

Extra High Voltage Underground Power Cables – Facilitating & Enabling Europe's Electricity Supply

June 2009

www.europacable.com

Europacable





Who are Europacable?

- Association of European Cable Manufacturers including:



CABLES
Well connected.



- Task Force: Harmonisation of Standards
- Working Group: High Voltage Systems (HVS)





Europacable goals

- ❑ Contribute to EU standardisation processes
- ❑ Promote innovative technology for underground cables
- ❑ Ensure complete & correct understanding of the technical specifications of XLPE cables

Europacable believes that XLPE cables

- ❑ **are a modern, innovative & reliable technology**
- ❑ **have limited & manageable environmental impacts**
- ❑ **have comparable life-cycle costs**





Europacable believes that partial undergrounding can

- **Facilitate** grid extension by addressing concerns of local communes, and
- **enable** the integration of renewable energy sources into Europe's future energy mix.





EU energy priorities:

1. Security of supply;
2. Mitigate climate change: “20% renewable energy by 2020”
3. Ensure competitiveness via “unbundling” & creation of truly functioning electricity market

Consequences:

- ❑ Significant infrastructure investments (e.g. TEN-E programmes)
- ❑ Increased co-ordination among European Commission, Transmission Group (ENTSO-E) & Regulator (ACER)
- ❑ TSO to prepare 10 year investment plans





“EnLAG”

- ❑ Streamlined approval procedures for 24 new lines;
- ❑ If lines within 200m of single houses/400m of residential areas, TSO required to consider cabling & regulator will conclude technical & economic considerations;
- ❑ For 4 pilot projects, TSO can choose to cable and regulator will allow incremental costs
- ❑ Legislation adopted 07/05/09

“Cable legislation”

- ❑ Salzburg, Austria
- ❑ If proposed Salzburg II 400kV line within 200m of single houses/400m of residential areas, TSO required to cable;
- ❑ Legislation reviewed by Federal Government and publication imminent

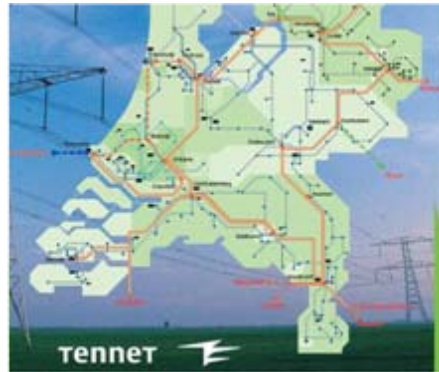


Ongoing underground cable projects in Europe:



2nd TEN-E Information Day, Brussels, 20th May 2008

TEN-E Interconnector
France - Spain



TENNET "Zuidring
Randstad"



Ganderkesee - St. Hülfe
Lower Saxony



Innovative & Reliable Technology

Environmental issues

Integration of cables in the transmission network

Comparable costs

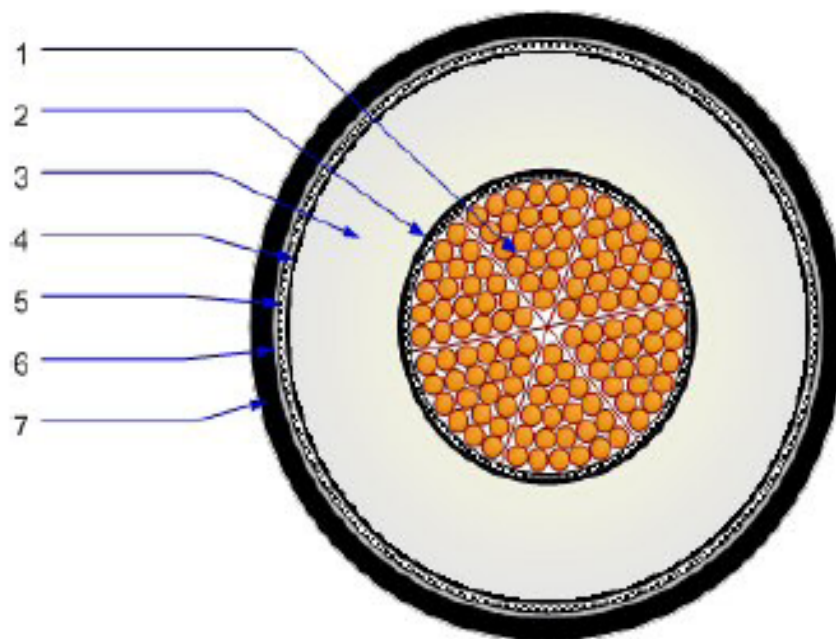
XLPE-insulated Cable

- ❑ More than 25 years commercial experience at HV levels (110-150 kV)
- ❑ More than 10 years experience at 400 kV – longest system (40 km of 500 kV - Japan)
- ❑ Current state of the art technology
- ❑ Easier installation and jointing
- ❑ Environmentally low risk
- ❑ Almost maintenance free



Cable design

- 1) Copper conductor (alternative Al)
- 2) Semiconductor
- 3) XLPE insulation
- 4) Semiconductor
- 5) Waterblocking
- 6) Welded aluminium sheath
- 7) PE outer sheath



Cable lengths & Cable Joint Bays

- ❑ 400 kV cables can be delivered in lengths of up to 1000 metres
- ❑ Joint Bays – generally unobstrusive underground structures



Overhead-Underground Transition Stations

- ❑ Can be size of tennis court, but in some cases a football field
- ❑ At voltages of 275kV and below, can be applied directly onto a pylon





Damage/disturbance

- ❑ Disturbance of underground cables occurs less frequently than for overhead lines
- ❑ Cables are not affected by severe weather
- ❑ Only outside influences can disturb/damage underground cables

Reliability

- ❑ Producers guarantee homogeneous cable quality according to international standards (IEC 62067)
- ❑ Repairs caused by damage
 - Quick & precise location identification
 - Repair time 2-3 weeks (if, as recommended, spare parts are kept in stock)

Life expectancy

- ❑ Innovative technology, with more than 10 years successful operating experience at EHV levels
- ❑ Careful long-term testing has been conducted and predicts a life expectancy of at minimum 30-40 years for XLPE cables



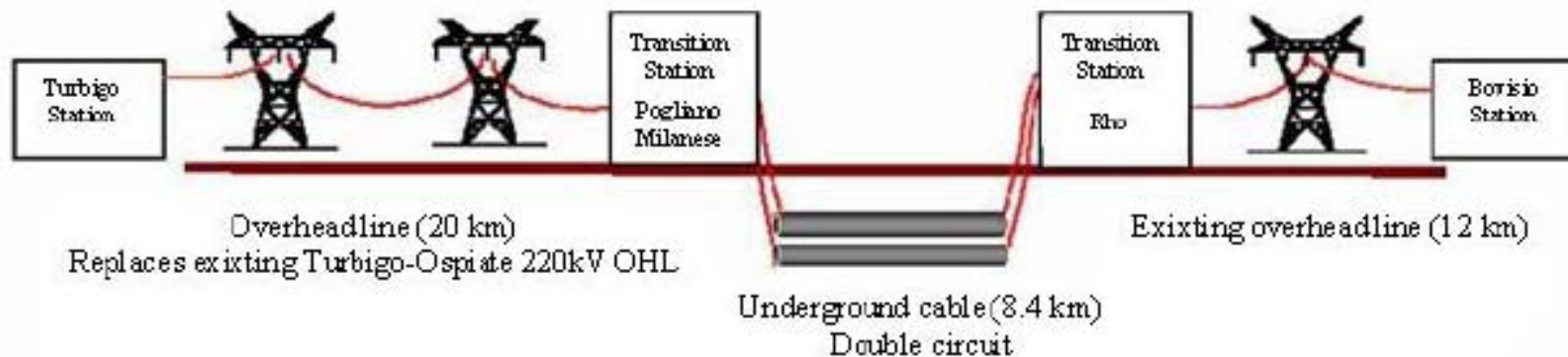


Examples of major 400kV projects in Europe

Location	Project	Cable circuits x length (km)	Cables per phase	Time period
Copenhagen	Elimination of overhead lines in urban area	1x22,1x12	1	1996 1999
Berlin	Connect West/East system	2x6;2x6	1	1998 2000
Vale of York	Area of outstanding beauty	4x6	2	2000/1
Madrid	Barajas Airport Expansion	2x13	1	2002/3
Jutland	Area of outstanding beauty, waterway & semi urban areas	2x14	1	2002/3
London	London Ring	1x20	1	2002/5
Rotterdam	Randstad waterway crossings	2x2.1	1	2004/5
Vienna	Provide power to centre of city	2x5.5	1	2004/5
Milan	Section of Turbigio-Rho line	2x8.5	2	2005/6
Switzerland/ Italy	Mendrisio – Cagno	1x8	1	2007/8

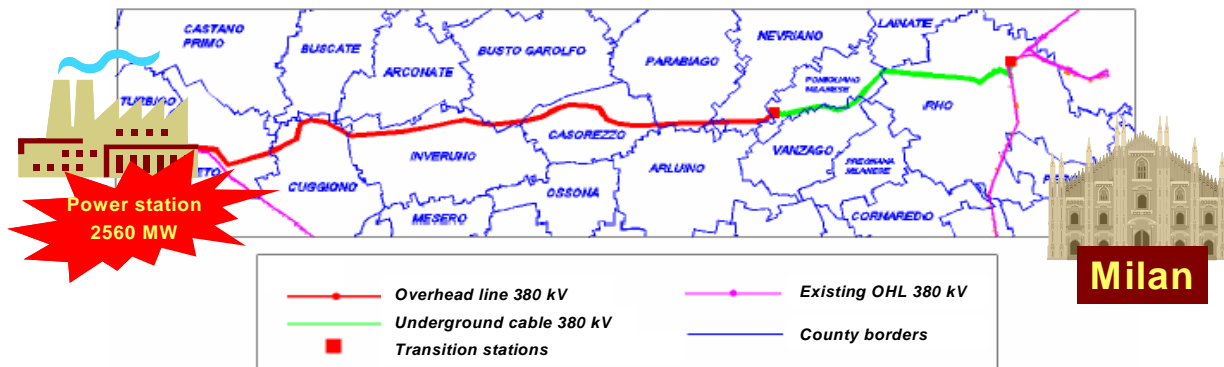


The Italian Turbigo-Rho 400 kV Project



Timeline

- 1991: Start of discussions
- 1994 -2004: "Deadlock"
- June 2004: Decision on partial undergrounding
- March 2005: Construction
- May 2006: Activation





The Italian Turbigo-Rho 400 kV Projekt



LINE ROUTE SIGNAL

AFTER THE CABLE LAYING

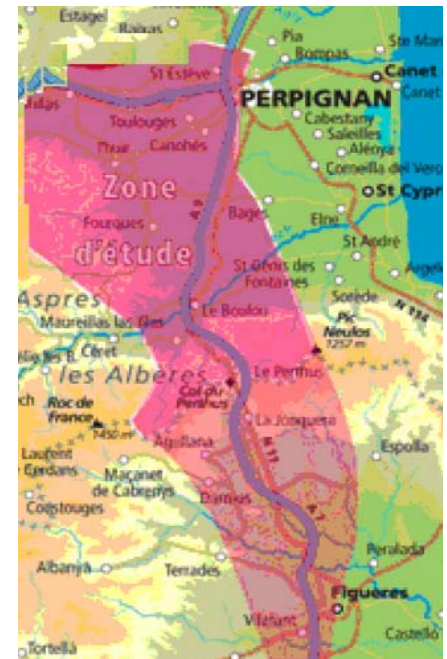


TRANSITION STATIONS



HVDC Cables

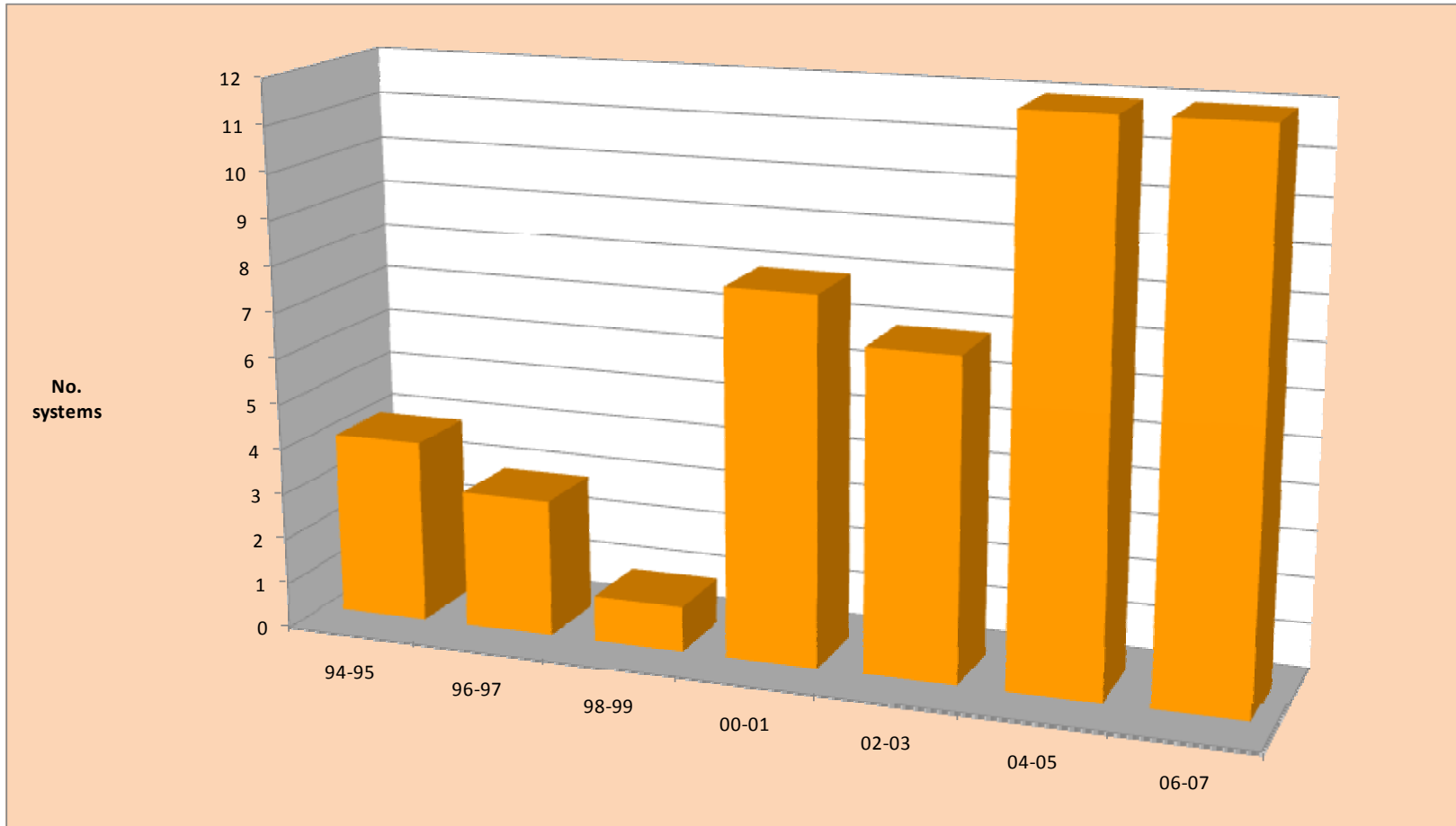
- ❑ reliable form of electricity transmission
- ❑ Increasing number of projects, e.g. TEN-E interconnections France-Spain / Sweden-Norway
- ❑ cost efficient alternative when fully undergrounding long point-to-point connections
- ❑ require converter station to integrate into AC grids
- ❑ Single core mass impregnated cables have proven capacity limit of up to 500kV and capacity of 1400A DC. This corresponds to maximum rating of 700MW for single core cables and 1400MW for bipole (two cables).



Interconnection between France and Spain



Number of EHV Cable Installations Globally





Innovative & Reliable technology

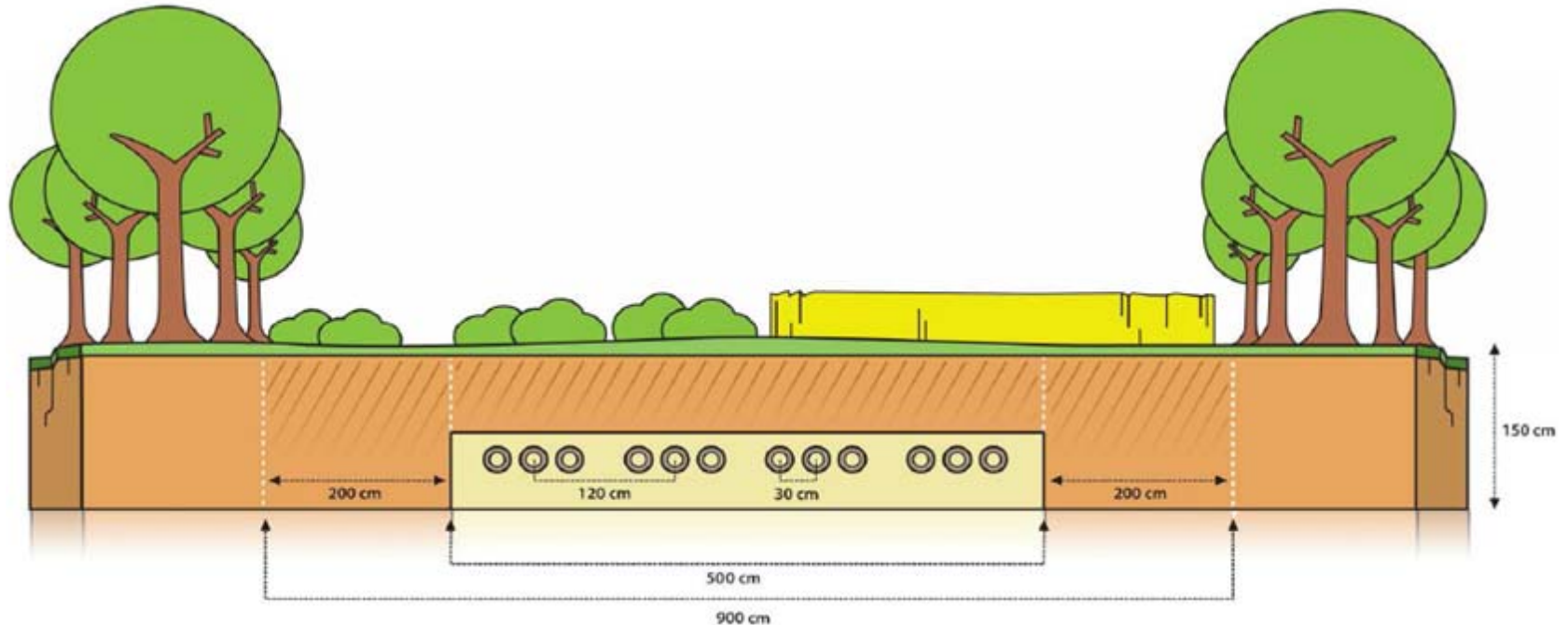
Environmental Issues

Integration of cables in the transmission system

Comparable costs

Trench width

- Dependent on the number of cables
- Number of cables depends on desired transmission capacity
- Maximum 2 cable systems for 1 overhead line system



Construction issues – urban areas

- ❑ Trench per system: ca. 1.5m deep, 1 - 2m wide
- ❑ Access for heavy machinery needs to be made available along the line
- ❑ Underground cables can easily be placed next to, under or between roads
- ❑ Subsequently the area is re-instated to original condition



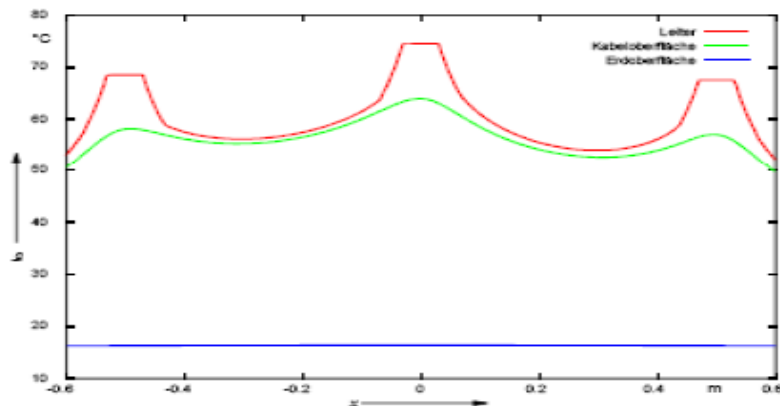
Countryside trenching

- ❑ Construction time depends mainly on ground conditions
- ❑ Trenching requires access for heavy machinery along the line
- ❑ A variety of “non-invasive“ procedures are available to pass under sensitive areas, roads or nature reserves
- ❑ Depending on the type of vegetation, landscape can be completely reinstated within 18-24 months



Possible heating of ground

- ❑ Operating temperature of cable depends on the current carried & load factor
- ❑ Heat distribution depends on the backfill material around the cable
- ❑ Impact is “strictly local and very limited“ (Ecofys 2008 report for Irish government)
- ❑ Extreme Conditions: Soil directly over the trench can heat up by approx. 2 °C
- ❑ 5 metre from the cable, no impact



Temperature increase caused by 380kV single-core XLPE cable calculated by FEM modelling temperatures in the conductor plane (—), in the plane directly above cables (—), and at the soil surface (—).

Source: University Duisburg-Essen

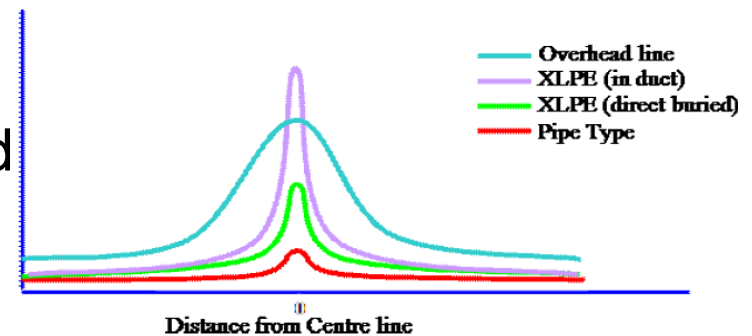
Use of land

- ❑ No restrictions for the cultivation of land
- ❑ Agricultural farming possible



Cable System

- ❑ No electric field
- ❑ Can be engineered to emit a lower magnetic field than overhead line
- ❑ No noise emitted, whereas overhead lines suffer (“korona discharge”)





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Integration is possible & potentially beneficial:

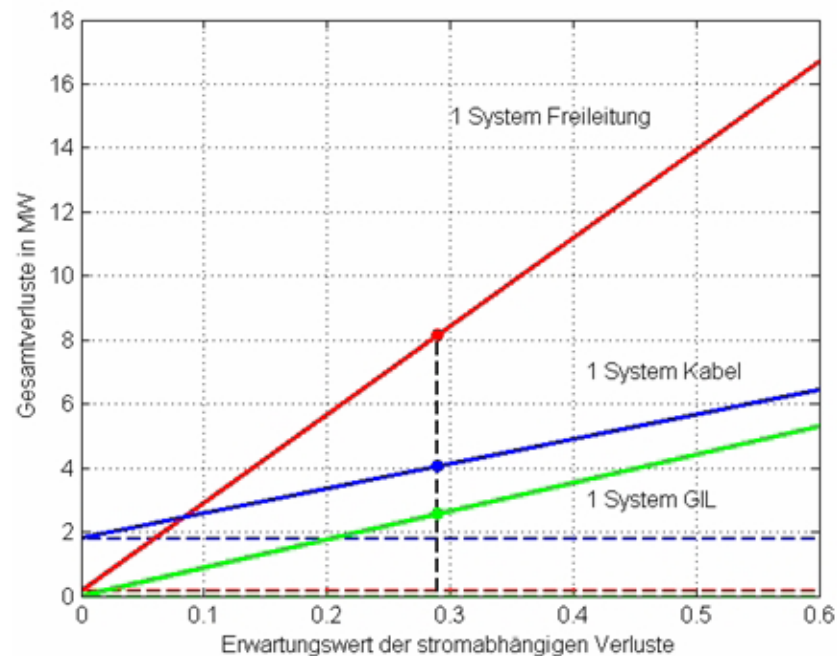
- ❑ XLPE cables can be directly intergrated into the existing grid for connections up to 20 km
- ❑ Only for connections >20km reactive compensation might be required
- ❑ Inserting AC cables into network can be beneficial to overall network performance, however insertion requires detailed planning





Transmission losses

- ❑ Losses for overhead lines and cables depend on system design & loading
- ❑ Independent studies have demonstrated that cables have lower transmission losses, due to larger conductor sizes





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Underground Cables versus Overhead Lines

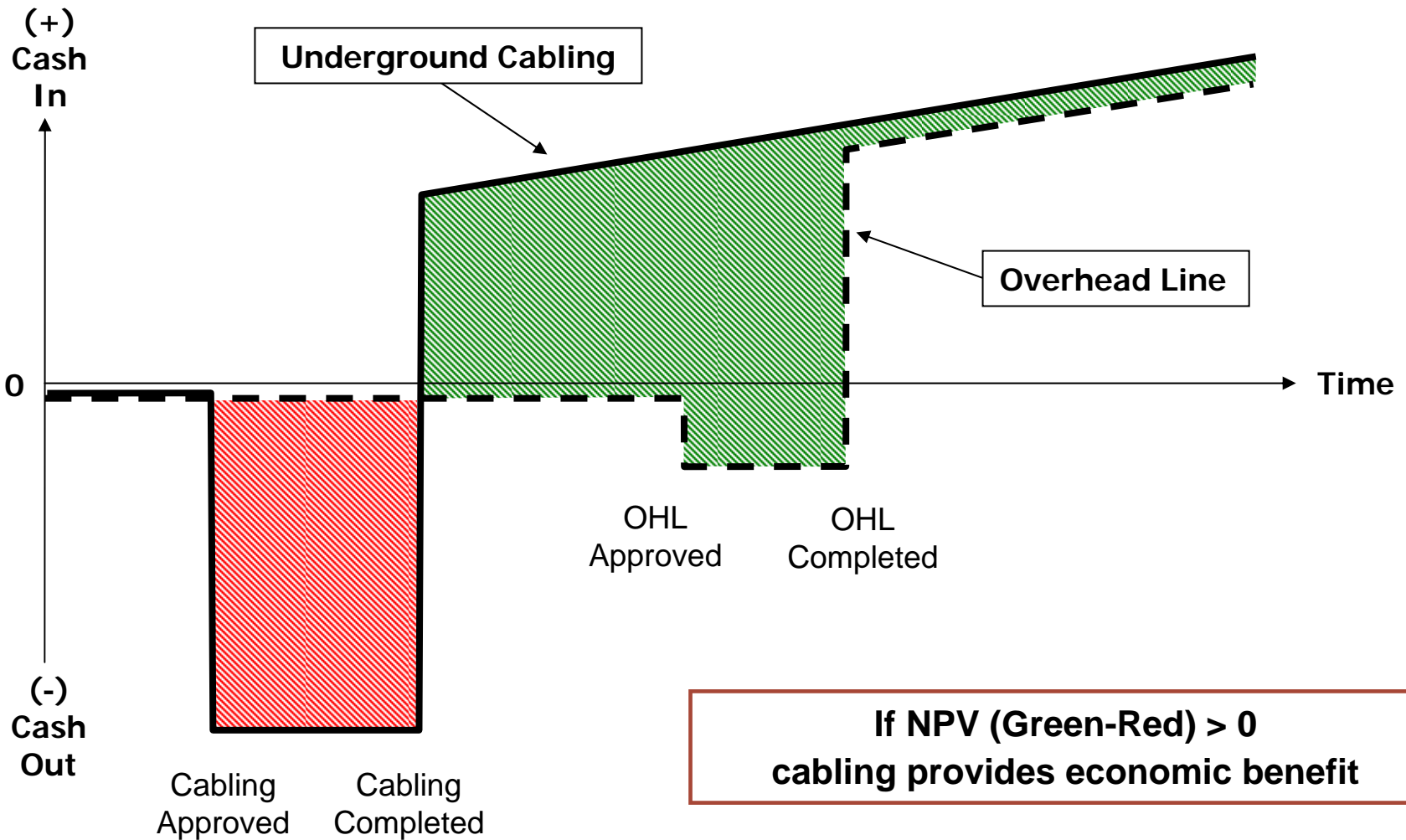
- ❑ Each project is unique: It is not possible to make generic cost estimates
- ❑ Underground cables are - at installation – more expensive than overhead lines due to higher product & installation costs
- ❑ Cost comparisons often only address costs of installation and ignore life cycle costs such as maintenance, losses, outages
- ❑ The cost of installation/civil works can represent up to 60% of total costs, which will benefit local companies

Latest life cycle analysis confirms that the cost factor compared to overhead lines can be as little as 2-5 times

Comparable costs



Timing & Potential Economic Benefits – Cash Flow Profiles



Impact of underground cabling sections of new overhead line on consumer bills in Lower Saxony Germany:

- Cabling would increase the average domestic electricity price by 0.004 cent per kilowatt hour

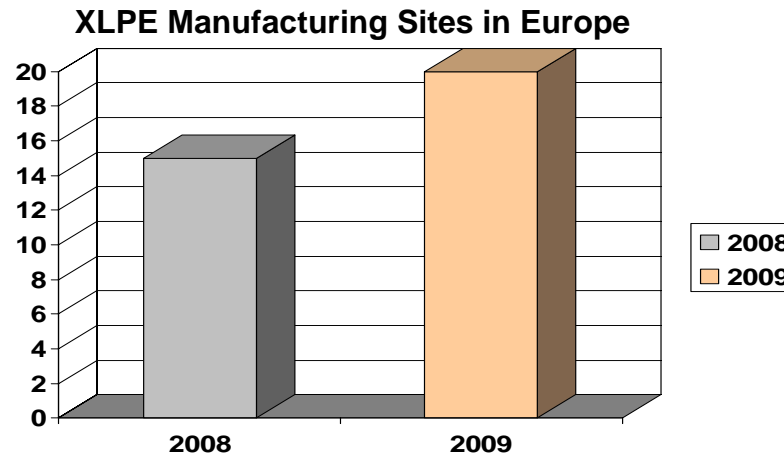


- For a four person household using 4500 KWh per year, the additional cost would be 18 Cents per year



Capacity

- ❑ Increasing demand for EHV XLPE insulated cables
- ❑ European Cable industry is expanding production capacity
- ❑ Based on annual capacity of 120 – 140 km per year per site, there's an annual production of 2,000 – 3,000 km per year
- Sufficient capacity to meets demand in Europe to 2015





Conclusion:

Europacable believes that XLPE cables

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