

CASE STUDY

REAL PROJECT

06

WIND ENERGY PROJECT

OFFSHORE WINDFARM / COPENHAGEN, DENMARK

RETScreen®
Customer Support

www.retscreen.net
rets@nrcan.gc.ca
+1-450-652-5177
+1-450-652-4621

*Cette publication est aussi
disponible en français.*

CANMET Energy Technology
Centre - Varennes (CETC)

In collaboration with:



Disclaimer

This publication is distributed for informational purposes only and does not necessarily reflect the views of the Government of Canada nor constitute an endorsement of any commercial product or person. Neither Canada, nor its ministers, officers, employees, and agents make any warranty in respect to this publication nor assume any liability arising out of this publication.

© Minister of Natural
Resources Canada 2001 - 2004.

RESULTS

The 40 MW Middelgrunden Windfarm is one of the first and, as of mid-2002, the world's largest offshore windfarm. Located just east of the harbour of Copenhagen, Denmark, the windfarm started production in late 2000 and now provides more than 3% of the city's electricity needs. The ownership of the project is shared equally between the Copenhagen Utility and a wind energy co-operative with over 8,500 members. Co-op members (mostly individuals) financed their half of the project by purchasing shares, each corresponding to 1 MWh of production and costing €567 each.

While the project came in slightly over budget, the turbines have also performed better than expected, supplying 100 GWh/yr of energy on average as compared to the minimum 89 GWh/yr guaranteed by the manufacturer.

SYSTEM DESCRIPTION

The twenty 2 MW turbines from Bonus Energy A/S are located 3.5 km offshore and spaced 180 m apart in a slightly curved row 3.4 km in length. The three-bladed turbines have a hub height of 64 m and a rotor diameter of 76 m. The hollow concrete foundations (each with the lower section of the turbine tower, transformer and switchgear) were floated out to the site and submerged to form gravity anchors. The rotor, nacelle and upper tower section were assembled in the harbour, brought to the site by barge and installed by means of an 80 m crane operating from a jack-up platform. Energy from the turbines is transported to shore via a 30 kV submarine cable.

At a total investment cost of about €1,300/kW, the project is one of the lowest cost offshore windfarms to date.

LESSONS LEARNED

- Offshore windfarms are generally more expensive to build and operate than on-shore projects. Costs drop however as experience with such projects grows. Middelgrunden demonstrates that large, financially successful offshore projects are achievable.
- The favourable project economics are due in large part to the price guarantees and green power premiums available to the windfarm in Denmark.
- Operations that may be routine on land are often complicated offshore. An offshore project therefore requires particular attention to planning, logistics and coordination.
- Financing of wind projects via the co-op model has proven very successful in Denmark. The involvement of a large co-operative also helped secure critical public support for a project located so close to a city.



Natural Resources
Canada

Ressources naturelles
Canada

Canada

THE BIG PICTURE

It can be argued that nowhere has wind energy been more successful than in Denmark, where it currently provides over 15% of the country's electricity demand. However, finding acceptable sites for new wind projects on land is becoming increasingly difficult, mostly due to limited public acceptance of large windfarms in a densely populated countryside. In much of Europe, offshore siting of turbines is seen as the next stage in expanding the use of wind energy. As of mid-2002, only about 90 MW of wind power capacity has been installed offshore, all of it in Europe. This compares to over 26,000 MW of capacity installed worldwide on land. However, in Denmark alone, five large new offshore windfarms are close to construction or in advanced stages of planning, representing about 770 MW of new capacity that is to be in place by 2006.

REFERENCES

Belotserkovsky, Vadim, "Personal communications," GPCo Inc., 2002.

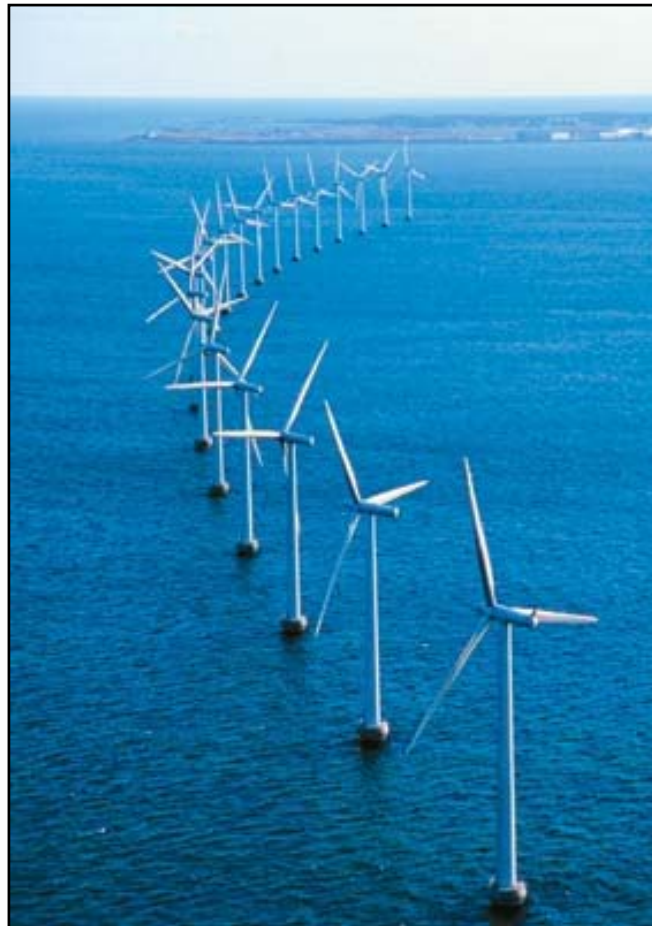
Delft University (report coordinator), Offshore Wind Energy – Ready to Power a Sustainable Europe, December 2001.

Middelgrundens Vindmøllelaug cooperative, website: www.middelgrunden.dk.

Sørensen, H.C. et al., Prestudy for the Danish Offshore 750 MW Wind Program, International Society of Offshore and Polar Engineers, ISOPE 2000 Conference Seattle 2000.

Sørensen, Hans Christian, "Personal communications," SPOK ApS, 2002.

Sørensen, H.C., Hansen, J., Experience from the Establishment of Middelgrunden 40 MW Offshore Wind Farm, SPOK ApS & SEAS Wind Energy Centre.



40 MW MIDDELGRUNDEN WINDFARM, COPENHAGEN, DENMARK

PHOTO CREDIT: JENS H. M. LARSEN, COPENHAGEN ENVIRONMENT AND ENERGY OFFICE,
WWW.MIDDELGRUNDEN.DK