Sheringham Shoal

by Scira Offshore Energy

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Generating electricity from the wind

Wind energy in Norfolk is not a new idea. In the past, wind blowing freely over the area's flat landscape pushed the sails of windmills to grind corn into flour. Out at sea, where the wind blows stronger still, fishermen used the wind to propel their boats. The same strong sea winds that once filled the sails of former fishing boats now turn the blades of wind turbines to generate electricity.

Offshore wind turbines are based on the same technology as their onshore counterparts and their expected lifespan is the same in that they require refurbishment after around 20 years. The main difference is their size. Sheringham Shoal Offshore Wind Farm uses Siemens 3.6MW turbines, which at 132m high, are around the same height as the London Eye.

The Siemens turbines have three blades mounted on a nacelle that houses the generator, gearbox, controller, shaft and other components. Sitting upwind of the tower, the 52m (170 feet) blades are made of tough fibreglass-reinforced epoxy resin designed to withstand the rigours of offshore conditions. The nacelle is mounted on an 80m (262 feet) tapered tubular steel tower with an internal lift enabling technicians easy access to the main workings.

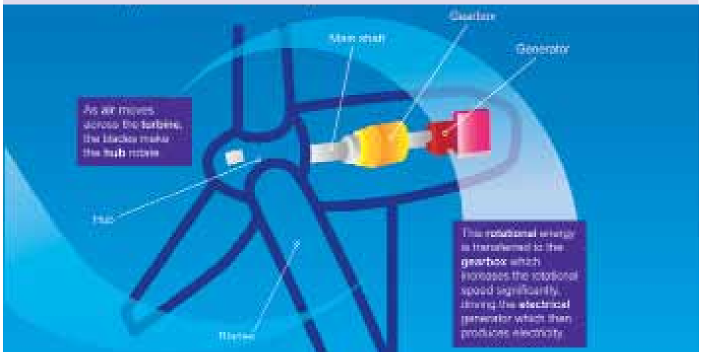
How does the wind farm work?

Wind turbines convert energy from the wind into electrical energy. First the wind blows on the aerodynamically shaped blades to make them rotate along with the central hub. The hub is connected via a hollow shaft into a gearbox, which increases the rotation speed enough for the generator to convert the rotational energy into electrical energy using magnetic fields. The Siemens turbines employ a power conversion system enabling the generator to operate at variable speed, frequency and voltage.

The power conversion system in the nacelle converts the energy produced by the generator from alternating current (AC) to direct current (DC). It is then transmitted to the base of the tower where it is inverted back to 690V AC 50 hertz (Hz) and a transformer increases the voltage to 33 kilovolts (kV). The use of a higher voltage increases the efficiency and reduces the losses during the power transmission.

The power generated by the turbines is transmitted via 33kV infield cables into one of Sheringham Shoal's two offshore substations, where it is collected and transformed from 33kV into 132kV. It is then transmitted to shore via two 23 kilometre long export cables – one from each substation. As well as carrying electricity, the export cables contain fibre optic cables for carrying computer and phone signals.

The onshore cables transport the power an additional 22 kilometres inland to the new Salle substation where it is fed into the regional grid, eventually connecting to the national grid in Norwich for general use by British consumers.



Sheringham Shoal's 88 turbines convert wind energy into electrical energy.

Wind speeds for operation

The Siemens turbines of Sheringham Shoal self-start, utilising what is called a cut-in sequence, the when the wind reaches an average speed of 3-5 metres per second (m/s).

The output of each turbine increases with the wind speed until it reaches 13-14m/s. At that point, the power is regulated at rated power. During operation below rated power, the pitch angle of the blades and rotor speed are continuously adjusted to maximise the wind turbine's aerodynamic efficiency.

Offshore turbines are tested to withstand extreme conditions, and if the average wind speed exceeds the operational limit of 25m/s, the turbine stops. The blades will automatically turn out of the wind and shut down for safety reasons when wind speeds become gale strength. When the wind drops back below the restart speed of 20m/s, the turbine will restart.

Availability of the turbines

The availability of the turbines will depend on how the turbines are operated and maintained. Experience from the existing offshore wind farms has shown an average availability of around 95 percent. By using the experience of both the owners – Statkraft from operation and maintenance of hydro power plants and Statoil from offshore oil and gas installations – the aim is to improve this percentage for Sheringham Shoal.

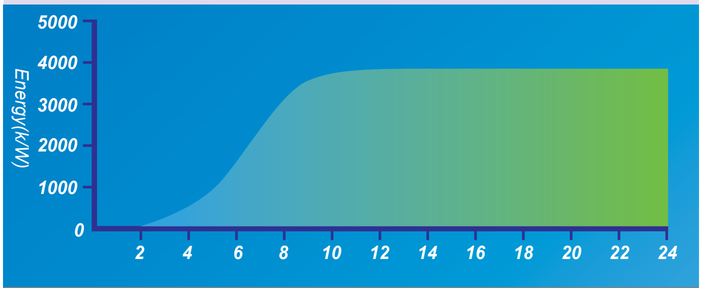
In the average year, the wind speed at Greater Wash is expected to be between 3-5m/s and 25m/s for 7970 hours. Assuming a standard technical availability of 95 percent, the normal operating time for each turbine will be approximately 7540 hours per annum or around 86 percent of the time.

Harnessing the wind

The amount of power harnessed from the wind is dependent on both the turbine size and the speed of the wind.

If the blade length is doubled, available power output increases by four times. As the cost of installation offshore is much the same regardless of the size of turbine selected, it is more cost effective to use the largest available machines as they have higher energy yields.

As well, increases in wind speed make a huge difference to the output of the turbine — double the wind speed and power output increases by eight times.



Energy produced by each Sheringham Shoal turbine at different wind speeds.

The power extracted by 88 turbines at Sheringham Shoal can be calculated by combining information from the power curve for the Siemens 3.6MW turbines (see graph) with data on wind speeds at the site. The total result, including losses in the system, is an estimated annual yield of 1.1TWh – and with UK homes using an average of 5000kWh a year, that's enough electricity to power 220,000 homes per annum and compared to fossil fuels, it is a reduction of CO_2 emissions by 475,200 tonnes every year.

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The Sheringham Shoal Offshore Wind Farm is owned equally by Statoil and Statkraft through the joint venture company Scira Offshore Energy Limited.

Statkraft

Statoil