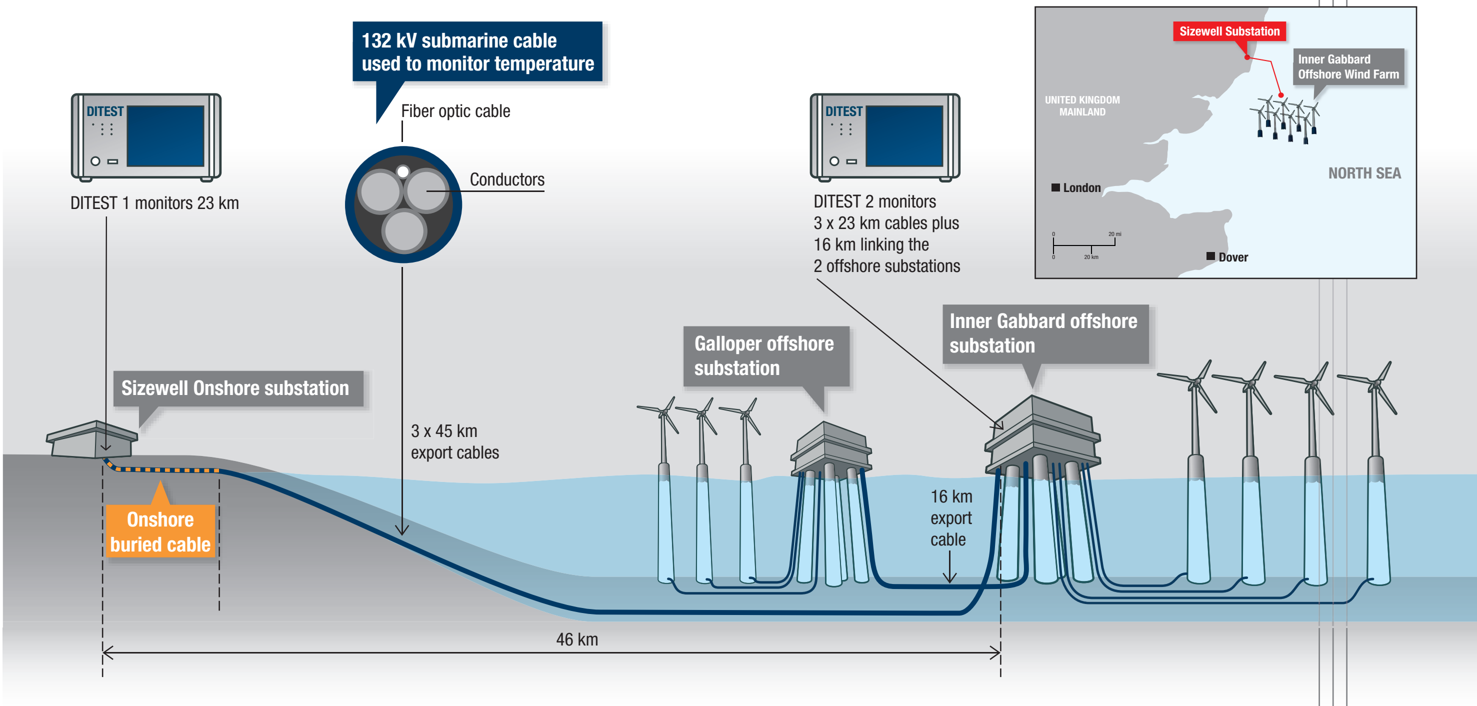
POWER

Case Study



Monitoring the temperature of 154 km Export Cables for Greater Gabbard Offshore Wind Farm, UK.

The challenge

Built on shallow sandbanks 23 km from the south eastern coast of the UK, Greater Gabbard offshore wind farm (GGOWL) is capable of generating 500 MW electrical power, producing 1,750 GWh, enough to power more than 500 000[(1)] homes. The project is a 50:50 joint venture between RWE npower renewables and Scottish and Southern Energy.

Three buried HV AC 132 kV (800 mm2) export cables, each 45 km long, (supplied by Prysmian Cables and Systems), transmit the electrical energy ashore to a substation adjacent to the existing 400 kV line near Sizewell. A fourth 16 km cable connects the Inner Gabbard and Galloper offshore substations. The subsea cables are in shallow water, at most 37 m deep, in a tidal area.

Many of the challenges facing subsea cables are factored into the project's design, but the environment poses many natural and man-made risks, among which are:

- Scour resulting in the exposure of the buried cables.
- Changes in the seabed morphology and environment (eg: underwater seismic activity and rising sea levels).
- Tidal currents which redistribute sediment and migrating sand waves.
- Dropped objects, dragged anchors, fishing tackle.

The export cables are designed to handle the 500 MW load of Greater Gabbard. If a fault occurs on one cable, the electrical energy can be re-routed to one of the others. Knowing the temperature of the cables under different loads helps the operator calculate how much can be safely switched and for how long.

About 7% of an offshore wind farm's capital expenditure is spent on export cable[(2)] but if a cable fails, the ability of the wind farm to produce is drastically reduced and the costs of remedial action are expensive and time consuming, dependent not only on the availability of a range of services to repair the cable but also finding a 'window' in the weather to carry out the work.

How does the operator know what challenges the cables are facing or when they are compromised, before the cable fails?

(1) *based on site specific data indicating a load factor of approximately 40% and using the average annual UK household consumption of 3.3 MWhrs.

(2) Kaiser, M.J. and B. Snyder 2011. Offshore Wind Energy Installation and Decommissioning Cost Estimation in the U.S. Outer Continental Shelf. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Regulation and Enforcement, Herndon, VA. TA&R study 648. 340 pp.

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CS-007 (Gr Gabbard windfm 52 km cable temp monitor) en-01

The solution

Since the temperature along a buried subsea power cable tells so much about its condition, continuous fiber optic temperature monitoring along each cable was specified, using some of the optical fibers integrated into the power cables for communication.

Omnisens DITEST LTM was chosen since it was able to monitor the entire cable distance (166 km) continuously with 3 m spatial resolution (2 m on the offshore substation interconnector) and temperature accuracy better than 1.5 ºC, every 30 minutes. Thanks to its large optical budget (19 dB on this installation) the Omnisens system continues to measure, even when there are a large number of splices or the fiber is 'lossy', building in a degree of 'future-proofing' should the power cable need repairing or extending with added optical fiber splices.

The information which may be inferred from the cable temperature includes:

- A cable which is running 'cool' at steady state has the potential to take extra load.
- Cold spots may indicate an uncovering of cable.
- A cable running above predicted temperature along its length may be overloaded.
- A developing hotspot may indicate that mud or sand is covering the cable, or that its insulation is compromised, perhaps due to damage from a dropped object.
- If the cable is seriously displaced (eg: seismic activity, or anchor drag) the break in the optical fiber will signal an alarm and give the location of the break.

Two DITESTs are used to monitor the entire cable length. One is housed in Sizewell substation and one on Inner Gabbard offshore substation.

Offshore substation

Results

The Omnisens system monitors the entire length (154 km) of the export cables. The latter are divided into 7 sections, each section having 10 zones, each zone having 2 alarm levels. The alarm levels are agreed with the operator and can be changed at any time, remotely, or from any computer in the operator's network which has the LTM interface loaded. Should the temperature of any zone exceed the 'pre-warning' or 'alarm' level, an alarm will be triggered via Modbus to the SCADA system. The operator has the full event information, (date, time, location and temperature). If required, the temperature profiles and evolution of temperature events can be viewed directly on the Omnisens DITEST LTM.

Omnisens expertise in the design and commissioning of monitoring systems extends to operator training and bespoke service contracts.

Instrument room on Inner Gabbard offshore substation. The DITEST rack weight and size is reduced for remote offshore use.

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