

Long length EHV electrical links by AC insulated power cables in Denmark

JICABLE'07 International Round Table

27 June 2007

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Long underground cable links in DK

- Voltage level 50 kV – 60 kV → cable links of **1930 km (24%)**
- Voltage level 132 kV – 150 kV → cable links of **515 km (13%)**
- Voltage level 400 kV → cable links of **52 km (4%)**
- Longest underground AC cable links at the voltage level 400 kV
 - Hybrid line with XLPE cable sections **2.5, 4.5 and 7.5 km** (double circuit 1200mm² Al)
 - **12 km** and **9 km** long underground XLPE cable lines (single circuits 1600mm² Cu)
 - Hybrid line with XLPE cable section **12 km** (single circuit 1600mm² Cu)
- Longest underground AC cable links at the voltage level 132 kV - 150 kV
 - **35 km** long underground XLPE cable line (single circuit 1200mm² Al)
 - **28 km** long underground XLPE cable line (single circuit 800mm² Al)
 - **25 km** long underground XLPE cable line (single circuit 630mm² Al)
 - **17 km** long underground XLPE cable line (single circuit 2000mm² Al)
- Longest sea AC cable links at the voltage level 150 kV
 - Horns Rev A - **20km sea /35 km land** XLPE cables (1x3x630mm² Cu/3x1x1200mm² Al)
 - Horns Rev B - **40km sea /56 km land** XLPE cables (1x3x630mm² Cu/?) from 2009

Extension of the transmission grid

- Since 1995 all new lines of the voltage $U = 50 \text{ kV}$ and 60 kV have to be built as underground cable lines
- Since 2000 all new 132 kV and 150 kV lines have to be built as underground cable lines
- Today it is in theory possible to build new 400 kV overhead lines but in reality it is very difficult to obtain the permission
- Due to the requests of politicians the Danish TSO Energinet.dk is investigating:
 - the possibilities of building new 400 kV lines, $\geq 100 \text{ km}$ long, as underground cable links
 - the consequences of replacing the existing overhead lines with underground cable links (extent, AC or DC, voltage levels, economic issues, system performance, power transit, technical difficulties, environment, etc)

Study case of a 106 km long 400 kV cable

- What if the planned 106 km long, 400 kV line IDU-EDR is built as an underground cable line?
- Detailed studies using computer model PowerFactory → E-TRAN → EMTDC/PSCAD
- Power flows and power losses?
- Reactive power compensation?
- Transient voltages and currents?
- Harmonic impedance?
- Remedy methods?



The message

- Till now, the Danish TSO Energinet.dk has not experienced any problems related to the operation of existing electrical links by AC insulated power cables
- Due to the current studies, Energinet.dk is interested in entering into technical discussions with cable manufacturers and other TSO's that have experience with long AC power cable links
