

Partial undergrounding complementing EHV overhead lines to accelerate grid extensions: the EnLAG opportunity!

Joint position paper of TenneT and Europacable

Introduction

Grid extensions define the success of Germany's "Energiewende". According to the German "Netzentwicklungsplan", more than 4.000 km of new Extra High Voltage (EHV) power transmission lines will have to be built and more than 4.000 km will have to be refurbished by 2022 – a distance from Berlin to Tokyo. So far, we haven't even reached Warsaw.

Quicker permitting procedures, thorough planning and higher acceptance by residents are the most important cornerstones for acceleration of grid extensions. Widening the range of technical possibilities for power transmission lines – including different tower designs and partial undergrounding – can offer an important contribution. It is for this reason that TenneT and Europacable jointly strive to enable partial undergrounding as a technical standard option.

Specifically, we endorse:

- **The appropriate deployment of partial undergrounding in sensitive areas in the context of an accelerated realization of EnLAG pilot projects;**
- **The creation of an evaluation programme for partial undergrounding accompanied by independent scientific experts;**
- **The creation of framework requirements for partial undergrounding for future projects of the German transmission grid following the completion of the evaluation programme.**

With this initiative, we would like to:

- document our common understanding of today's feasibility, reliability and legal framework for the installation of EHV lines with in partial undergrounding in Germany; and
- accelerate the learning process of TSOs and cable industry and to develop a roadmap enabling the deployment of partial undergrounding of EHV power transmission lines as a standard technical option.

1. Availability of Technology

In electricity transmission at voltages of 380kV, overhead line technology is the most widely used standard technology.

TenneT and Europacable share the view that partial undergrounding of EHV power transmission lines represents a viable solution to complement overhead lines in sensitive areas. This is also stated by the Joint Paper of ENTSO-E and Europacable in January 2011: "*Feasibility and technical aspects of partial undergrounding of extra high voltage power transmission lines*".

It is to be noted that each transmission project is unique due to its specific features. Furthermore a combination of an overhead line transmission system with partial undergrounding increases the

complexity of the transmission system. Thus a thorough case-by-case analysis of the technical specifications is a precondition for integrating partial underground sections.¹

2. Operational & system integration

The needs of the European EHV transmission system have changed dramatically: Originally designed as a fallback-system complementing regional and national distribution networks, the EHV grid has turned into a transmission grid that has to fulfill both high transportation and stability needs.

Integrating underground cables into meshed extra high voltage grids is an innovative and challenging concept. Today, underground cables and overhead lines mainly differ in aspects such as transmission capacity, overload possibility, repair time and outage rate as well as usage time.² While EHV power transmission lines have been increasingly undergrounded around the world in recent years, the use of cables in 380kV-grids remains rare. Today, around 0.3% of the German EHV grids are installed via underground cables.³ Our objective is to deploy partial undergrounding on a wider basis and to monitor their functioning. Doing so will allow us to gain additional experience so that partial undergrounding can complement overhead lines in backbone infrastructure in the future.

TenneT and Europacable agree that monitoring of partial undergrounding in a meshed transmission grid is of utmost importance. Two aspects should be highlighted to illustrate this:

- Construction and repair procedures have to be standardized to minimize repair times and maximize reliability.
- Equipment and their performance need to be carefully monitored.

In Europe, TenneT is a driver for technical innovation of EHV partial undergrounding: In the Netherlands, the construction of 20 Kilometer EHV cable sections has started in 2011. In Germany, TenneT is planning partial undergrounding sections in the pilot projects defined by the EnLAG.

3. Life-cycle cost-benefit analysis of partial undergrounding

TenneT and Europacable agree that following completion of the evaluation programme, partial undergrounding may widen the range of technical options for EHV transmission infrastructure projects. Like other technical options (e.g. tower design of overhead lines, high temperature cables), higher initial investments costs can be justified if such innovative technology options contribute to a higher public acceptance and to a faster and less confrontational approval process.

TenneT and Europacable fully support that infrastructure investments are to be approved by the regulators. We ask for a comprehensive approach to evaluate investment costs. It should take all aspects of the project into consideration - and notably possible benefits obtained due to faster project realization which may compensate for higher initial investment costs. An accelerated project realization will allow a sooner offset of grid congestion costs which may have a significant benefit in the overall economic balance.

4. Legislative framework

In Germany today, the deployment of partial undergrounding complementing overhead lines in sensitive areas is restricted to the four pilot projects outlined in the EnLAG. In order to pave the way

¹ For detailed information on the feasibility and technical aspects of partial underground of EHV transmission lines, please consult the Joint Paper on www.entsoe.eu or www.europacable.com.

² Federal Ministry of Environment, "Ökologische Auswirkungen von 380kV-Erdleitungen und HGÜ-Erdleitungen", Berlin 2012, Ergebnisbericht der Arbeitsgruppe Technik/Ökonomie, p. 9.

³ Federal Ministry of Environment, "Ökologische Auswirkungen von 380kV-Erdleitungen und HGÜ-Erdleitungen", Berlin 2012, Ergebnisbericht der Arbeitsgruppe Technik/Ökonomie, p. 6/7.

for the further future deployment of this concept for grid expansion in a responsible manner, TenneT and Europacable believe that the EnLAG projects should be fast-tracked. Doing so will enable transmission system operators and their industry partners to gain the necessary experience as envisaged by the EnLAG.

The findings of the current testing phase in Germany and the experience of TenneT's Randstad cabling project may then translate into a clear and unambiguous legislation defining the scope of partial underground cabling in the future.

5. The new approach by TenneT and Europacable

As a contribution to accelerating grid extensions, TenneT and Europacable present the following approach:

Our objective:

We want to make partial undergrounding complementing overhead lines in sensitive areas an integrated part of the future technology options available for building innovative and future-proof EHV transmission systems in backbone infrastructure. We share the same view on the possibility to realize this technology and the challenges of operational system integration of EHV cables.

Our approach:

- 1. The appropriate deployment of partial undergrounding in sensitive areas in the context of an accelerated realization of EnLAG pilot projects:** To enable a speedy realization, the use of partial undergrounding in the EnLAG projects should be limited and be based on proven experience in other power systems worldwide. We agree that in the EnLAG projects a reasonable limitation of the number of 'ups and downs' between overhead line and undergrounding of a transmission line has to be defined as well as the optimal length of the section to be undergrounded.
- 2. The creation of an evaluation program accompanied by independent scientific experts:** In the interest of a thorough evaluation TenneT and Europacable recommend the appointment of an independent third party to monitor the performance of EHV-cable sections in the grid. Among others, the evaluation should cover the following aspects: definition of standards, construction and installation, gaining operational experience, impact on system stability, acceleration of project and improving local acceptance. The test phase comprises the EnLAG projects as foreseen by the legislator as well as the Dutch underground cable project in the Randstad region.
- 3. The creation of framework requirements for partial undergrounding for future projects of the German transmission grid:** We agree that partial undergrounding may be introduced as an innovative transmission technology if the evaluation phase has been passed successfully. TenneT and Europacable will jointly develop proposals for a roadmap for the test phase as well as steps required for future legislation.

Outlook:

As concrete first steps, we encourage the creation of a joint working group under the guidance of the Universities of Hannover and Delft to develop the concept for the evaluation programme and the road map in short term.

This working group will be able to draw upon the technical support of TenneT and Europacable.

A first interim report shall be presented to the public in the coming months.



TenneT is Europe's first cross-border grid operator for electricity. With approximately 20,000 kilometres of (extra) high voltage lines and 35 million end users in the Netherlands and Germany we rank among the top five grid operators in Europe. Our focus is to develop a Northwest European energy market and to integrate renewable energy. Taking power further.



Europacable represents approximately 85% of the European wire and cable manufacturers. Founded in 1991, our member companies include global technology leaders as well SME's highly specialized in the production of energy-, telecommunication- and data-cables. With over 55.000 employees across Europe, € 20 billion of wire and cable consumption in 2009, Europacable member companies have produced some 38 million km of cables in Europe alone. Europacable is registered with the EU Institutions at 453103789-92.