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Experience with undergrounding projects in Denmark

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Dear Ramunas Valiokas,

Sorry for a very late answer to your questions about our experience with 400 kV underground cables in Denmark.

1. What are the conclusions regarding the technical performance since this underground cable infrastructure has been in operation, i.e. is it as reliable as equivalent overheadal lines? Any studies published on that issue?

The first 400 kV underground line in Denmark was made in Copenhagen and commissioned in 1997 and 1999. There are two lines, 12+8 km commissioned in 1997 and 12 km commissioned in 1999. It is a single circuit lines with XLPE insulation, CU-conductor. The circuits have all worked without any problems. The link boxes for the cross bonding system include some voltage limiters (surge arrestors). Some of them have been changed.

The second 400 kV underground cable system was three sections in an overhead line between the cities Aarhus and Aalborg. There are three sections with route lengths, 4.5 km, 2.8 km and 7.4 km. The cable sections are double circuit lines: 2 x 3 x 1200 mm² Al, XLPE insulation, with cross bonding of the shield. The continuous rating is about 1400 A for the double circuit. The cable is connected to an overhead line with a capacity of 2750 A. The continuous rating of the overhead line is almost the double of the cables' rating. When we take into consideration the short term rating, the capacity of the line is sufficient for the transmission system.

We have had no failures on the cable system, which was commissioned in 2004.

The third 400 kV underground project is being constructed now. We are building a new double circuit 400 kV overhead line Kassoe-Tjele. Three sections will be undergrounded with the route lengths: 2.5 km, 4.5 km and 1.6 km. For each overhead line circuit we need two underground cable circuits. At three sections

we have 2 x 2 underground cable circuits – or 2 x 2 x 3 x 2000 mm² Al, XLPE insulation, with cross bonding of the shield.

The first section (2.5 km) has in November 2012 been high voltage tested (1.7 x U₀ = 390 kV) without problems. It is ready for commissioning that is expected in February 2013.

We have had good experience with the underground cable connections until now. We have had no failures. During operation and during the new projects we have focused much on induced voltages caused by parallel lines (or neighbor cablesystems). It must be possible to make service or repair works on a cable circuit without disconnecting other important lines. This can be handled, but it must be prepared in advance.

2. What is the actual cost ratio per km of the underground cable vs OHL in Denmark, as estimated for construction and operation?

It is not possible to make direct cost comparisons between overhead lines and underground cables, because the rating of the two solutions may be very different.

We often don't need the total capacity of the overhead line, and we make use of the cables' short term capacity.

We pay a high compensation to the landowners, when we are building overhead lines, because we pay for the price reduction of their houses related to the new overhead line.

For the new line Kassoe-Tjele we also spend about 50% more on the towers, because it was a demand from the authorities that we should develop a new design tower for this project.

When we compare costs for overhead lines and underground cables, we must take the issues mentioned above into account.

Our experience is that the costs for underground cables are 3-5 times higher than the costs for overhead lines – depending on the rating demands.

I hope you understand my answers. Please see also the attached documents written for some Cigré conferences.

Best regards,



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