Position Paper

Underground cables and overhead lines

TenneT
Taking power further

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When people think of high voltage connections of 110 kV and higher they mainly envisage overhead power lines. This does not correspond with the current practice, however. High voltage connections are increasingly being constructed below ground, partly thanks to various innovations.

TenneT owns the national grid of 110kV to 380kV in the Netherlands and over 10.000 kilometres of the 220 to 380kV grid in Germany. In all grid expansion projects TenneT tries to make full use of existing high voltage lines first. For instance, in various places in the Netherlands and Germany, lines are being expanded by installing extra wires (conductors), which provide additional transmission capacity. Another possibility is to upgrade existing connections by replacing their wires, and introducing more and more smart applications. In Germany, for example, TenneT is working with a new system which allows more electricity to be transmitted thanks to wind cooling. We are currently investigating whether this system can also be used in the Netherlands.

110 kV and 150 kV: underground installation possible

New high voltage connections of 110,000 to 150,000 volts (110 to 150 kV) are increasingly being installed below ground. These links are referred to as cable connections. Connections of up to 150 kV can easily be installed below ground. Moreover, their operation is based on proven technology and the costs of installation and operation are comparable to the costs incurred for an overhead connection.

380 kV: installation above ground, but with innovative applications

New extra high voltage connections of 220 kV and 380 kV are installed above ground, to avoid as much new landscape transsections as we can. Where possible, TenneT therefore opts to combine these lines with other infrastructure, like existing high voltage connections, railway lines and motorways.

Although it is technically possible to install these connections below ground, the operation of underground lines at these voltage levels is not yet state of the art. More failures occur and the risk of grid instability is significantly greater than with overhead lines. Experience has shown that repairing these failures takes up to 480 hours per disruption. With a view to the security of supply it would therefore be irresponsible to use such underground connections on a large scale. More experience first needs to be gained with its use worldwide.

More experience to be gained with installation below ground

To gain more experience with underground 380 kV connections, TenneT is installing 20 kilometres of a new 380 kV connection in the Randstad conurbation below ground in the Netherlands. The cables will be laid in several separate sections along the entire route. The 20 km underground section will consist of 240 km of physical high voltage cable (i.e. a bundle of twelve separate cables) – a highly innovative concept that will place TenneT at the cutting edge of international cable construction. A length of 20 kilometres is the cutting edge in the size of the Dutch transmission grid. TenneT will also introduce cable sections at four pilot line projects in Germany. Two sections were already applied.

Equal number of overhead kilometres

The Dutch government's policy as set out in the third Electricity Supply Structure Plan (Structuurschema Elektriciteitsvoorziening III) states that the total length of all above ground electricity connections in the Netherlands may not increase. This means that if a new overhead 380 kV line is installed somewhere, an existing connection (with a lower voltage level) will need to be transferred below ground at another location. In its implementation of this policy, TenneT is constantly trying to find a proper balance between spatial integration and security of supply.

TenneT is innovative in underground cable construction

Q&A

Why is it possible to install a cable to Norway or the UK below ground, but not a 380 kV line within the Netherlands?

For long distance subsea cable links TenneT makes use of direct current (DC) connections, which can be installed below ground or below the seabed. The electricity grid, however, is based on alternating current (AC). This means that large converter stations are needed to convert direct current to alternating current at all the 'access and exit points' of such a connection. Direct current is more efficient across long distances.

Do underground cables present any specific disadvantage in the event of a technical failure?

In view of the vital role of the electricity transmission grid, the time needed to repair a high voltage line must be reduced to a minimum. The social and economic damage of disruptions is enormous. Experience with cable connections has demonstrated that the duration of a failure affecting an underground cable can vary from 48 to 480 hours per disruption. The time to repair overhead connections varies between 8 and 48 hours. In other words, the time needed to repair failures is negatively affected by installation below ground.

What about the compensation principle?

As indicated above, the Dutch government has adopted a policy stipulating that there must be no increase in the total length of overhead lines with a voltage level of 110 kV or higher. New 380 kV connections can therefore only be installed above ground if a section of high voltage line of the same length (but with a lower voltage level) in a different location is transferred below ground. In this way, the total number of kilometres remains the same. Underground cables can be used where relevant, technically responsible and efficient – near built up areas, for instance. The additional costs of underground installation of 110 kV and 150 kV connections are much lower than the additional costs of underground installation of 380 kV connections.

TenneT is Europe's first cross-border grid operator for electricity. With approximately 20,000 kilometres of (extra) high voltage lines and 36 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

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September 2011

CE5007OB.UK1109