News From Japan

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World's First DC 400-kV XLPE Cable System

The completion of installation and the commencement of operation of a new high-voltage (HV) DC power interconnection system connecting between two major islands in Japan, Honshu and Hokkaido, using cross-linked polyethylene (XLPE) insulated cables, was reported in "News from Japan" in the November/December issue of the Electrical Insulation Magazine [1]. As a continuing article, the outline of a 400-kV HVDC XLPE cable system connecting between the United Kingdom (UK) and Belgium is introduced in this article [2].

As mentioned in [1], building a large circular power grid is very important for achieving efficient, stable, and robust operation of transmission of electric power. This is especially the case for the UK and countries in the European Continent, where a tremendously large number of facilities for electric power, such as wind power and solar energy, have been installed. With this background, a joint venture, called the NEMO Link interconnector, was founded between National Grid Interconnector Holdings Limited, a subsidiary company of the UK's National Grid Plc., and Elia Group in Belgium, aiming at installing the first electricity interconnection between the UK and Belgium.

Building a power link between the UK and Belgium has many advantages. First, the electricity transmission network in Belgium is densely connected all over Europe. Secondly, holding a large power grid helps the UK to make its power system more robust. Thirdly, the distance between the two countries is relatively short.

The NEMO link is composed mainly of the following systems. The first system is two sets of symmetrical monopole 400 kV HVDC converter stations that convert AC to DC, and vise versa, with a capacity of 1000 MW, one in the UK and the other in Belgium. The second system is a DC 400 kV XLPE-insulated cable that connects the two converter stations. Figure 1 shows the cable route of the NEMO HVDC link. Since power transmission systems in the UK and continental Europe are operated in AC, two AC/DC converter stations, equipped with a voltage sourced converter (VSC), are set in Richborough, Kent, UK and Zeebrugge in Belgium. These two sites were chosen for the following reasons. Many offshore wind farms and other renewable power generating facilities have been built in the coastal area of Belgium, while the electricity demand is very high in the south east region in the UK. The main part of the link, an approximate length of 130 km, is under seawater. This subsea section is connected to the two converter stations via two land sections, 2 km in the UK and 9 km in Belgium.

Figure 2 shows a profile of the seabed along the cable route. The seawater depth is less than 40 m in most parts, although it is around 55 m at the deepest portion near the UK. The highest sand wave accumulation was estimated to be 12 m. The structure and material of the cable system was sensitively decided by taking account of these conditions.

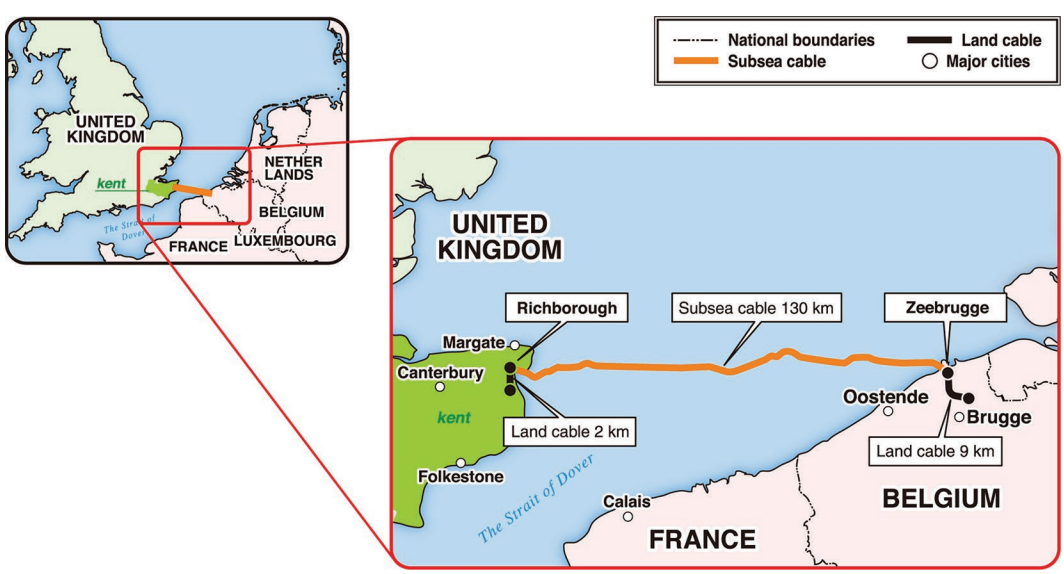

Figure 1. Schematic illustration of the route location of NEMO HVDC link.

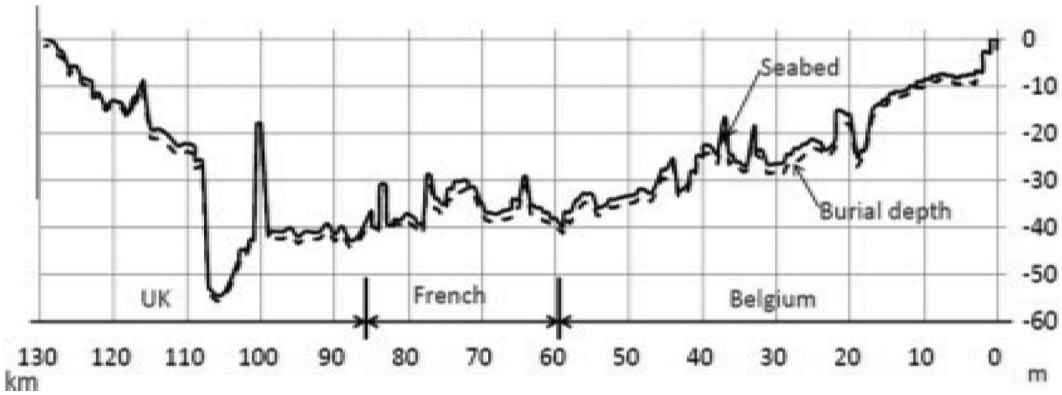

Figure 2. Profile of the subsea section in NEMO HVDC link.

In June 2015, a contract for engineering, procurement, and construction (EPC) was made between the J-Power Systems Corporation, Tokyo, Japan and NEMO Link Ltd. The J-Power Systems Corporation is a subsidiary of Sumitomo Electric Industries, Ltd., which transferred the transmission cable and conductor business to Sumitomo in 2016.

Figure 3 shows the cross section (a) and a photo of a real model (b) of the submarine cable. The conductor has a cross section of 1100 mm2 and is watertight for the installation at sea depth of 100 m. The cable is equipped with 16 single-mode optical fibers for data communication and 16 multimode optical fibers for temperature distribution measurement. The optical fiber system allows online monitoring of the occurrence of damages to the cable during its installation and operation.

Figure 4 shows the cross section (a) and a photo of a real model (b) of the land cable. The land cable has a large cross section of 1600 mm2 compared to the submarine cable, while it has 16 single-mode optical fibers for data communication and 16 multimode optical fibers for temperature distribution measurement similar to the submarine cable.

The manufacture of the cable was started in April 2016 in Sumitomo's Ibaraki Works and completed in February 2018. The submarine cable was manufactured by dividing it into four lots. The first two lots, 69 km each, and the second two lots, 71 km each, were loaded out in May 2017 and in February 2018, respectively. Figure 5 is a photo that shows a scene of embarking the cable into a transport ship from an onshore cable yard in Ibaraki Works, while Figure 6 shows a bundle of cable being

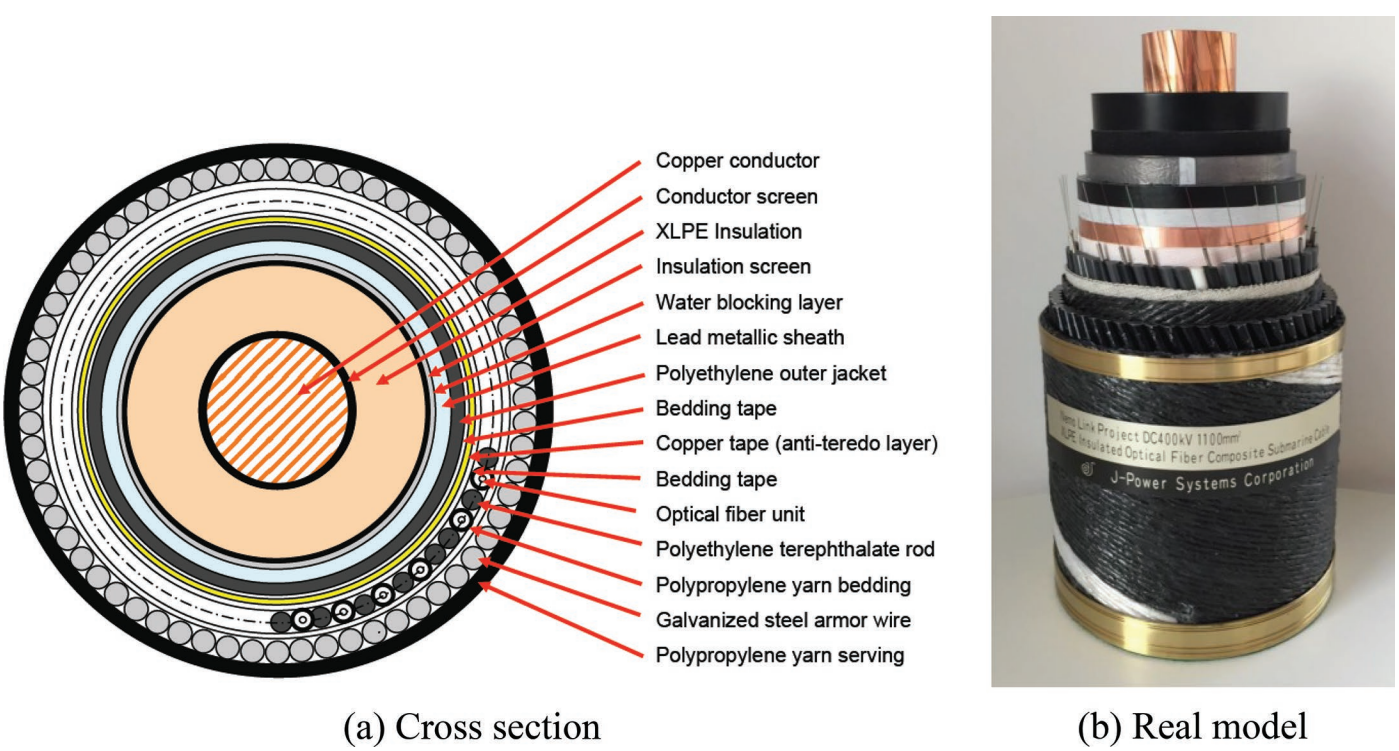

Figure 3. Schematic illustration of the cross section (a) and a photo of a real model (b) of the submarine cable.

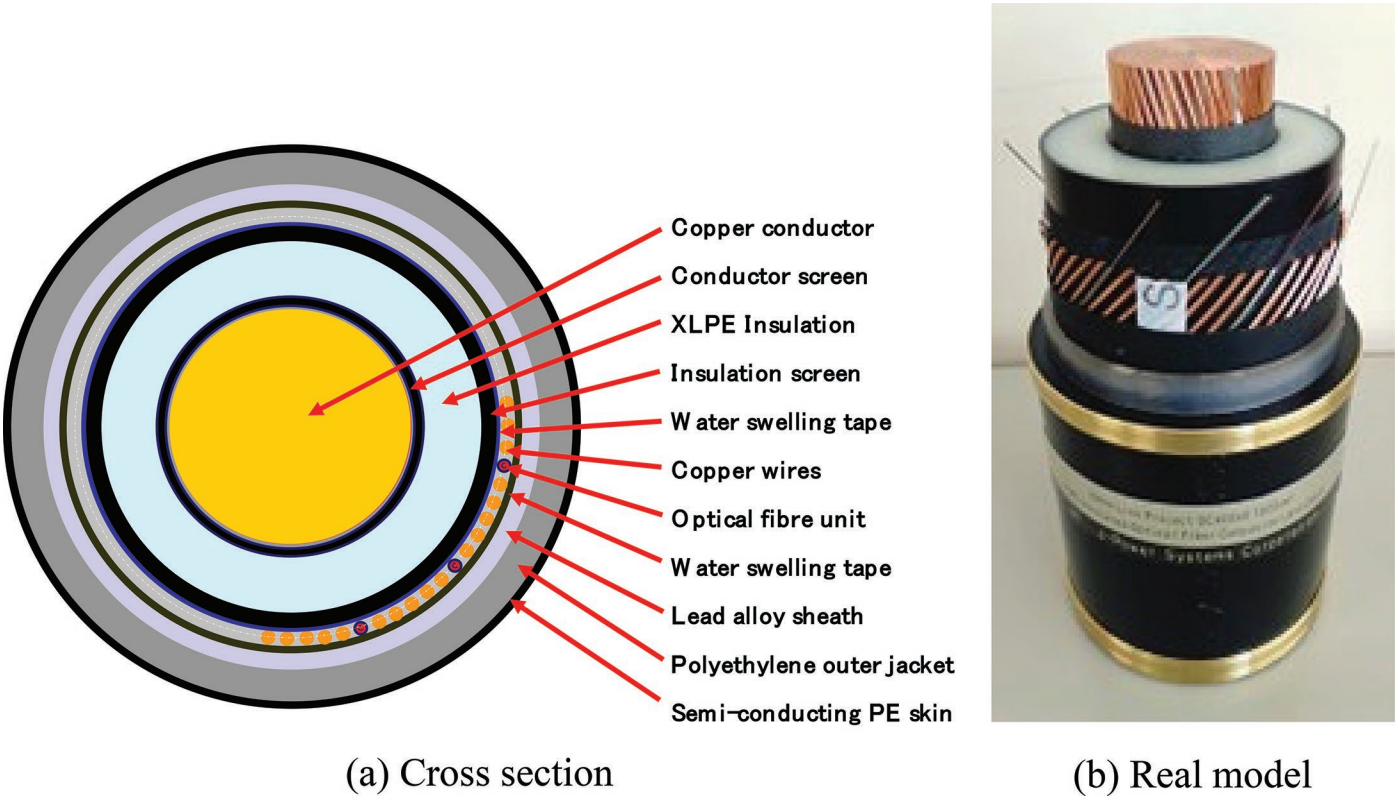

Figure 4. (a) Schematic illustration of the cross section and (b) a photo of a real model of the land cable.

Figure 5. A scene of the embarkation of cable from an onshore yard to a transport ship.

Figure 6. A bundle of cable is being loaded into the ship.

loaded into the ship. After the finish of very difficult work for cable installation into the sea and on the land, the NEMO link started its commercial operation on the 31st of January 2019. The designed maximum cable operating temperature is 90°C, much higher than other DC XLPE cables.

This article was completed in cooperation with Mr. Satoshi Nishikawa of Sumitomo Electric Industries, Ltd.

References

[1] Y. Ohki, "News from Japan – A New 250-kV HVDC XLPE Cable System in Japan", IEEE Electr. Insul. Mag., Vol.35, No.6, pp.43-45, 2019.

[2] T. Igi, S. Asai, S. Mashio, S. Nishikawa, S. Tomioka, T. Miyazaki, and T. Kazama, "Qualification, installation and commissioning of world's first DC 400kV XLPE cable system", JICABLE'19, A6.1, Versailles, France, 23-17 June 2019.