Sheringham Shoal

by Scira Offshore Energy

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Green out of the blue

The world needs more energy and in future an increasing amount of its power supply will have to be obtained from renewable sources such as tides, waves and wind.

With approximately 40% of the EU's entire wind resources available in British waters, it makes sense to harness the wind.

The 317MW Sheringham Shoal Offshore Wind Farm, located off the coast of North Norfolk in the UK, comprises 88 wind turbines and generates around 1.1TWh per annum. This is enough clean energy to power almost 220,000 British homes and reduce CO_2 emissions by 475,200 tonnes every year based on the current UK generation mix.

The wind farm became fully operational in September 2012, just over a year after the first turbine began supplying power to the national grid.

Norwegian industry leaders Statoil and Statkraft own the wind farm equally through joint venture company Scira Offshore Energy Limited. Scira is the wind farm operator. The development has benefitted from experience gained through Statoil's longstanding offshore oil and gas experience and Statkraft's expertise as Europe's leading renewable energy company. It also utilised the specialist knowledge of its key contractors and their supply chain, as well as local organisations with specialised knowledge of the area.

Statkraft

Statoil

The **start**

The lease for the diamond-shaped 35km² site was granted as part of The Crown Estate's Round Two in 2004. It is located in the Greater Wash, between 17 and 23 kilometres (10 to 15 miles) off the Norfolk coast, north of the seaside town of Sheringham, Waters here are comparatively shallow at between 17 to 22 metres, wind speeds are high and consistent and access was good for construction and, will continue to be so for the on-going operation and maintenance phases.

After five years in development and planning, construction work began in June 2009 with the start of the installation of the 132kV cable from landfall at Weybourne to a new substation 22 kilometres inland. Work on the offshore wind farm site itself began in March 2010 with rock placement for scour protection at selected foundation locations. This prepared for the start of the installation of the giant monopile structures in June 2010, followed by the cables and other wind farm components, most noticeably the wind turbines, which began appearing on the horizon in July 2011.

Wind farm facts

The wind farm itself comprises:

- 88 turbines (3.6MW Siemens)
- two offshore substations
- inter-array cabling
- two 132kV submarine export cables
- a 21.6km onshore cable
- new inland substation at Salle, Norfolk.

Construction **vessels**

The construction of an offshore wind farm requires the use of different vessels designed to carry out a wide range of tasks. Many are state-of-the-art vessels built especially for the offshore wind farm industry.

At Sheringham Shoal, the first actual construction vessel to arrive on site was the 164m long bulk carrier *Nordnes* that placed rocks around the locations of 79 of foundation sites to reduce the likelihood of scour and protect the cables at each turbine base.

The impressive 183m crane-vessel *Oleg Strashnov* lifted the substations onto their foundations in May 2011 and finalised the foundation installation a few months later. Elastomer spring bearings to reduce the vertical load on the grouted connection between each inner monopile and the outer transition piece were also installed.

Many large vessels were utilised during the construction but two of the stalwarts were the 86m *Team Oman* which installed the infield and export cables, and the 77m *Smit Constructor,* responsible for prepared the foundations for the cable installation.

Turbine installation vessels including *Endeavour, Leviathan* and *Sea Jack*, transported two turbines at a time from Great Yarmouth to the site where they jacked up to undertake a highly technical lifting procedure – first raising and installing the 80 metre tower, and subsequently the nacelle, followed by the three 52 metre blades.

Floating hotel vessels were particularly busy when construction work peaked and more than 600 workers were employed offshore.

Each vessel had a vital part to play in the complex feat of engineering which has resulted in the Sheringham Shoal Offshore Wind Farm.

Offshore **components**

Turbines

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

The turbines have three blades mounted on a nacelle that houses the generator, gearbox, controller, shaft and other components. Sitting upwind of the tower, the rotor has a diameter of 107m (350feet) and blades 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.

Foundations

The wind farm comprises 90 giant monopiles, which, together with the transition pieces joining the turbines and offshore substations to them, were fabricated to individual specifications. Each foundation is between 44 and 61 metres long, has a 4.2 to 5.2m diameter and weighs from 375 to 530 tonnes.

Offshore substations

Sheringham Shoal is actually two distinct wind farms, sitting side by side. They duplicate each other with six infield cables tying-in strings of six to eight turbines – 44 on each side – and wiring them into one of the two substations. The 1000 tonne offshore substations, are each 30.5 metres long, 17.7 metres wide and 16 metres high. Fabricated in Hartlepool in the North East of England, they sit atop specially designed foundations.

Export and infield cables

The offshore cables include both power and fibre optical elements bundled together into one unit.

There are two long export cables carrying the power from the wind farm to landfall – one 23 kilometres and one 21 kilometres – weighing 77 kilograms per metre. That's a total weight of 3,388 tonnes!

There are two different types of infield cables connecting the turbines and the offshore substations. Type one (27kg/m) connects the turbines closest to the substations, while type two (18kg/m) connects the turbines further out.

Onshore **connection**

Onshore substation and cables

To feed the electricity generated by the wind farm into the national grid, an onshore connection was required. Through liaison with the National Grid, the connection point was selected at an existing substation site at Salle, 22 kilometres inland from the landfall at Weybourne.

In June 2010, work started on an onshore project consisting of two main components:

- An underground cable system between Weybourne and the substation at Salle (approximately 21.3km in length).
- A new substation adjacent to the existing EDF Energy substation at Salle.

UK contractor Carillion installed the onshore cable below ground in plastic pipes or 'ducts'. Fibre optic cables for communication purposes were installed at the same time. The majority of land along the cable route was cultivated agricultural land separated by hedgerows and occasional trees. Agreements were reached with local landowners and farmers before the work could proceed.

Along most of the route the cables were installed using a method of open-cut-trenching, using trenches around 2.2m wide and 1.6m deep.

The route crosses the local road network in 14 locations and local landmarks such as the North Norfolk Railway, River Bure, several areas of woodland and the Kelling Heath holiday park. In these locations open trenching was not appropriate, and a technique known as 'direction drilling' was used to install the cable ducts and minimise surface impact.

The construction of the new substation was completed in late 2010, and the main commissioning leading up to the energising of the substation during the early months of 2011.

How the wind farm **works**

The wind turbines of Sheringham Shoal convert energy from the wind blowing in the Greater Wash 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 alternating current (AC) produced by the generator to a direct current (DC) transmitted to the base of the tower. 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 export cables – one from each substation. As well as carrying electricity, the fibre optic element of the cables carry 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.

Operations and **maintenance**

To ensure that the wind turbines operate to their maximum capacity, an effective programme of operation and maintenance (O&M) is needed, with wind turbine technicians travelling to and from the wind farm every day.

When looking for an O&M base, Wells-next-the-Sea was the natural choice, being only 20 nautical miles from the Sheringham Shoal site. There was one key challenge however – its limited access due to tidal restrictions.

Working with the Wells Harbour Master and Commissioners, and following approval from all the relevant agencies and authorities. A dredging initiative was developed to overcome these restrictions by deepening the harbour entrance channel. This extended the tidal window to provide better access for vessels.

A new commercial outer harbour with pontoons was constructed so wind farm work vessels did not interfere with established port operations. A specially constructed dredger – an excavator mounted on a barge with GPS tracking to ensure precision – did the capital works and will continue to maintain the depth of the channel at one metre at low tide.

Scira and the Wells Harbour have signed an agreement confirming that the developer will use the harbour as its wind farm operational base for up to 50 years. Work is well underway on the construction of a brand new home two miles south of the town.

The administrative base and associated storage facility on the Walsingham Estate, Egmere, will be home to a team of around 60 permanent employees looking after the daily operation and maintenance of the wind farm.

By establishing its hub in the town, the Sheringham Shoal Offshore Wind Farm will help to ensure a viable future for the port and provide employment and other economic and social benefits to the area, whilst safeguarding its unique character and charm.

Contact details and more information

Scira Offshore Energy Limited
Polka Road, Wells-next-the-Sea
Norfolk NR23 1EE

T: +44 1328 710341
E: info@scira.co.uk
W: www.scira.co.uk

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

Statkraft

Statoil