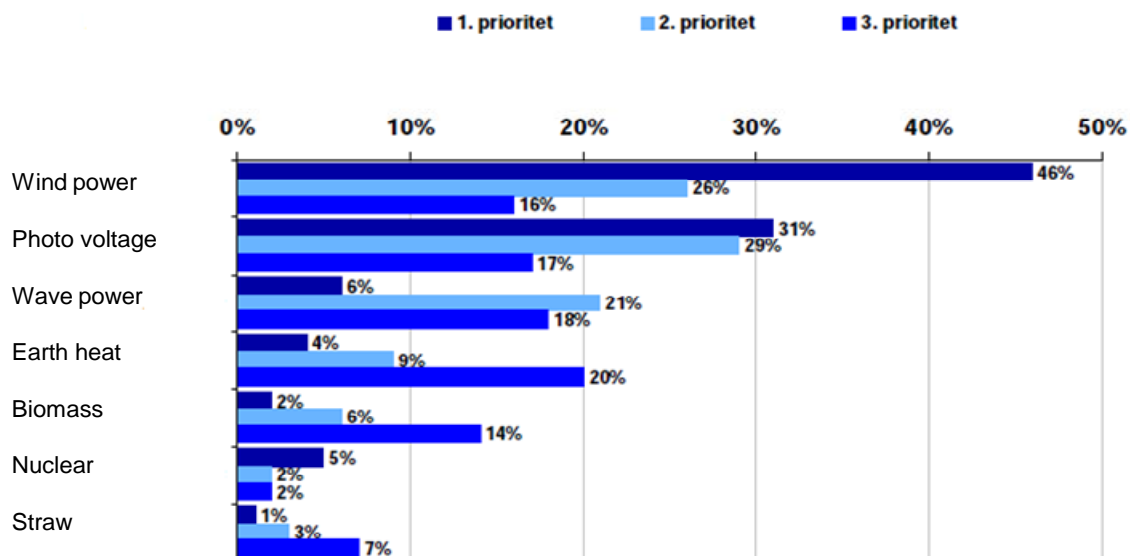
'Abstract

Energy planners have shifted their attention towards offshore wind power generation and the decision is supported by the public in general, which in the literature has a positive attitude towards offshore wind generation. However, globally only a few offshore wind farms are operating. As more wind farms start operating and more people become experienced with especially the visual impacts from offshore wind farms, the public positive attitude could change if the experienced impacts are different from the initially perceived visual interference. Using a binary logit model, the present paper investigates the relation between different levels of prior experience with visual disamenities from offshore wind farms and perception of visual impacts from offshore wind farms. The differences in prior experience are systematically controlled for sampling respondents living in the areas close to the large scale offshore wind farms Nysted and Horns Rev and by sampling the a group of respondents representing the Danish population, which has little experience with offshore wind farms. Compared to previous results in the literature, the present paper finds that perception of wind power generation is influenced by prior experience. More specifically, the results show that people with experience from offshore wind farms located far from the coast have a significant more positive perception of the visual impacts from offshore wind farms than people with experience from wind farms located closer to the coast. These results are noteworthy on two levels. First of all, the results show that perceptions of offshore wind generation are systematically significantly influenced by prior experience with offshore wind farms. Secondly, and in a policy context, the results indicate that the future acceptance of future offshore wind farms is not independent of the location of existing and new offshore wind farms. This poses for caution in relation to locating offshore wind farms too close to the coast.'

**c. Danish Survey, Megafon 2009, made for The Danish Wind Turbine Association**

The survey is yet only in Danish and proves, that more than 90 per cent of the Danes will expand the wind energy. The expansion shall be onshore as well as off shore, and also be prioritized in the local areas.

## Which of the below energy sources should DK prioritize until 2020 ?



[http://www.windpower.org/download/359/091009\\_Megafon\\_Befolkningsunders%F8gelse.pdf](http://www.windpower.org/download/359/091009_Megafon_Befolkningsunders%F8gelse.pdf)

## References

Danish Energy Agency (November 2009): "Wind Turbines in Denmark", [www.ens.dk](http://www.ens.dk)

Danish Wind Turbine Owners' Association (2009), Cooperatives – a local and democratic ownership to wind turbines, <http://www.dkvind.dk/eng/index.htm>

Ladenburg, Jacob (2007): "Attitudes towards on-land and offshore wind power development in Denmark; choice of development strategy", *Renewable Energy* 33 (2008) 111–118

Ladenburg, Jacob (2008): "Visual impact assessment of offshore wind farms and prior experience". *Applied Energy* 86 (2009) 380–387

Danish Wind Turbine Association (2009): Danish Survey, Megafon  
[http://www.windpower.org/download/359/091009\\_Megafon\\_Befolkningsunders%F8gelse.pdf](http://www.windpower.org/download/359/091009_Megafon_Befolkningsunders%F8gelse.pdf)

Danish Energy Agency, Statistic, [www.ens.dk](http://www.ens.dk)

Danish Energy Agency (2008): "Renewable energy act", [www.ens.dk](http://www.ens.dk)