

# **HORNS REV 1** **OFFSHORE** **WIND FARM**

Mankind has been making use of wind power for thousands of years. The current trend is moving away from small groups of land-based wind turbines to larger offshore wind farms. Offshore turbines usually generate more electricity than land-based turbines do as the winds at sea are stronger and more constant than on land.

Wind energy is complementary to hydropower, nuclear power and thermal power. It provides a much-needed contribution to our electricity production and is also free of environmentally harmful emissions.

Vattenfall gives priority to wind energy. Wind power generation will increase substantially over the next few years. In percentage terms, wind energy is the energy source seeing the sharpest growth worldwide. At Vattenfall we are committed to wind energy by building new wind turbines and replacing old turbines with new and more efficient ones.





Horns Rev 1 Offshore Wind Farm is located in the North Sea, 14-20 km off the southern part of Denmark's western coast.

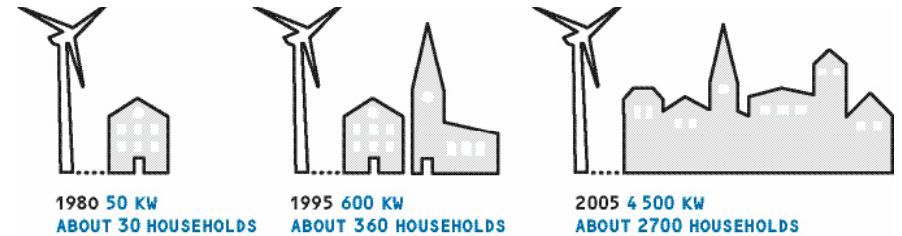


To obtain maximum capacity utilisation for each wind turbine, they have been erected 560 metres from one another. The 80 turbines have been installed to occupy a total area of 20 sq. km.

Since 2002 the 80 wind turbines have been spinning at Horns Rev in the North Sea, barely 20 km off the western coast of Jutland, Denmark. These turbines generate about 600 million kWh combined. That corresponds to the electricity consumption of some 150,000 private households (based on 4000 kWh per household) and 2% of Denmark's total consumption.

### Why choosing Horns Rev?

To obtain maximum capacity utilisation for a wind turbine, it is necessary to find the right location with strong, constant winds, which release much energy. These wind conditions are most frequently found at sea. Horns Rev in the North Sea is one of the areas that are considered to offer the very best conditions for wind energy.



Our wind turbines are becoming highly efficient. So far, their capacity has doubled every five years. In the early 1980s, each turbine had a capacity in the order of 50 kW, which was sufficient to supply just over 30 households with electricity. A wind turbine from the mid-1990s could supply about 360 households. Today a single modern turbine can produce enough electricity to meet the demand of a small town.



Here the wind blows at an average speed of 10 metres per second. That is ideal conditions for wind power generation. A limited water depth is another important factor to make sure that the construction of the wind farm will not be unreasonably costly. The deeper the water, the costlier the project. At Horns Rev the water depth is in the range of 6 to 14 metres.

**How are flora and fauna affected?**

Both before and during the construction of Horns Rev 1 Offshore Wind Farm, large-scale environmental surveys were carried out to identify the impacts of the wind farm on flora and fauna. The following questions were addressed:

- What are the impacts on porpoises and seals?
- What are the impacts on benthic fauna?
- What are the impacts on bird life?

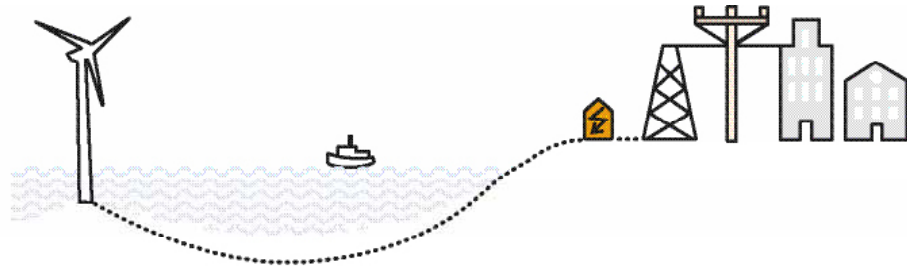
The environmental surveys showed that the wind turbine foundations have developed into a place where benthic fauna and algae, including several endangered species, thrive and grow. Meaning more food for fish, porpoises and seals. Migratory birds usually avoid wind turbines and do not fly over the farm. Some bird species do not populate the offshore wind farm.

### From sea to shore

The wind turbines are interconnected in a 33 kilovolt cable system. The power generated passes to a transformer platform on the fringe of the offshore wind farm. Here the voltage is transformed up to 150 kV before the electricity is taken to the shore through a 21 km long submarine cable to Hvidbjerg Strand.

The submarine cable, manufactured in Norway, is the first plastic-insulated 150 kV cable in the world. With a diameter of 19.2 cm, it is also the thickest submarine cable ever made.

The electricity generated passes through cables in the tower, then through submarine cables into a substation and, eventually, is supplied to the transmission grid and the consumers.



### From shore to land

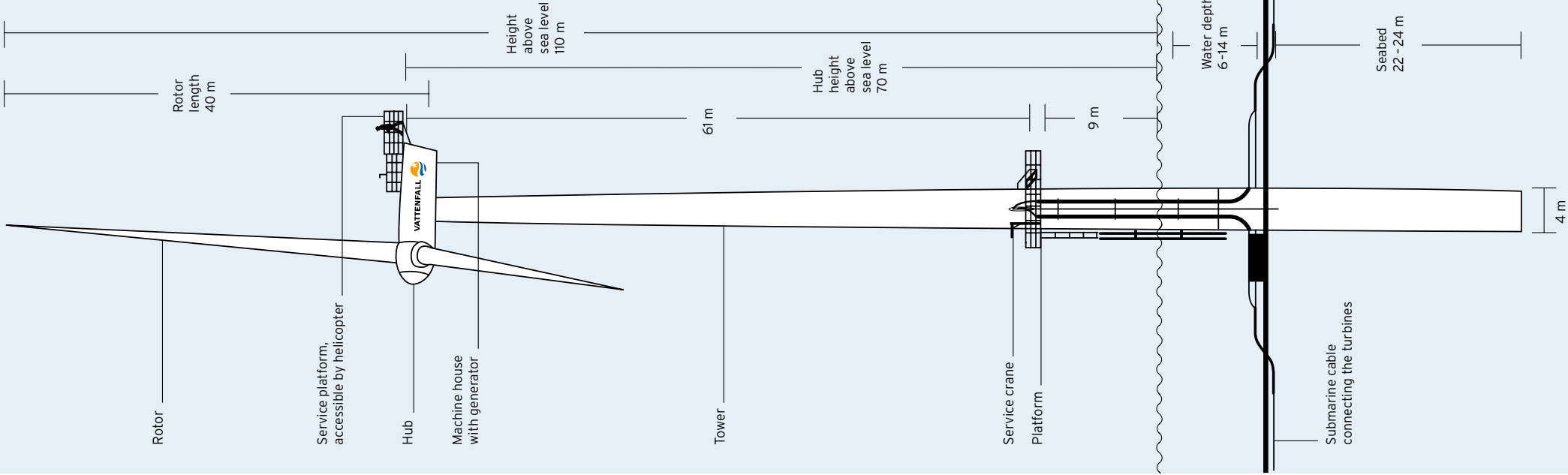
From a cable station, designed so as to blend into the landscape at Oksby, the electricity is transferred to a land-based cable. Through this cable, the electricity passes to the substation at Karlsgårde, 36 km away, and is then connected to the main transmission grid.

The land-based cable is made up of three conductors, interconnected in a triangle in the 1.3 metre deep and 1.4 metre wide cable trench.



### Technical data on Horns Rev Offshore Wind Farm

- Number of wind turbines: 80
- Hub height: 70 m
- Blade length: 39 m
- Rotor diameter: 80 m
- Speed: 8-18 rotations per minute
- Capacity: 2 MW per turbine
- Start wind speed for electricity production: 4 m/s
- Stop wind speed for electricity production: 13 m/s
- Turbine weight: About 500 tonnes, including foundation
- Distance between turbines: 560 m



### How it works

When the wind hits the rotor blades of the turbine, differences in pressure occur between the downwind and upwind sides of the blades. The differences in pressure cause the main shaft to rotate. The main shaft drives a generator where the electricity is produced. The generator is placed in the machine house at the top of the tower.

[www.vattenfall.dk/vindkraft](http://www.vattenfall.dk/vindkraft)

