

# WIND ENERGY

# KØBENHAVN (Denmark)

*Wind energy is not the energy source that immediately comes to mind when thinking about renewable energy in cities. Few cities have enough space within their area to build large wind farms. You may rather find small wind turbines on suitable locations within the city's area or see cities doing feasibility studies on this subject. Besides the erection of wind turbines, there are many other ways that cities can promote this renewable energy source. These include applying procurement procedures that favour a certain technology or giving support to organisations that buy or run wind energy plants. The city of København is currently taking part in a large, offshore wind farm project two kilometres from the city's coastline. The project is based on a partnership between the municipality and local shareholders.*

## GENERAL ASPECTS

The capital of Denmark, København, (469,000 inhabitants in the municipality, 1.3 million with the outer suburbs) is situated on the very east of Sjælland, being by far the biggest city of Denmark. It lies on the west bank of Øresund, a major access route to the Baltic Sea and the Baltic countries. The history of København goes back to just after the Viking period (1167 AC), where the Archbishop Absalon made it the capital of the Kingdom of Denmark.

### Climatic Dates:

Mean wind speed (off shore): 7.2 m/sec  
Annual mean temperature: 8.0 °C



## CONTEXT

In 1996, 'Københavns Miljø og Energikontor' (environment and energy office) took the initiative to organise a working group which was to undertake research concerning offshore wind energy close to København. Citizens with different educational background were invited – all with the belief that the project would be a success. The co-operative "Middelgrundens Vindmøllelaug I/S" (partnership) was founded and so far (14.03.00) approximately 6,000 local citizens have joined the co-operative and reserved 85% of the available shares.

The wind farm is supposed to be owned fifty-fifty percent by the co-operative and the local utility, Københavns Energi (KE) which is owned fully by the municipality of København. KE has committed itself to achieve a 25% reduction in the CO<sub>2</sub> emissions in 2005 compared to the level in 1992. In its 1998 environmental report, KE states that the means of achieving this will be due largely to the use of a "green account", which every year monitors the environmental influence caused by the production of heat and power. This, combined with the proactive, environmental policy, will help KB to achieve its goals. – And the offshore wind farm is a part of this policy.

# EXPERIENCE OF KØBENHAVN

The Ministry of Environment and Energy granted €<sup>1</sup>. 578,000. The money was allocated to investigate technical and environmental matters concerning shallow water and wind power development as well as to prove the feasibility, organisationally and economically, of co-operative-owned offshore wind farms. The result of this investigation is all that exist at present concerning the project. This includes an official homepage, reports, wind speed measuring, and so on.

As of yet, there is no Danish circular concerning private ownership of offshore wind farms. The circular for onshore wind farms is as follows: Anyone 18 years or older that lives or works in the county of København is allowed to reserve and eventually buy shares. There is at present no clear practice concerning this subject, so everybody interested is signed up for a share. If they later are disqualified by some rules/circulars they will get their money back.

For the moment the citizens of København can reserve shares directly on the internet, at a cost of €6,7 per share. There is an upper limit of 30 shares per person. When the project is completed one share will cost € 570; and it is supposed to equal 1000 kWh produced electricity per year. The annual yield is calculated to be approximately €67 per share.

The wind farm is supposed to be financed 50 % by the co-operative (40,500 shares with a value of €570 equals approximately 23.1 million €) and 50 % by the KE.

The co-operative is based on "partnership", which means that in a case of a bankruptcy every shareholder is supposed to pay his or her part of the debt. Therefore, it is written in the articles of "Middelgrundens Vindmøllelaug" that the partnership in no way is allowed to contract debts. This insures the shareholders that their only risk is the amount of the share.

## **Technical data of the wind farm**

The wind farm is supposed to be placed 2 kilometres off the coast, placed in an arch following the coastline of København. This is done for aesthetic reasons. The yearly calculated production of power corresponds to approximately 3% of the power consumption in the municipality.

Start of operation	Autumn 2000
Number of wind turbines	20
Size of one wind turbine (BONUS)	2 MW
Height of hub	75 m
Rotor radius	36 m
Maximum noise level	40 dB(A)
Calculated electricity generated	90,000 MWh/a
Corresponding CO <sub>2</sub> -savings	75,000 tons/a

### *Technical specifications*

The difficult technical part in the planning of the construction has been the foundation on the sea; either plain concrete or gravitation foundations (reinforced concrete) will be used. Because of the close distance to the city, much effort has been done to reduce the visual impression from the coastline. It is intended for the wind farm to look harmonious and plain

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<sup>1</sup> One € equals here 7.46 Danish Kroner.

from all sides. Fortunately, it will rarely happen that the citizens see the wind turbines in one long line with the disturbance caused by the rotation of the wings.

The impression of a wind turbine is a subjective question. The aim is to cause as little a disturbance as possible to the citizens of København.

It is predicted that the wind turbines will not be heard on the coastline under normal weather conditions

The full erection and assembling is planned to last approximately 50 days in fine weather.

Supplier of the turbines will be BONUS, the foundations is delivered by Monberg and Thorsen and NKT is responsible for the grid connection.



*The planned position of the wind farm*

## EVALUATION AND PERSPECTIVES

As of March 2000, approximately 6,000 persons in København have signed up for almost 85% of the available shares in the co-operative. There is no specific stipulation saying that a special amount of shares has to be sold before erection. Middelgrundens Vindmøllelaug and KE have signed an agreement saying that KE will buy the shares not reserved by the citizens, when it is decided to begin the erection.

The report on "assessment of influence on the environment" is finished, and it has been in public hearing. This ended in September 1999. The schedule thus far, shows that the turbines will begin being erected during summer 2000, and that the wind farm will begin producing power in autumn 2000.

Locally based commitment and co-operation between the co-operative (in the beginning, the environmental and energy office), the local utility, KE, and the municipality of København has been a significant precondition for the development of the project so far. The co-operation has provided credibility to the project in relation to politicians, the public etc. In addition, the co-operation has, through a dialogue with all kinds of interest groups like fishermen, sailors, and environmental organisations, generated a widespread understanding and acceptance for the chosen location and layout of the park.

The economy of the wind farm – and thereby the shareholders – is basically based on the national subsidy concerning renewable energy. Every "CO<sub>2</sub>-free" produced kWh receives 0.036 € which is, in reality, paid by the consumers.

The contract between Middelgrundens Vindmøllelaug and KE states that in 20 years from the first power production date, the partnership will leave the project leaving the municipality (KE)

with the decision to continue producing electricity with the old wind turbines, to remove the turbines, or reinstall some new ones.

The chosen offshore site is situated outside the frames of municipal and regional planning. Instead, the Danish Energy Agency held a direct hearing including authorities and interest groups like the municipality, the county, citizens and state authorities.

The computer-generated visualisation of the project has been a very important part of the process so far. – This has been used in the image below.



*Part of the computerized visual impression from the city's coastline.*

## FOR FURTHER INFORMATION

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