

RGI Technical Workshop in Arnhem

**Transmission Technologies
Cable and Overhead Line- AC and DC Innovation**

08.09.2010, Wilfried Fischer, 50Hertz Transmission, Berlin

Content

- 1. Who is 50Hertz Transmission?**
- 2. New Projects for Grid Extension**
- 3. Power cable Transmission Systems in Operation**
- 4. Power Cable Transmission Systems in Planning**

VDE/ETG Study on Transmission of Electrical Energy

The screenshot displays the VDE website interface. At the top, there is a navigation bar with links for 'Prüfung', 'Beratung', 'Veranstaltungen', and 'Technik'. Below this, a search bar and a 'Login' button are visible. The main content area features a large banner for 'NETZWERK ZUKUNFT' (Network Future). A sidebar on the left contains a 'VDE' logo and a list of services including 'InfoCenter', 'Studien + Positionen', 'Fachliteratur', 'Ratgeber/Marktforschungswerte', 'Informationen zum VDE', and 'Unsere AGB'. The central article is titled 'VDE-Positionspapier: Übertragung elektrischer Energie' (VDE Position Paper: Transmission of Electrical Energy). The article text discusses the challenges of increasing renewable energy and the need for grid expansion and smart grids. Below the article, there is a download button and a price table for members and non-members.

	Download	Versand
Nichtmitglieder	0,00 €	0,00 €

Impressum | © 2010 VDE Verband der Elektrotechnik Elektronik Informationstechnik e.V.

<http://www.vde.com/de/fg/ETG/Publicationen/Studien/Seiten/Homepage.aspx>

One university ,Two manufactures, four transmissions system operators

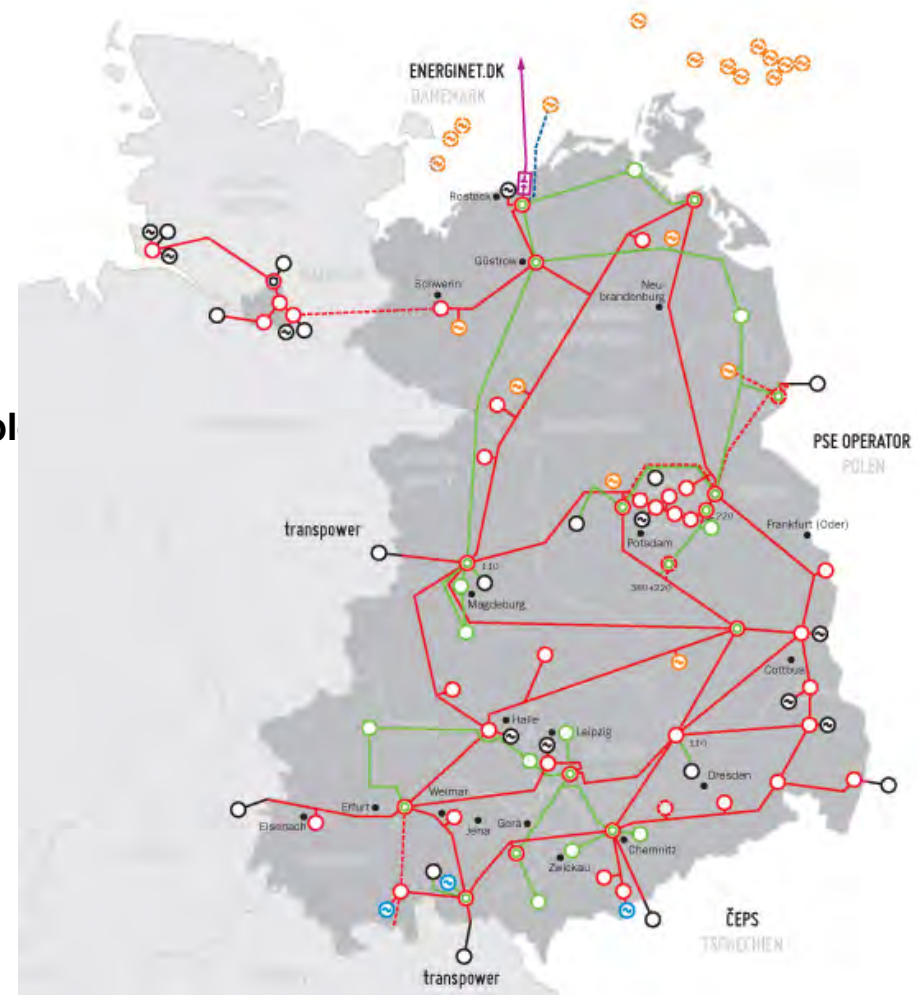
50Hertz Transmission

The transmission grid 220/380 kV

The grid lays right in the center of Europe with Interconnectors to Poland, Czech Republic, Denmark and Transpower provide securing reliable power supply to Europe

Some facts and figures:

- System Length: 9.700 km thereof 58 km as cable systems
- Number of Substations: 69
- Employees: 600
- Company seat: Berlin
- 6 Regional Centers
- 24/7 service .
- One HVDC Converter Station 600 MW,400 kV
- 13 km HVDC Land cable oilfilled



Key figures 50Hertz Transmission by December 2009

Area: ~ 109.000 km² (~31%)*

Inhabitants: ~ 18,2 Mio. (~22%)*

Demand: ~ 95 TWh (~20%)*¹



RES-infeed:	~ 25,4 TWh ¹
2008	~ 22,7 TWh
thereof Wind:	~ 16,9 TWh ¹
2008	~ 16,5 TWh
P_{install.} Wind:	~ 10.570 MW (~42%)*
2008	~ 9.680 MW (~41%)*

Maximum load control area: ~ 17.500 MW²

Maximum vertical grid load: 10.330 MW

Minimum vertical grid load: – 3.303 MW

Power plants and storages in the control area (P _{install.} in MW)	Grid connection (voltage level)	
	380/220 kV	≤ 110 kV
Thermal	~ 12.860	~ 7.100
Pump storage and hydro	~ 2.400	~ 500
Wind power (~42%*)	~ 910	~ 9.660
Biomass, PV u.a. ¹	~ 30	~ 1.970
Subtotal	~ 16.200	~ 19.200
Total sum	~ 35.400	

* Anteil von D ¹ vorläufige Angaben ² berechnet

Power cable systems within 50HzT

In Operation

XLPE-Cable Supply Systems in Berlin

- 380 kV Diagonal 23 km –four systems
- 220 kV South in feed 3,6 km – two systems

Oilfilled Cable systems in Berlin and at the coast of the Baltic Sea

- 380 kV Diagonal 31,4 km –four systems
- 400 kV HVDC oil filled Cable –13 km flat cable

In Planning

- 380 kV AC XLPE Cables Transmission systems for Thuringia

•Under construction

- 150 kV AC XLPE Seacable for Windpark Baltic 1 , 51 km
-

Priority network extension project in Germany

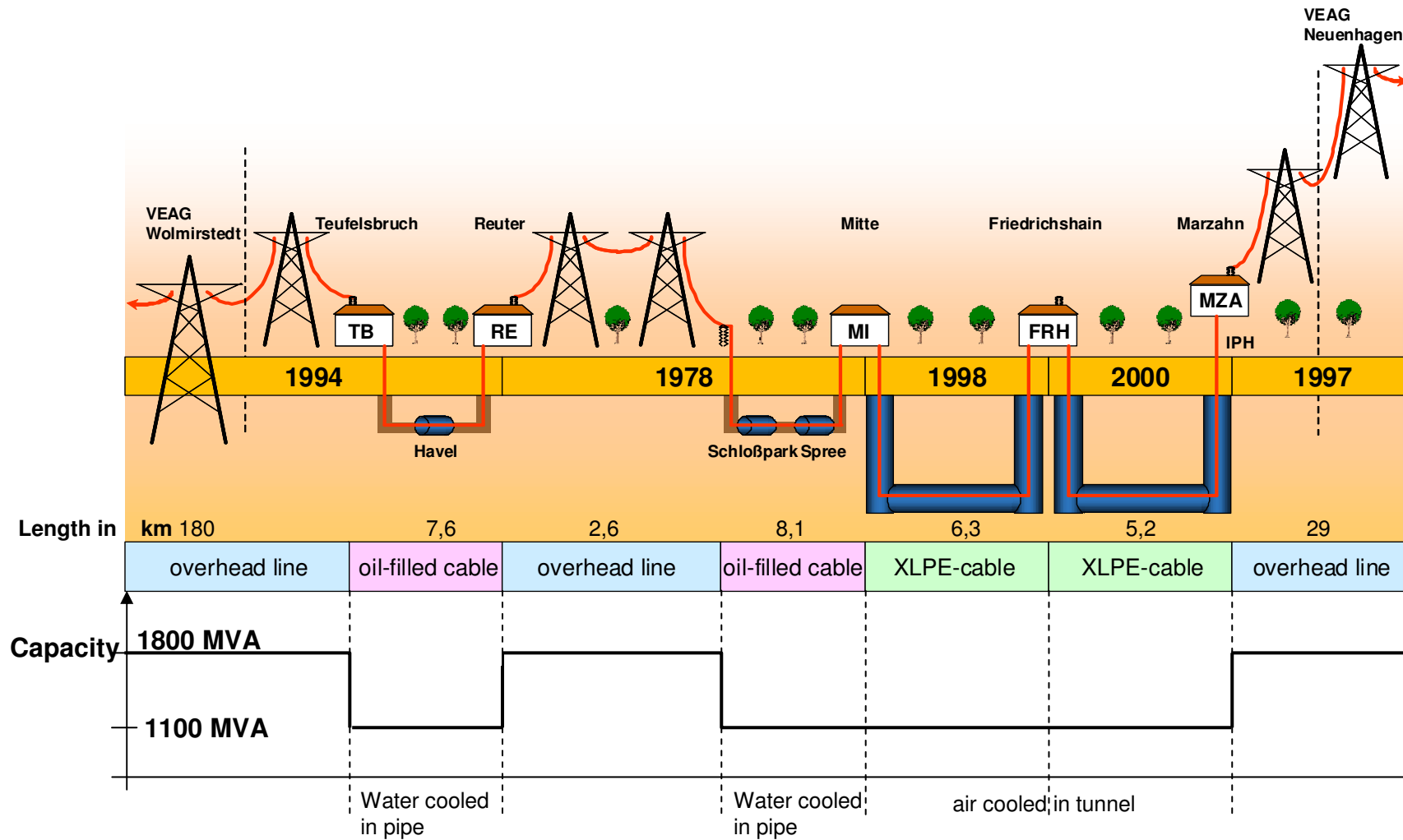


- German law on the extension of overhead power line connections: “Projects for which there is a high-priority requirement“ (2009)
- Renewable Energies Act (2009)
- Ordinance on system connection of power plants (2007)
- EU Directive: “Priority project in the European interest“ (2006)
- Energy Industry Act in connection with the Infrastructure Planning Acceleration Act (2006)
- “dena I” power system study (2005)

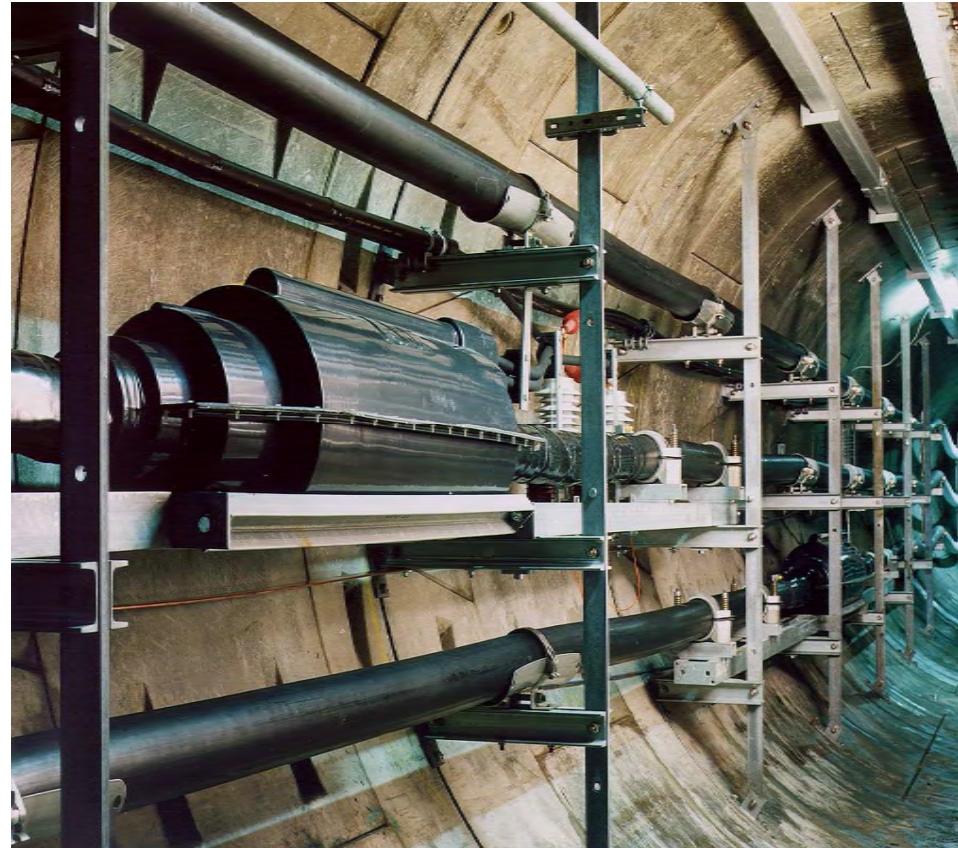
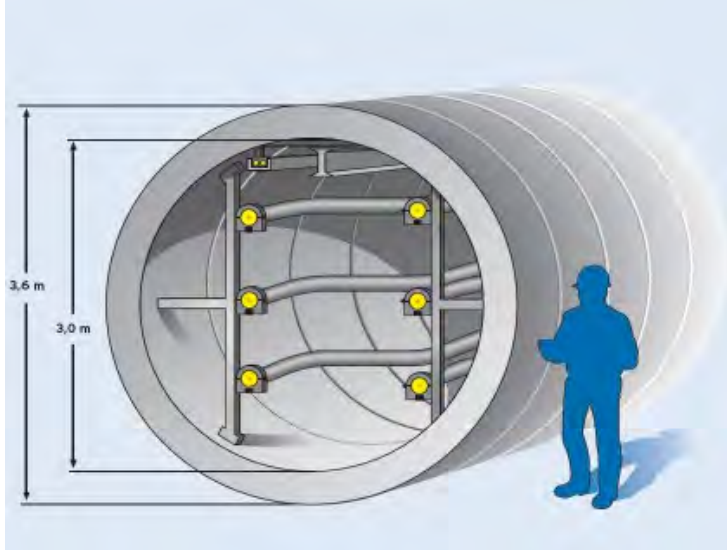
● **Netzausbau
2007 bis 2010**

- 1 Audorf – Dollern, 110 km
- 2 Ganderkesee – Wehrendorf, 80 km
- 3 Neuenhagen – Bertikow/
Vierraden, 110 km
- 4 Lauchstädt – Vieselbach, 80 km
- 5 Vieselbach – Altenfeld, 80 km
- 6 Altenfeld – Redwitz, 60 km
- 7 220/380-kV-Umstellung
Redwitz – Grafenrheinfeld
- 8 Zubeseilung Bechterdissen-
Elsen – Twistetal
- 9 220/380-kV-Umstellung
Irsching – Raitersaich
- 10 Dauersberg – Hünfelden 59 km

380-kV-Diagonal Berlin



View into the Berlin Tunnel



**11,5 km x 3 phases x 2 syst. = 69 km single
core cable (3 suppliers, 4 sections)**

15 x 3 x 2 = 90 partial lengths

13 x 3 x 2 = 78 Joints

4 x 3 x 2 = 24 Terminals

400-kV-Failure on System 921, L2, EV 2



Two Exploded Cable terminals

- First cable failure on 1.1.2008
failure at terminal phase L3 of line 302 (supposed : poor workmanship), repair until 29.1.2008
- Second cable failure on 1.2.2008
failure at terminal phase L2 of line 291 including contamination and damages of adjacent properties (unclear: design mistake?)
- Loss of confidence twice !
We in technology and stakeholders in us
- Decommissioning of both systems on 1.2.2008
- Start of special operational conditions in 110-kV-grid



**Parameter for aging tests
of XLPE cables of six different
suppliers in 1993 -1997
two one year test series**

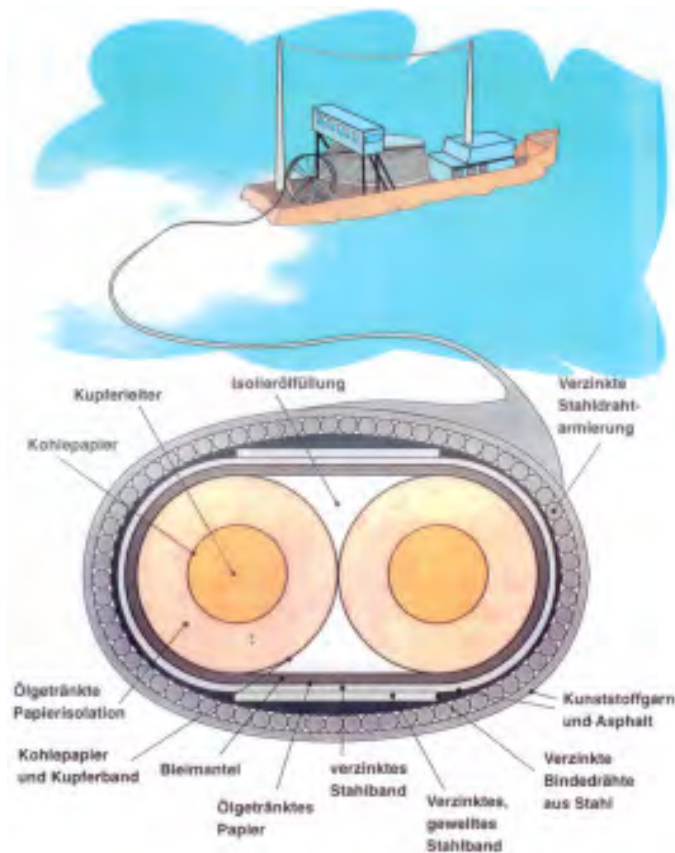
- Cable length 120 mts
 - Heat/cooling cycle 16 h / 32 h
 - max. temperature of conductor 90 °C (+ 5 K, - 0 K)
 - Test Voltage at 50Hz 400 kV *)
 - Test duration 1 year (twice)
 - Switching impulse voltage
(250/2500 μ s)
 - 950 kV (5 pos, 5 neg)
 - Lightning impuls voltage
(1,2 / 50 μ s)
 - 1175 kV (10 pos,10 neg)
- *) with continuous monitoring and
messuring of partial discharge at all joints
and terminals



Test Field at CESI Laboratory Milan

HVDC Link Kontec Danmark-Germany 400 KV

oilfilled cable in flat design, length 13 km , land cable



Cable Joint

IEEE PES SWITZERLAND

Operational Experiences on power cable systems

IEEE PES
Power & Energy Society

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[IEEE Milestones celebration August 2010](#) | [workshop april 2010](#)

Workshop April 2010

High Voltage Power Cables
OPERATIONAL EXPERIENCE OF HIGH VOLTAGE POWER CABLES IN TRANSMISSION AND DISTRIBUTION SYSTEMS

April 14, 2010
Hotel Allegro - Kulkaal Bern
Kornhausstrasse 3, 3000 Bern ZH

[Detailed Program \(72 KB\)](#)

Program

	Klaus-Peter Brand (ABB)	Opening and Welcome by the chair of the Swiss Chapter of IEEE-PES
	Charles Moser (BKW)	Welcome by the host
	Wilfried Fischer (Vattenfall)	Operational experience of high voltage power cable systems in Berlin and future planning for bulk power lines
	Teruo Ohno (TEPCO)	Operation and Protection of High Voltage Cable systems in TEPCO
	Luc Uyttersprot (ELIA)	Protection of mixed conductor circuits
	Anika Bosse (nkt cables)	High voltage underground power cables - Experiences and future techniques

<http://pes.ieee.ch/archive2010/1004/index.html>

Power Cable Systems in Planning

Southwest Coupling Line- Power Bridge of Thuringia

Feasibility Study on power cable section in the natural resort Thuringia Forest at the crestline Rennsteig

Scope of the study:

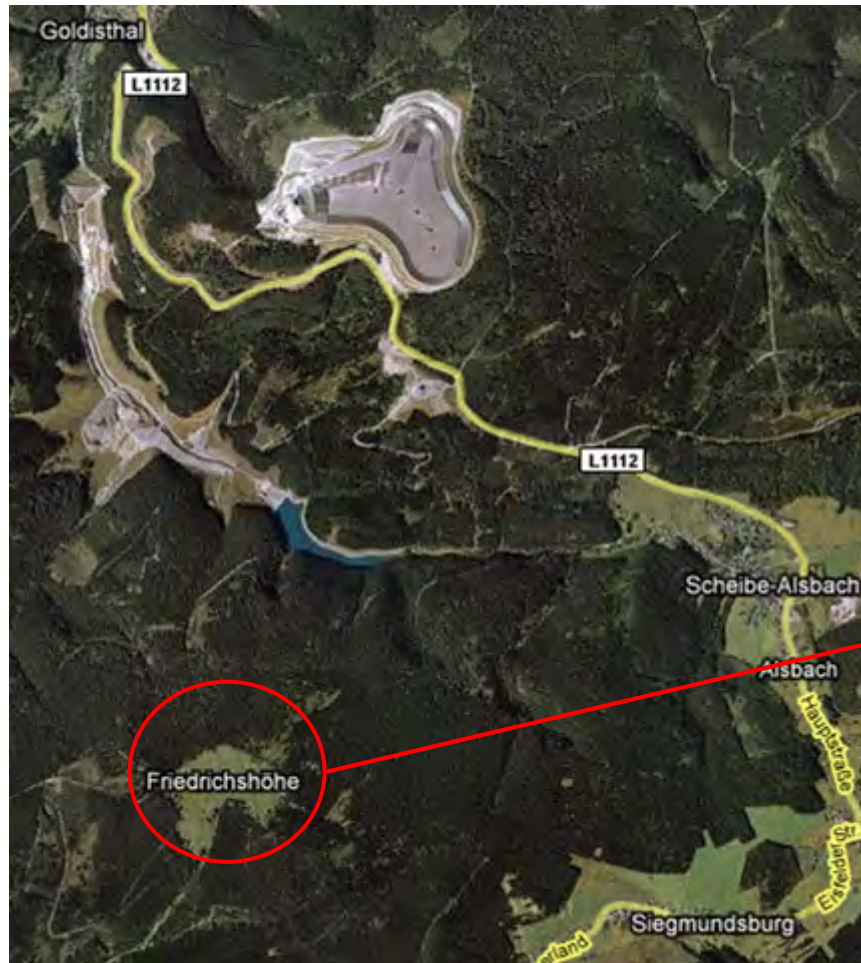
- Dimensions
- Investment Costs

- Logistics
- Outdoor activities –environmental impact
- Construction time

More under

http://www.forum-netzintegration.de/uploads/media/Sassnick_VET_170309_DUH.pdf

Rennsteig crossing near Friedrichshöhe

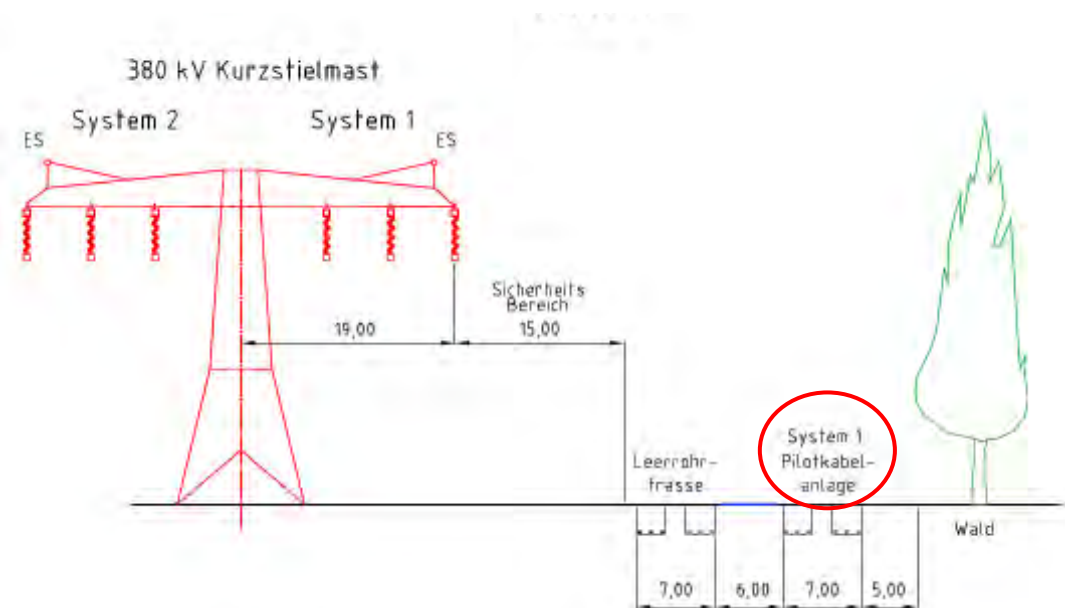


- Length: approx. 1,730 m
- Gradient of up to 15%
- Construction in slate mountains is possible only in this section because of the plateau location

➤ Cable laying with such a gradient is an enormous challenge and has never been executed before

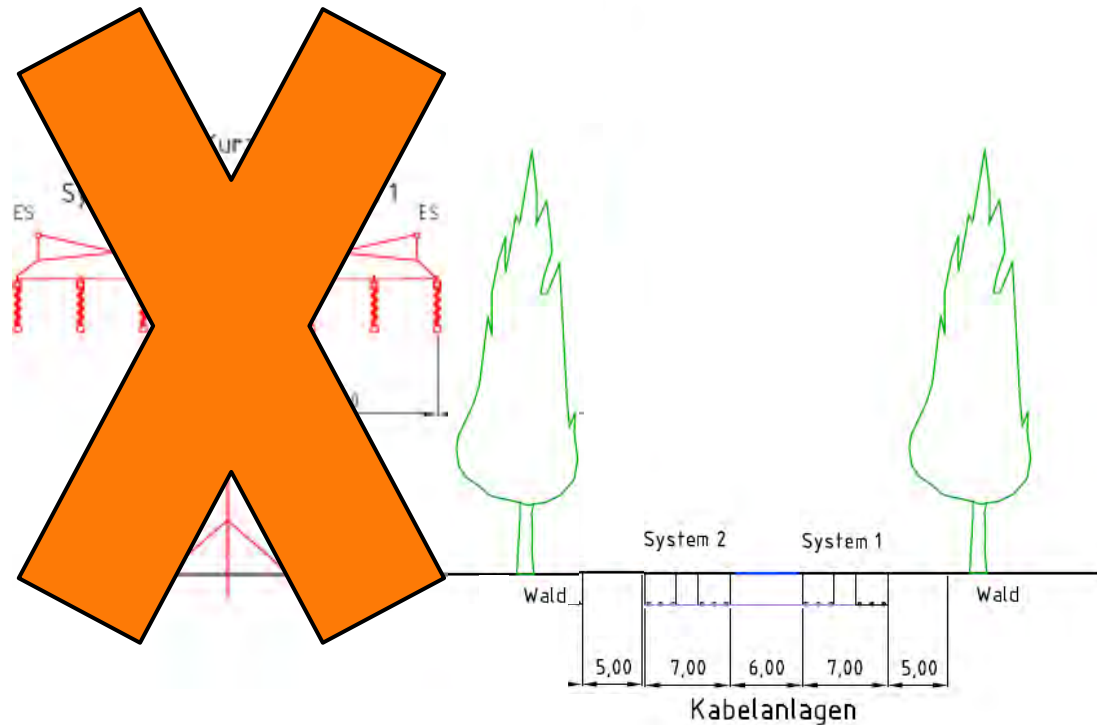
Pilot / test phase

- During the test phase, a **pilot cable system** (1 double-circuit system) will be used to test whether the **buried cable is technically sufficiently reliable**.
- In order to ensure **service security** during this time, a low-height **overhead line will initially cross the Rennsteig** in addition to the pilot cable system.
- Should any faults occur on the cable system during this time, secure transmission service can be maintained with the help of the parallel 380 kV overhead line.



Completion of the pilot/test phase

- As soon as the **test phase** has been **successfully completed**, the **second double-circuit cable system** will be pulled into the conduit.
- The **cable system** can now start into **full-scale operation**.
- The **overhead line** across the Rennsteig will be **dismantled**.



Technical data of the individual cable and the cable system



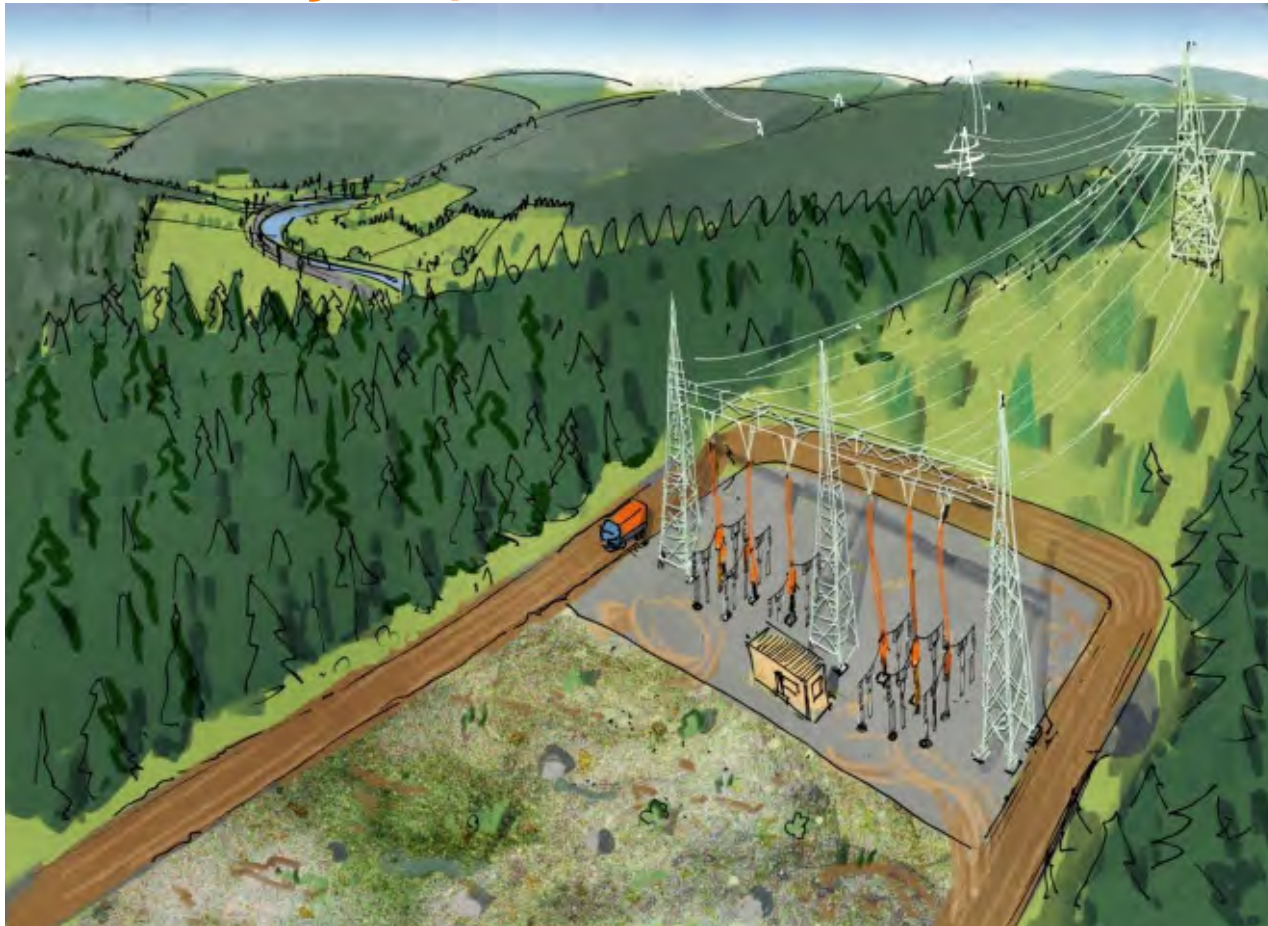
Key technical data of the individual cable

- Conductor material: copper 2,500 sqmm
- Insulation: Cross-linked polyethylene (XLPE)
- Rated voltage: 230/380 kilovolts
- Current: max. 1,800 amperes
- External diameter: 15 centimetres
- Weight: 40 tonnes per kilometre



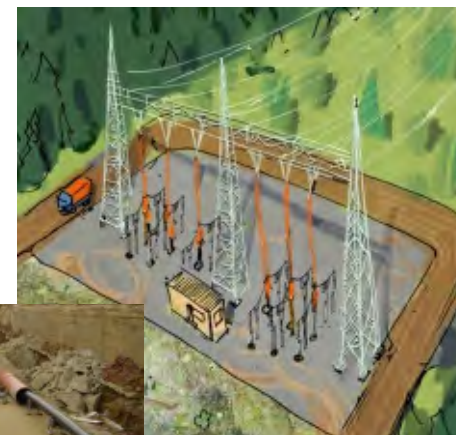
- Losses for each three-phase system at 1,800 amperes: 120 kilowatt/kilometre, resulting in a heat output of 60 watts per sqm
- Equivalent to the volume of heat required to heat 10,000 litres of water up 10°C per hour and system.
- **Each three-phase system would therefore be capable of heating up 50 bathtubs (of 200 litres each) by 10 degrees each hour.**
- 40,000 litres for 2 double-circuit cable systems (200 bathtubs)
- 80,000 litres for 4 double-circuit cable systems (400 bathtubs)

Structure for transition from overhead line to cable (double-circuit layout)



Structure for transition from overhead line to cable (double-circuit transmission line,
35 x 70 mts)

At a glance



Overhead line

Transition structure

Buried cable system incl. junction structures

Transition structure

Overhead line

Costs

		Friedrichshöhe	Kahlert
Length of section		approx. 1,730 metres	approx. 830 metres
Pilot phase cable	1 system of double-circuit cable incl. civil works preparing laying of the second double-circuit cable system	19	8.3
Mountain cable system	Two systems with double-circuit cables	30.5	12.8
Mountain cable system Final stage	Four systems with double-circuit cables	61	25.6



Overhead line 1. stage	2 Systeme	2,6 €	1,15 €
Overheadline final stage	4 Systeme	3,1 €	1,4 €

- Some cost drivers for cable systems in mountainous regions:
 - Costs of construction (expensive civil works, junction and transition structures)
 - Construction of access roads
 - Shorter technical lifetime (50% of overhead lines)
 - Maintenance and routine attention costs

(prices in € million)

Timetable

- **Construction period approx. 36-37 calendar weeks net (approx. 8.5 months)** for each line run
- This net schedule, however, will be subject to **limitations** on the **periods of time available for works**:
 - Restrictions from **March to June** for **ecological reasons** (nature conservation requirements like e.g. breeding periods)
 - Restrictions from **November to February** for **climatic reasons** (weather-related winter break due to the impact of snow and cold)
- This means only approximately **four months per year** are available for construction works
- The **construction activities in gross terms** will therefore span **several years** (two or more summer periods)



Conclusion

- Installing a cable system in **mountainous surroundings** is a **technical novelty**, and has yet to prove its full equivalence in comparison with overhead line technology in a pilot phase of several years.
- The geographical position of the cable runs (slate mountains) involves **several challenges**:
 - Access roads and neighbouring villages have to carry a heavy burden in view of the expected road transport; **additional new access roads** have to be built to allow access for heavy duty trucks.
 - Civil engineering and cable laying works will have to be performed in sloping terrain in mainly rocky soils. These have to be blasted and milled away which will result in **enormous noise emissions**.
 - The gradient in the mountainous landscape implies enormous challenges for transport and installation.
- **The use of buried cable necessitates massive interventions in the natural environment, especially in the soil balance, both during construction and operation.**
- **Maintaining the security of service with a mountain cable system requires costly maintenance and routine attention.**



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