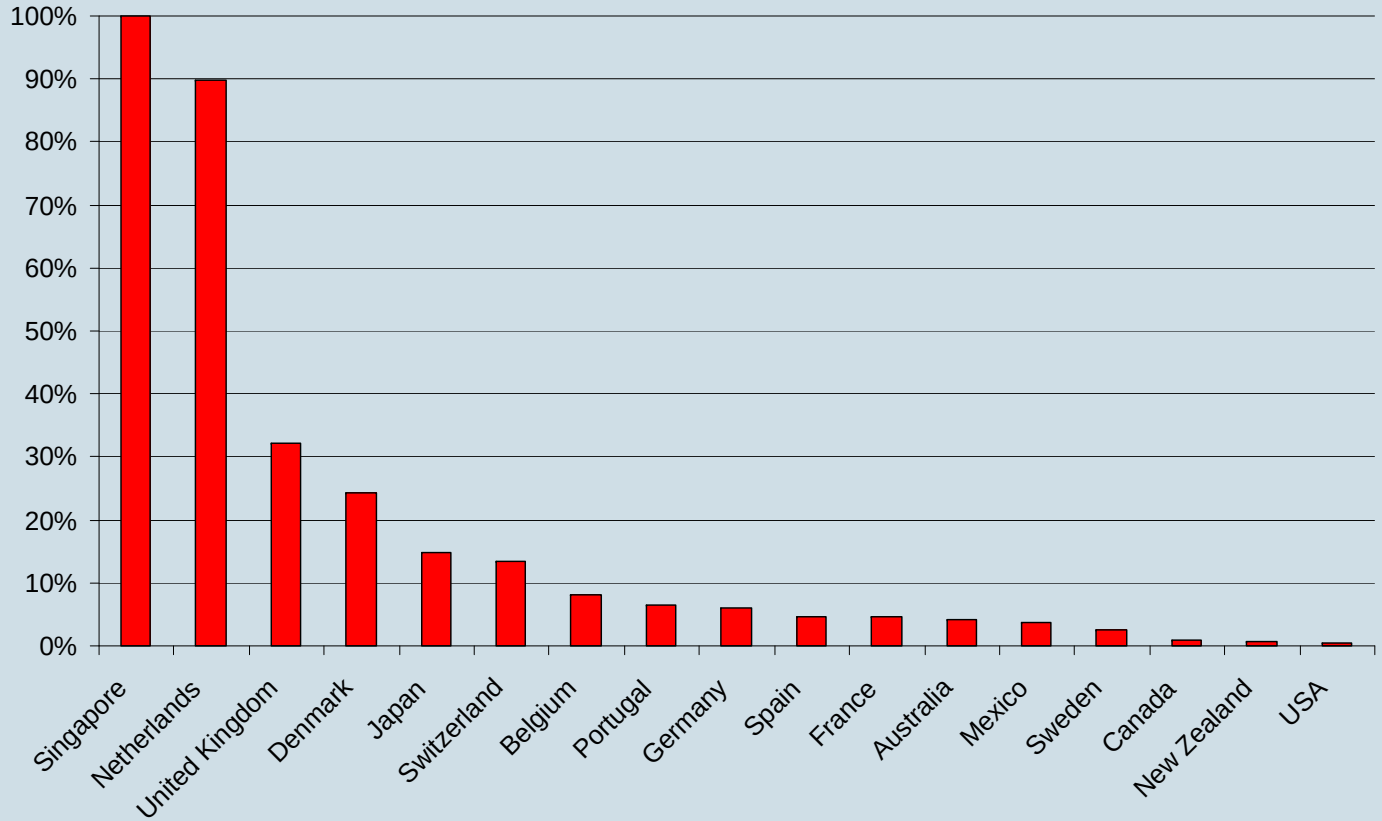
Long length links in the world: Characteristics

- Geographical situation of the link
- Design of the link
- Characteristics of the link
- Characteristics of the cable

Christian Jensen

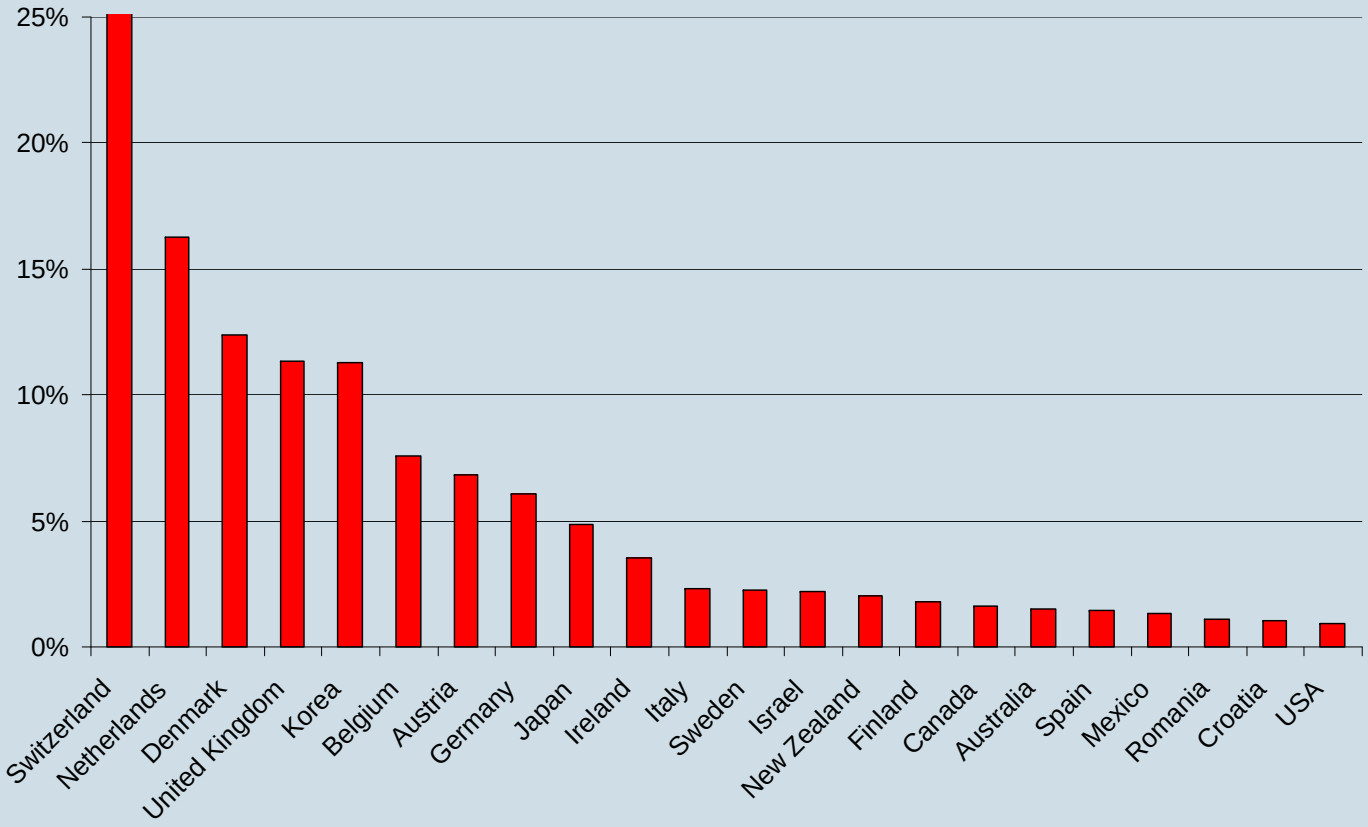
Energinet.dk (Danish TSO)

Underground cables, 50-109 kV



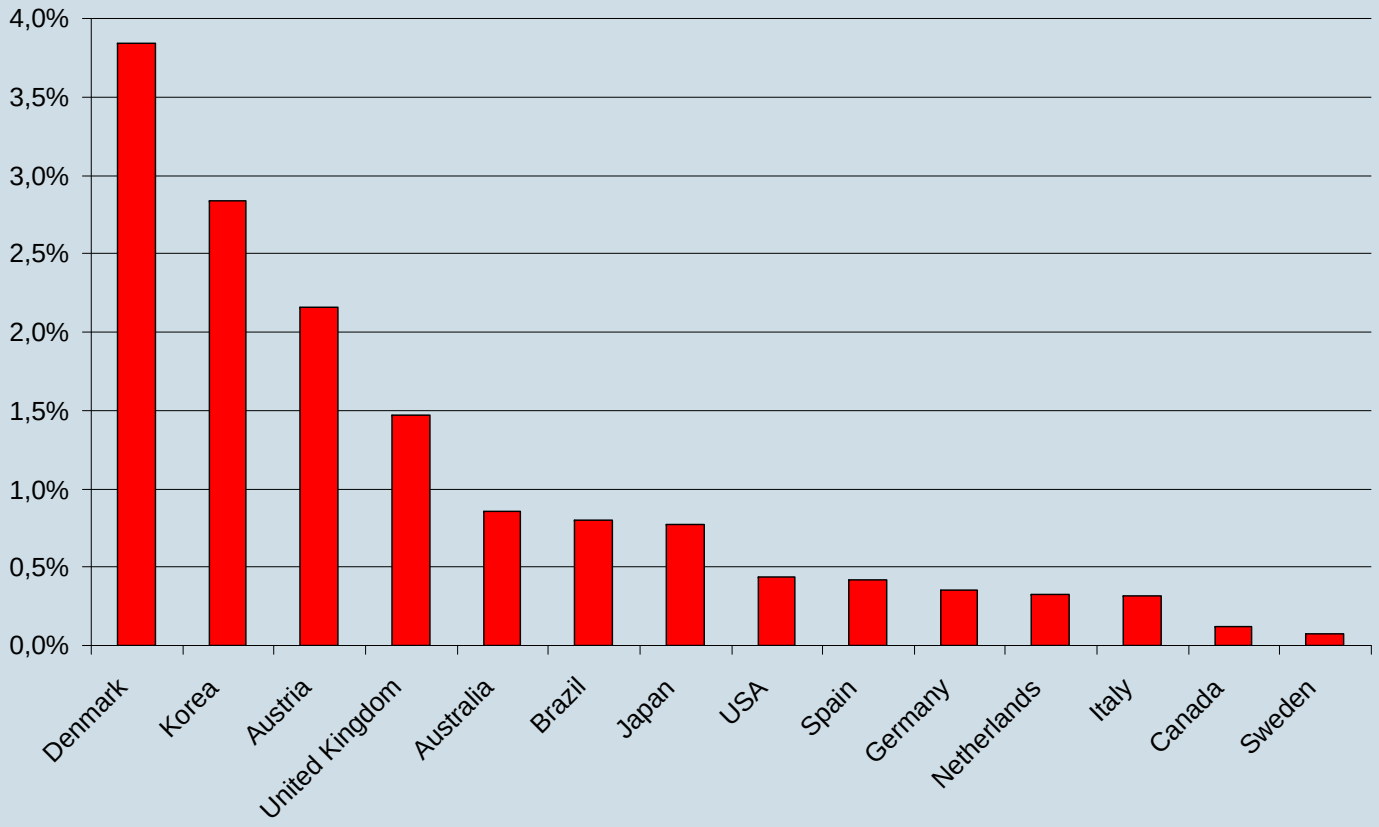
Percentage of the total circuit length underground at the 50 – 109 kV voltage level

Underground cables, 110-219 kV



Percentage of the total circuit length underground at the 110 – 219 kV voltage level

Underground cables, 315-500 kV



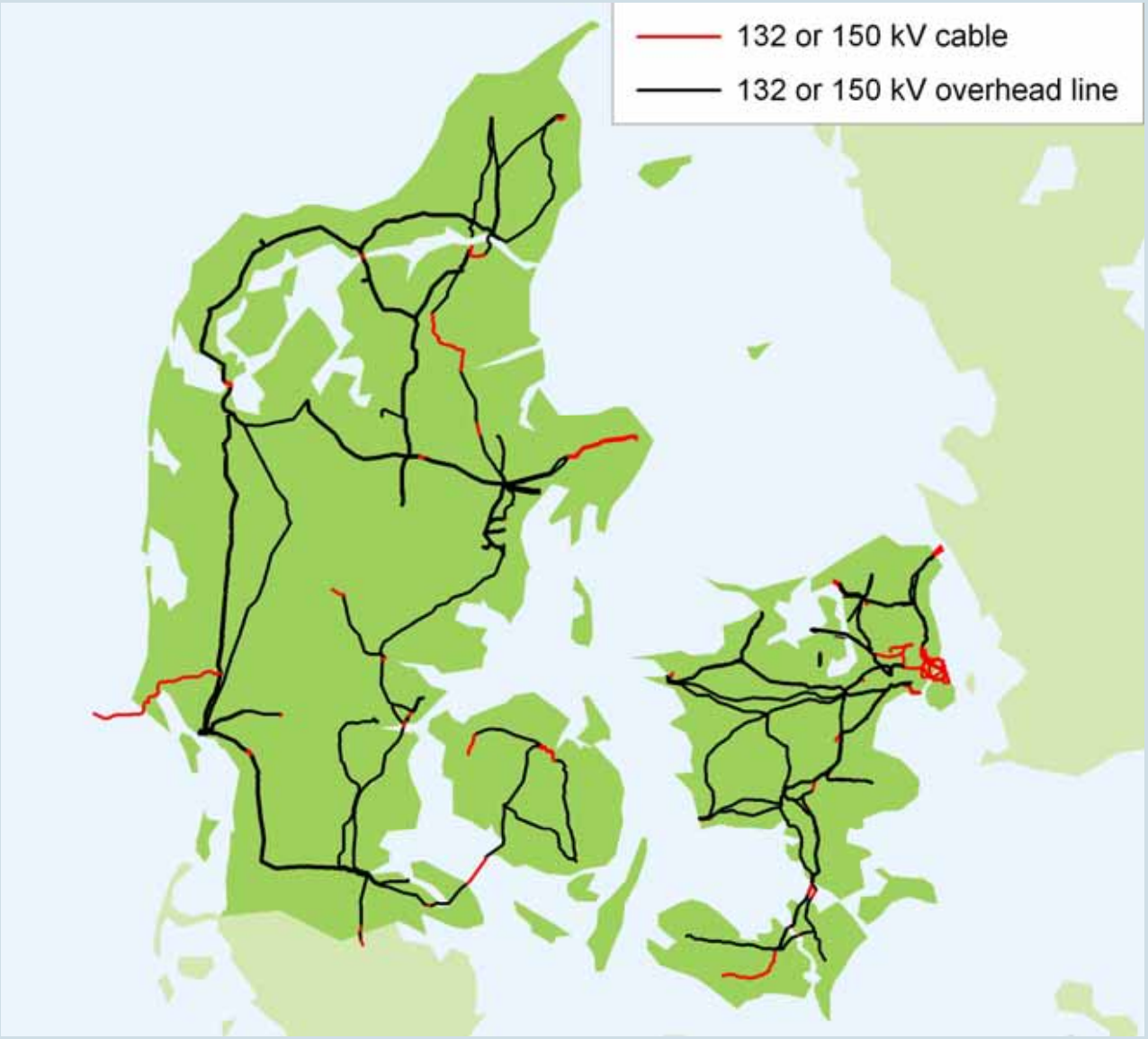
Percentage of the total circuit length underground at the 315 – 500 kV voltage levels

Underground cable length, Denmark

Voltage Level	50-109 kV	110-219 kV	315-500 kV
Denmark	**1930 km**	**515 km**	**52 km**

Danish transmis-sion grid, DC and 400 kV AC

Danish transmission grid, 132 and 150 kV



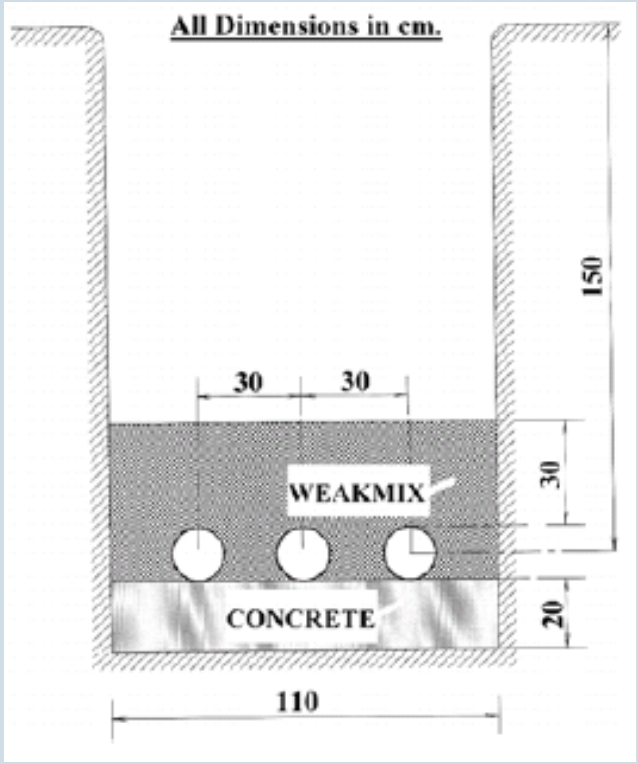
Long underground cables

Location	Project name	kV	Conductor (mm2)	Conductor material	Insulation material	Continuous rating MVA	Circuits	Cores per phase	route length (km)		Hybrid cable & OHL route	Commissioning Date
Jutland	Aarhus-Aalborg	420	1200	Al	XLPE	1200	Single	2	2.5, 4.5 & 7.5	Direct buried or duct	Yes	aug-04
Copenhagen	Metropolitan Power Project	420	1600	Cu	XLPE	975	Single	1	12.0, 9.0	Direct buried	No	1997
Copenhagen	Metropolitan Power Project	420	1600	Cu	XLPE	975	Single	1	12,0	Direct buried	yes	1999
Copenhagen	GLN-STA	145	2000	Al	XLPE	250/335	Single	1	17,0	Direct buried	No	2005
Lolland	Radsted-Rødby	145	630	Al	XLPE	125	Single	1	25,0	Direct buried + ducts	No	okt. 1999
Lolland	Radsted - Vantore Str.	145	1200	Al	XLPE	180	Single	1	18,0	Direct buried + ducts	No	nov. 2002
Zealand	Skuderløse-Teestrup	145	1200	Al	XLPE	200	Single	1	3,5	Direct buried + ducts	No	22.10.2001
Jutland	Mesballe-Aastrup	170	800	Al	XLPE	115	Single	1	27,6	Direct buried or duct	No	2000
Jutland	Trige-Aastrup	170	800	Al	XLPE	115	Single	1	27,7	Direct buried or duct	Yes	2000
Jutland	Karlsgårde-Blåvand	170	1200	AL	XLPE	160	Single	1	35,0	Direct buried	No	2001
Jutland	Tinghøj - Haverslev	170	1200	AL	XLPE	215	Single	1	21,0	Direct buried	Yes	
Jutland	Tinghøj - Mariager Fjord nordside	170	1200	AL	XLPE	215	Single	1	6,0	Direct buried	Yes	

400 kV cables in Copenhagen

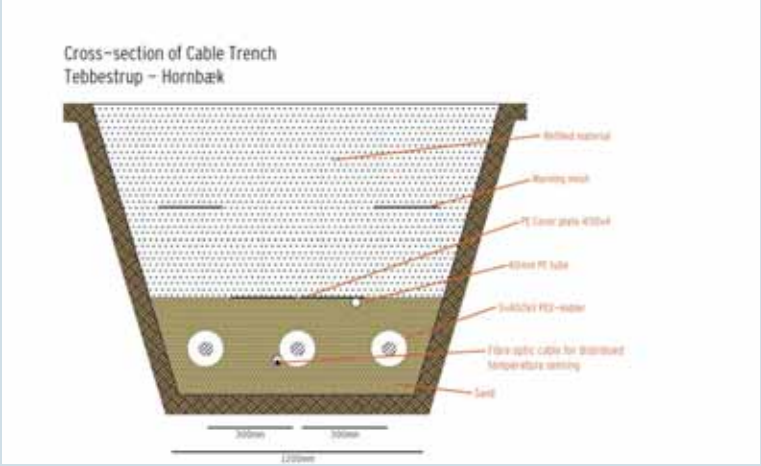
Installation method

- Copenhagen 400 kV underground link
  - In service from 1997/1999
  - 1600 mm2 Cu conductor
  - Flat formation
  - Weak mix
  - Single line
  - 12 km
  - 12 + 9 km
  - No service problems



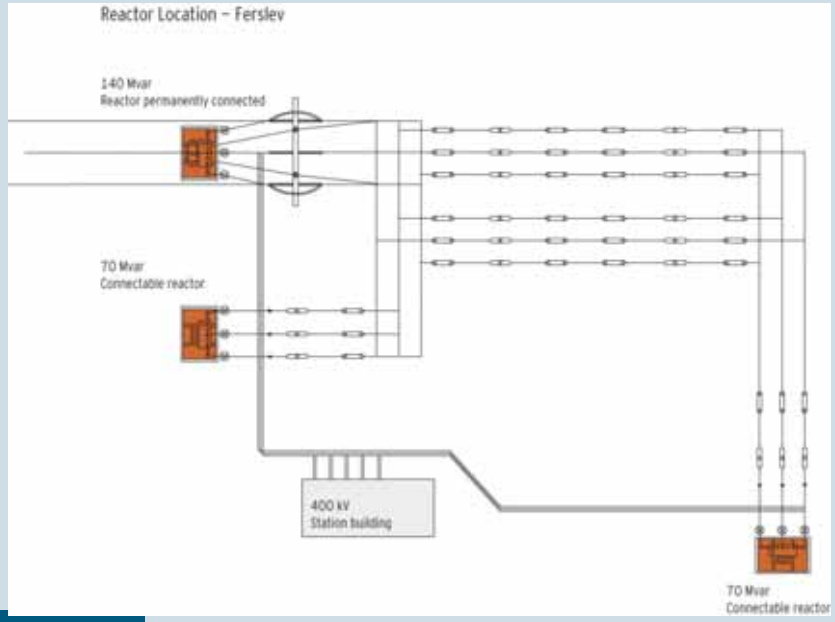
Installation method

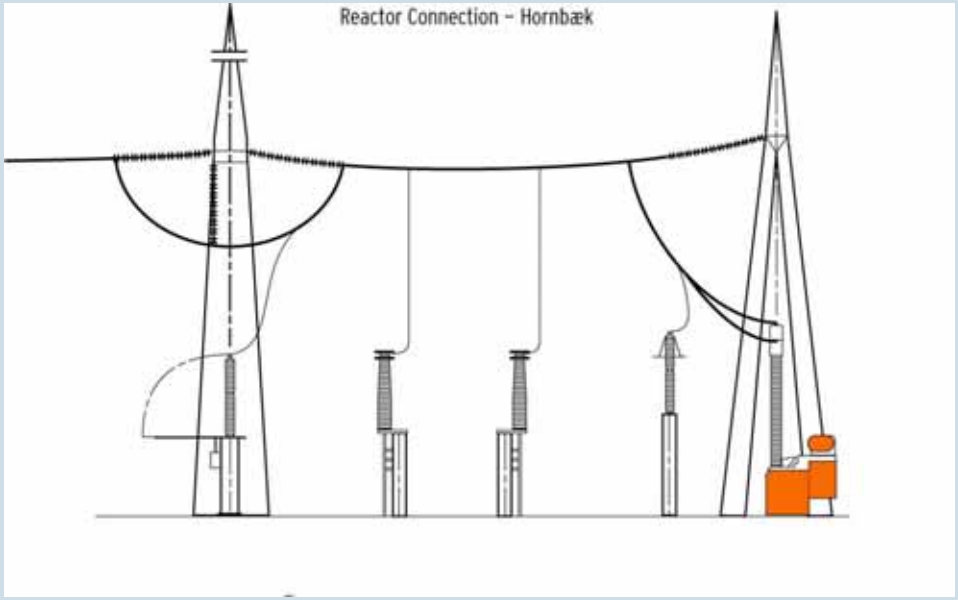
- Most cable installations:
  - simple installation
  - direct burial
  - sand and original soil as backfill
  - mechanical excavation and simultaneous cable laying in wet areas
  - cheap and fast
  - cross country
  - 1.0 – 1.5 m deep
  - crossing of roads, streams etc. with directional drilling
  - experienced contractors
  - no turn key solutions



Compensation

- 150 kV cables (max voltage, 170 kV)
  - long cables (> 20 km) – compensation with reactors connected directly to the line
  - short cable lengths – compensation not for single lines but for a number of cables - in central substations
- 400 kV cables
  - reactors directly connected to the line

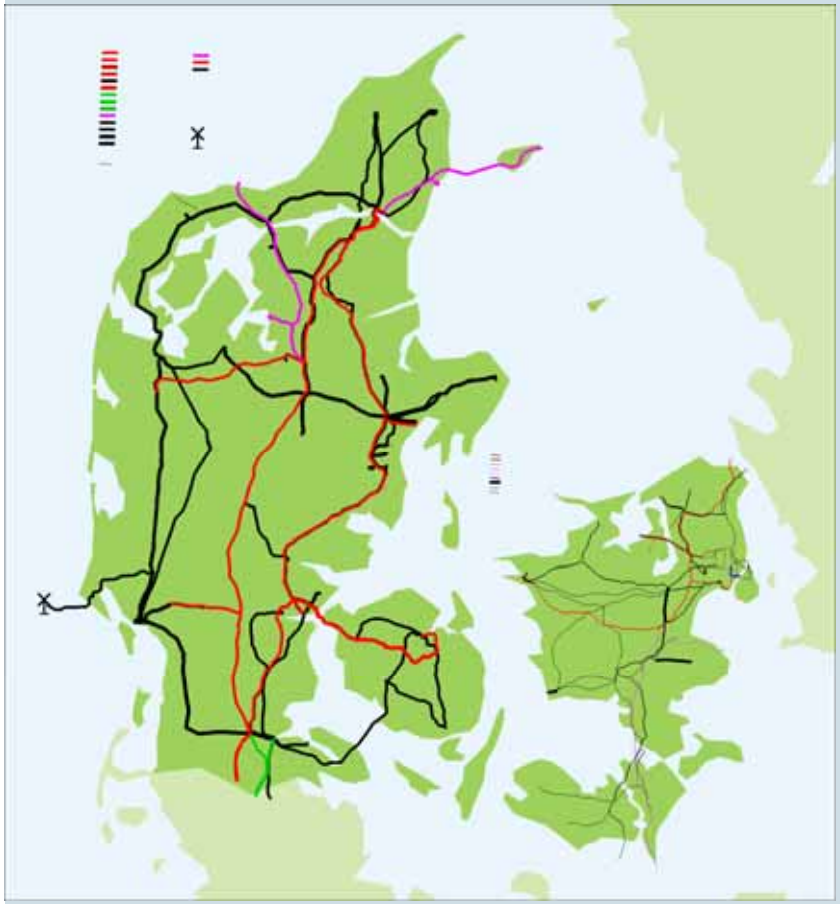


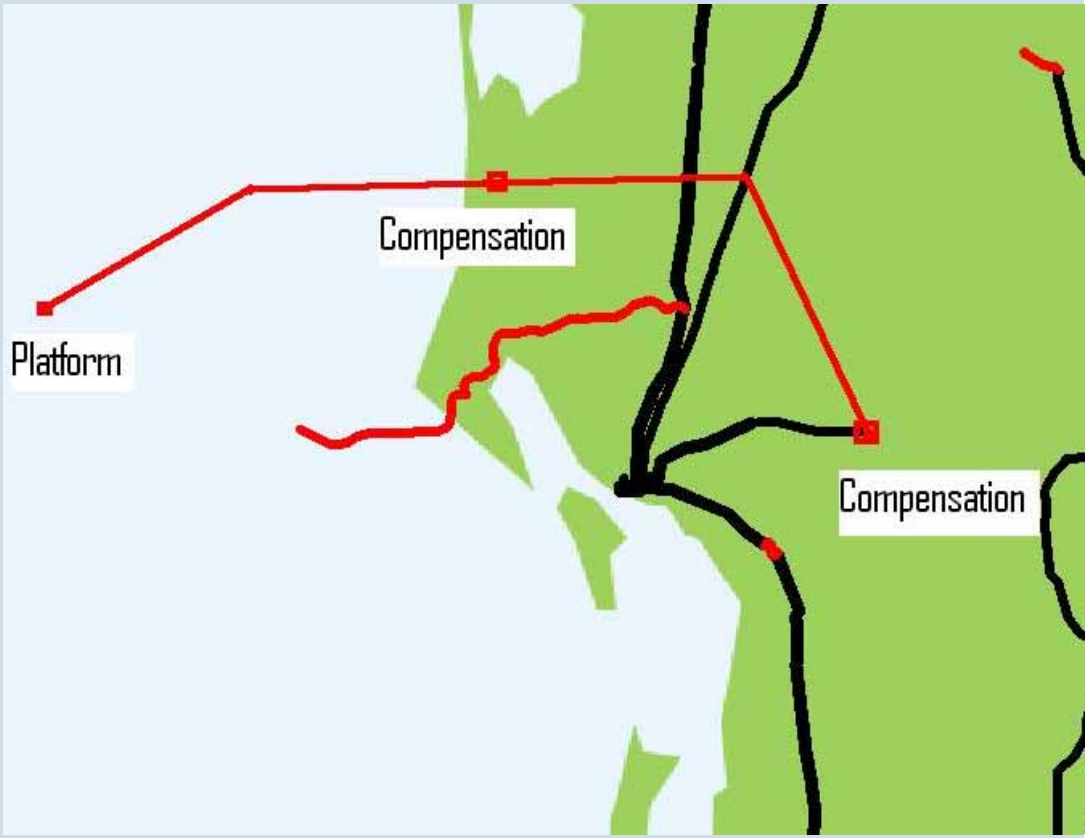


Bonding

- Most underground cables < 132 kV are solidly earthed
- 132 and 150 kV with high transmission capacity are cross bonded or single point bonded
- 400 kV cables are cross bonded or single point bonded

150 kV cable for offshore wind farm, Horns Rev 2





150 kV cable for offshore wind farm, Horns Rev 2

- Submarine cable
  - 40 km
  - 630 mm2 Cu conductor
- Land cable
  - 56 km
  - 1200 or 1600 mm2 Al conductor
  - cross bonded
  - open trench
  - sand and original soil as backfill
  - directional drilling under roads
- Compensation
  - Middle of cable
  - End of cable on shore


ATLAS


ATLAS


ATLAS

Mechanical laying – in wet areas