

# TROLLEBODA WIND FARM



In 2005, we were granted permission by the Government to build five wind turbines in Kalmar Sound as a test installation for offshore wind power generation. The orientation today is to build bigger wind farms that can deliver a significant energy supplement for a large number of people.

We are now studying the possibility of building a larger wind farm with around 30 wind turbines in the same region, i.e. at Trolleboda in Kalmar Sound, 6 km from the mainland and about 12 km from the island of Öland.



If the wind farm at Trolleboda is built, it will be sited about six kilometres from the mainland and will generate the domestic electricity for around 100 000 homes.

### **At sea**

A wind farm always affects the landscape to a greater or lesser extent. On the other hand, the impression of size and dominance, that a wind farm makes, differs from one person to the next. The wind turbines at Trolleboda are located about 6 km from the shore and will thus be visible on the horizon.

The authorities place strict conditions on the sound emitted by the wind turbines. However, the sound from the wind turbines is normally not audible

due to the already existing sound of wind and waves, traffic and people.

### **Electricity for 100 000 homes**

Trolleboda will be built on a commercial basis. The energy generated by the farm is expected to be around 500 GWh annually. This corresponds to the domestic electrical energy for almost 100 000 homes - which is the same as the entire annual electricity consumption of the city of Kalmar or Karlskrona.



### **Why just Trolleboda?**

To achieve maximum possible output, a wind turbine must be sited in the right place, where the winds are strong and uniform and can generate a large amount of energy. Such places are usually offshore. Trolleboda in Kalmar Sound is one of the areas considered to have the very best conditions for wind power. The average wind velocity at Trolleboda is more than 8 m/s at a height of 80 metres. This is ideal for wind power.

A moderate depth of water is also important, so that it will not be unreasonably expensive to build the wind farm. The deeper the water, the more expensive it is to build. At Trolleboda, the water depth is between 11 and 23 metres.

Kalmar and the County of Blekinge are among the 13 counties in Sweden that have been identified by the Swedish Energy Agency as being so-called national sites of interest for wind power. This means that these areas have very good conditions for wind power.

### **How would the environment be affected?**

All energy generation affects the environment in one way or another. The impact of a wind farm is greatest during the construction period. Once in place, it is admittedly a new element in the environ-

ment, but it is virtually free from environmentally harmful emissions. Moreover, the site of a wind turbine can be restored and the material can be recovered at the end of the useful life of the turbine.

### **Environmental studies before, during and after construction**

All interests must be carefully weighed when a wind farm is being planned. Serious consideration must be given to the flora and fauna, leisure activities, the cultural environment, shipping and fisheries, and also to the residents in the region. We benefit from the experience gained from other offshore wind farms and the research studies carried out on these sites. In order to minimize the impact on the environment, we carry out environmental studies before, during and after the construction of the wind farm.

### **Birds**

The Kalmar Sound area is rich in bird life. It is estimated that around 3 million migratory birds pass the area every spring and autumn. Studies have shown that very few sea birds collide with the turbines. Birds have good vision, relatively good hearing and good navigation capability. When birds approach a wind farm, they generally change course and



fly to one side of the wind farm. Overhead power lines and road traffic represent a much greater threat to bird life.

### **Seals and fish**

The work of excavating the sea bed for cable trenches and foundations temporarily makes the water turbid. This may lead to impaired growth of plants and animals. Research has shown that turbidity of the water usually has little effect and is of a short-lived nature. The water recovers quickly.

Experience has shown that the foundations of the wind turbines become a sort of artificial reef in which fish, algae and invertebrates appear to thrive. They are quickly colonized and create entire communities of marine life. Mussels on or in the vicinity of the wind turbines may even do better from the nutrient viewpoint than mussels far from the wind turbines.

Noise and vibrations from working vessels and foundation works can frighten away the fish and mammals. But since the construction work is in progress for a limited period of time, these activities are considered to pose little risk.

Fish can hear the sound of the wind turbines, but research reports indicate that they are probably not affected to any great extent. The studies made show that certain fish species with

swimming bladders may react to sounds in the immediate vicinity of the foundation, where the sound is at its highest, and that they then avoid this area.

Seals have good hearing for high-frequency sound, but are hardly able to perceive sound at frequencies below 1000 Hz. It is therefore considered that they can hear the sound of a wind turbine only when they are in its immediate vicinity. Seals have good ability to become accustomed to fixed installations, as shown by the large seal colonies at the lighthouses in Kattegat and Skagerak.

### **Recycling**

A wind turbine installation is expected to have a service life of 20 - 25 years. At the end of its useful life or when it is to be replaced, virtually all parts can be recovered. When the site is no longer used for wind power, it can be completely restored. The environmental impact of decommissioning a wind farm is roughly the same as the impact caused when the farm is being built.

### **In operation by 2009?**

If the wind farm meets the demands made by Vattenfall on its projects and if the Vattenfall Board decides to build Trolleboda, the wind farm is expected to be completed by around 2009.

Wind has been used as a source of energy for thousands of years. Around 700 wind turbines are now in operation in Sweden, principally in the southern parts of the country, along the coasts and on the island of Gotland. Vattenfall owns 39 of these (in 2005), but intends to increase this proportion substantially in years to come. Development will progress from smaller groups of wind turbines ashore to large wind farms out at sea, since offshore wind turbines usually deliver much more power than their counterparts ashore.

#### **Long term research into wind power**

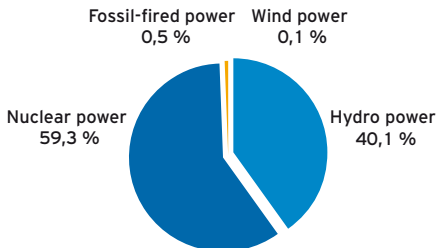
The construction of wind power plants in Sweden has so far been modest. This is largely due to our excellent availability of hydro power and nuclear power. Vattenfall has devoted almost 30 years to research and development of wind power. We now account for 7 percent of the total wind power generated in Sweden, and our turbines jointly produce 0.05 TWh annually. This corresponds to the electrical energy demand of roughly 10 000 homes during one year. But this proportion will increase

substantially when the Lillgrund wind farm, which will be supplying domestic electric power to 60 000 homes, is taken into operation at the end of 2007. We are confident that wind power will be a good supplement to other power generation sources. So we are studying the possibilities of expanding this energy source further in years to come.

#### **Renewable electricity should increase**

To meet the electric power demand while also conserving the environment, power

generation from renewable sources should increase substantially in the immediate future. Swedish Parliament has therefore set a target based on an EU directive: By 2016, power generation from renewable energy sources should have increased by 17 TWh from the level in 2002. The increase corresponds to around 12 percent of the electrical energy consumption in Sweden. Vattenfall will play a leading role in this increase.



**Power generation by Vattenfall in Sweden in 2005.** Power generation from renewable energy sources will increase substantially in the immediate future. Vattenfall will play a leading role in this increase.

### **Wind power - the world's most rapidly growing energy source**

Wind power is the electricity generation source that worldwide is increasing at the highest percentage rate. In 2005 alone, production increased by more

than 40 percent. Sweden is now in seventeenth place in the world in terms of wind power generation capacity. But this position will change in the near future.

Even though the proportion of wind power is increasing robustly, it will account for less than 2 percent of the world's total power generation in 2030.

### **FACTS:**

- In Sweden, wind power accounts for 0.6% of the total electricity consumption
- In Denmark, wind power accounts for 18.5% of the total electricity consumption
- In Germany, wind power accounts for 6% of the total electricity consumption

### **National sites of interest for wind power**

The Swedish Energy Agency has identified a number of areas that are particularly well suited for the construction of wind power plants, which are known as national sites of interest. These amount to a total of 49 areas in 13 counties. It would however be difficult to estimate how much wind power will actually be built in these areas. That depends among other things on factors such as the acceptance afforded to the project by the authorities and residents of the area. Trolleboda is a national site of interest for wind power



### **Everyone will be paying**

Vattenfall wind farms will be built on a commercial basis, with the same return on capital requirements as for other power generation plants. But it is expensive to build new power generation capacity, regardless of whether or not it is renewable. The Swedish Government has introduced a system of electricity certificates that are intended to favour expanded use of renewable energy sources. This means that all electricity consumers are paying a small surcharge per kilowatt hour, which is known as the electricity certificate charge. Since wind power is renewable, it is also entitled to financial support through the electricity certificate system. This enables wind power and other renewable electric power generation to compete with other power generation sources.

### **Sweden is well suited for wind power**

The conditions for wind power in Sweden are good. Our country is in the “west wind belt”, where the average wind velocities are higher than in many other countries. Wind power also fits well into our Swedish system in which nuclear power and hydro power account for base load generation. Hydro power serves very well as regulating power for taking up the shortfall whenever wind energy is insufficient.

### **More electricity from offshore wind power**

Wind power outside our coasts – out at sea – has good opportunities for delivering more electricity and being competitive. The winds are often stronger and more uniform than they are ashore.

A wind farm out at sea is less disturbing to the residents and their leisure pursuits than it would be ashore. But an offshore wind power plant is costly to build today. The further out to sea it is located, the more expensive it is to build and connect to the grid ashore.

The offshore wind power technology is relatively new and is still in the course of development. But offshore wind farms are expected to be less expensive to build in the long term, in pace with growing knowledge and further development of the technology.

### **Free from emissions**

Wind power will not replace nuclear power. The generation methods are totally different and are based on different conditions. On the other hand, wind power is a good supplement to hydro power and nuclear power. It offers a vital addition to our power generation system. Moreover, its operation is virtually free from environmentally harmful emissions.

[www.vattenfall.se/trolleboda](http://www.vattenfall.se/trolleboda)

