

## Lillebælt – Manufacturing, Installation and Commissioning of world's first 420 kV 3-core Submarine Cable

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### ABSTRACT

In this paper, the experiences of the design, production, installation and commissioning of the world's first 420 kV 3-core submarine cable are presented.

The scope of the project was to replace the two 400 kV overhead lines crossing the Lillebælt (Little Belt) with underground and submarine cables.

Through detailed project engineering including seabed surveys, soil investigations and intense dialogue with authorities the optimal layout for the project was found.

This paper covers all aspects in relation to the cable system, from conception to the realization of the project and the decommissioning of the old overhead lines.

### KEYWORDS

420 kV 3-core submarine cable, submarine cable burial methods, EHV, XLPE, world first, parallel circuits.

### INTRODUCTION/BACKGROUND

In November 2008, the Danish Parliament agreed on the principles on which the future expansion of the electricity transmission grid in Denmark should be based. This agreement was based on the work done by the Electric Infrastructure Committee [1].

Amongst others, the agreement implied:

- That the visual appearance of selected sections of the 400 kV grid will be enhanced (decided 2009).
- That the whole of Denmark's 132/150 kV transmission grid will be placed underground in future (the future Cable Action Plan).
- That new 400 kV overhead lines can only be built to replace old overhead lines in their existing right-of-way agreements. Otherwise 400 kV underground cables must be used.

The commitment to improve the visual appearance of the 400 kV grid, which involved six visual enhancement projects, was part of the new guidelines for undergrounding and expanding the transmission grid in Denmark.

The decision of the selected projects was based on the conclusions in the Visual Enhancement Report [2].

Initially, the state-owned environmental centres and Energinet.dk pinpointed 22 possible sections whose visual appearance had the potential to be enhanced. Following a detailed review, the 22 sections were reduced to six.

The six projects were chosen on the basis of an assessment of the environmental impact of the entire 400 kV grid, taking aspects such as people, protection areas, former county landscape designations, coastal zones and coast protection lines in consideration - One of these six projects was the project to cable the overhead lines crossing the Lillebælt Strait.

### SCOPE OF THE LILLEBÆLT PROJECT

The overall scope of the project was to replace the double 400 kV overhead line systems crossing the Lillebælt strait, which is the strait between the Danish island of Funen and the Jutland peninsula.

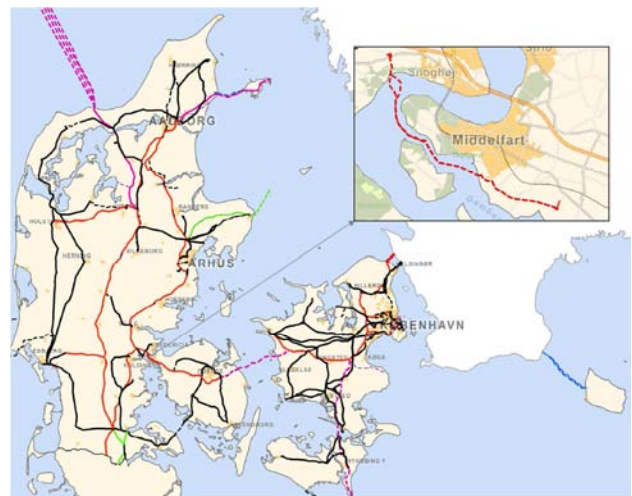


Figure 1: Overview map of Denmark.

A total of 2 x 12 km overhead lines were removed at the strait crossing and on land.

The project consisted of 3 parts:

- Cabling offshore and underground
- Building two transition substations/compounds
- Decommissioning of and rerouting of overhead line

The new cable part consisted of two 420 kV circuits each approx. 13 km in length divided in 1 km of underground cable system on the Jutland side, 7,5 km of submarine cable system in the Lillebælt strait and 4,5 km of underground cable on the Funen side next to the town Middelfart.

The substation part even included design of substations specifically designed for the project to accentuate the visual enhancement of the project. In addition to this, shunt reactors were installed in an existing substation nearby.

### ENGINEERING

The two 400 kV connections across the Lillebælt strait are two of the most important lines in the Danish electricity system; therefore the engineering solution should end up with a solution that was robust in every way.

It should also be noted that during the engineering process, it was not known if the solution would have to account for six single core submarine cables or two 3-core submarine cables.