



# HORNS REV OFFSHORE WIND FARM

GROUND-BREAKING WIND POWER PLANT IN THE NORTH SEA



## ENVIRONMENTAL IMPORTANCE

During summer 2002, Elsam erected the world's largest offshore windfarm at Horns Rev in the North Sea - an offshore wind power plant.

The farm comprises 80 wind turbines erected under real offshore conditions 14 to 20 kilometers out in the North Sea.

The wind farm at Horns Rev is a considerable contribution to the international objective to reduce CO<sub>2</sub> emission and will cover almost two per cent of the total Danish power consumption.

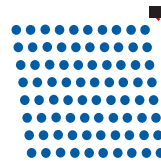
### Environmental gains

Until recently wind power was confined to be land-based, but increasing problems to obtain permissions to erect wind turbines and the technological development of the wind turbines have made it possible to establish offshore wind farms on competitive conditions. By placing the wind turbine offshore, where the wind blows freely, a production from each wind turbine is obtained which is approx 50 per cent higher than it would have been if the wind turbine was placed on land.

### Focus on wildlife

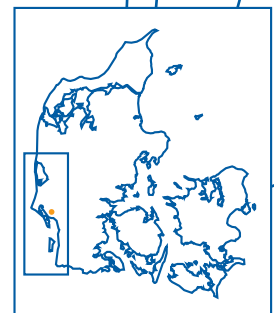
Before, during and after the erection of the offshore wind farm, comprehensive environmental studies have been carried through shedding a light on wildlife and vegetation. The results form part of the basis for further expansion with wind turbines in the years to come - in Denmark as well as abroad.

## Horns Rev



Blåvandshuk

● Esbjerg





# COMMISSIONED 2002



The wind farm was established during summer 2002.

Because of the harsh weather conditions in the North Sea, the erection of totally 80 wind turbines was carried out with a number of different specially built vessels. The work had been thoroughly planned from the outset and was carried through in well-defined phases:

1. The foundations, which are monopiles - i.e. steel pipes - with a diameter of approx 4 meters, were rammed approx 25 meters into the seabed. After ramming down, each foundation was terminated with a transition piece on which the working platform, the landing stage and the cable protections had already been mounted.
2. Wind turbine erection was made by specially built jack-up vessels which can stand firm on the seabed by means of submersible supporting legs. The vessels carried two complete wind turbines at a time and could lift the wind turbines into position on the foundations with cranes on the vessels.
3. Having been erected, each wind turbine was electrically connected to the transformer substation through submarine cables. The wind farm production is collected at an offshore transformer substation and is transmitted through a buried submarine cable to the onshore power transmission grid.

By the end of 2002, all wind turbines had been commissioned and non-polluting power could be transmitted into the power grid.

## Operation and surveillance

As a result of the exceptionally advanced surveillance and control, the offshore wind farm is practically to be considered as a medium-sized power plant capable of controlling production in case of, for example, restrictions in the power grid. Remote surveillance is made from the Elsam onshore control plant.

The wind farm being situated far out at sea has made it necessary to develop new concepts for wind turbine maintenance, including the possibility that service personnel can be landed on the wind turbines from a helicopter.

The wind turbines are buoyed for the sake of marine and air traffic.

Wind turbine type	Vestas V80 - 2 MW
Total wind farm output	160 MW
Expected annual production	600,000,000 kWh
Rotor diameter	80 m
Hub height	70 m
Weight, blade	6.5 tonnes
Weight, nacelle	79 tonnes
Weight, tower	160 tonnes
Weight, foundation	180-230 tonnes
Total weight per wind turbine	439-489 tonnes
Cut-in wind speed	4 m/s
Full power output from	13 m/s
Cut-out wind speed	25 m/s
Mean wind speed at 62 metres' height	9.7 m/s
Water depth	6-14 m
Distance from land	14-20 km
Distance between wind turbines	560 m
Wind farm area	20 km²
Total project costs	DKK 2 billion/EUR 270 million







## ELSAM – AN INTERNATIONAL PLAYER

Owning the centralised power plants in Jutland and on Funen, Elsam A/S is Denmark's largest producer of power and heat. Elsam's business fields are production and sale of power and district heat, as well as project development within environment and energy - be it national as well as international.

In addition to the Horns Rev project, Elsam is also engaged in a number of wind energy projects in Denmark and abroad. Projects based on the know how Elsam has obtained through many years' practical experience with wind energy exploitation.

With the Horns Rev project, Elsam's employees have gained new, valuable experience and know how, and they have demonstrated that it is possible to exploit the huge energy potential arising from placing wind farms at sea.

Further information:

You can read more about the project at [www.hornsrev.dk](http://www.hornsrev.dk).

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