Position Paper

Gas Insulated Lines (GIL): No integration in transmission grid planned yet

Taking power further

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Gas Insulated Lines (GIL): No integration in transmission grid planned yet

GIL technology has been around for years and can in highvoltage substations as well as high-voltage connections. At the moment, TenneT only uses GIL technology at highvoltage substations. Currently, a total of around 250 km of GIL connections have been installed around the world, mainly as short-distance, above-ground applications or in tunnels, with only 1 km below ground.

GIL – what is it?

A GIL construction consists of a conductor in an earthed metal tube. The room between the tube casing and the conductor is filled with pressurised gas, which causes electrical insulation. The conductor is kept in place with insulating spacers.

International developments of GIL are monitored closely

Pros and cons

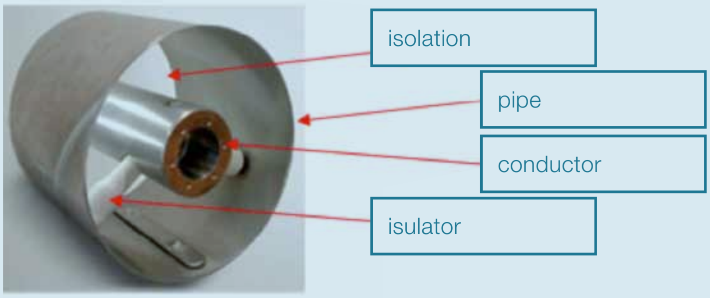
There are certain pros and cons to the use of GIL technology in the electricity grid.

Pros

- Lower grid losses. Compared to other technologies, less electricity is lost during transmission. In GIL connections, transmission losses are generally about a third compared to overhead lines and more or less equal compared to regular underground cables.
- Limited electromagnetic field. In the tube and in the conductor, there are two opposing electrical currents. Either current generates a magnetic field, but these more or less rule each other out as they are opposed. This reduces the external electromagnetic field with a factor of 15 to 20.
- Reduction of compensation equipment. With GIL technology, no compensation equipment to control voltage levels is needed for the circuit lengths customary in the Netherlands.

Cons

- Security of supply over longer distances cannot be guaranteed. There is very little experience worldwide with underground GIL technology over longer distances. As a result, the technology is not proven for application in existing high-voltage grids. There is no experience with power failures and recovery times for underground GIL connections for instance. Currently, a total length of around 250 km has been installed around the world, mainly as short-distance, above-ground applications at high-voltage substations. As of 2010, only around 1 km of circuit length has been constructed as a pilot underground connection. Generally, recovery times are known to exceed those of overhead high-voltage lines.
- Less suitable for routes with curves and drillings. A GIL construction is fairly inflexible. Curves can only be constructed using specific bended elements. If drillings are present, diagonal connections have to be used. Connections will have to be welded together from a pit in order to circumvent any objects. While working from the pit, the GIL connection itself should be kept clean. In case of (construction) faults, accessibility is a problem.
- Use of SF6 gas. GIL applications use SF6 gas (sulphur hexafluoride) for insulation. SF6 is relatively expensive and contributes to the greenhouse effect if it escapes. A new generation of GIL technology is now available, in which SF6 is mixed with nitrogen (which is abundantly present in the atmosphere) under high pressures. Each “pressure vessel” should contain a sensor to monitor any leakage. Depending on the manufacturer, pressure vessels may be between 150 and 1,000 m long.
- Longer recovery times. Generally, underground cable connections have longer recovery times than overhead high-voltage lines. As cables are not easily accessible, they take longer to repair in case of failures.



Developments in the use of GIL technology

At the moment, TenneT only uses GIL technology above ground over short distances at high-voltage substations. Outside of its own premises, TenneT has not used GIL technology in its 380 kV grid. Neither has enough relevant experience been gained elsewhere with GIL technology in high-voltage connections over longer distances. Experience is especially lacking with regard to longer routes with open excavations and earthworks and subsequent maintenance and inspection of such connections.

It should be noted that current inspection methods used for gas pipes do not apply to GIL connections. As opposed to GIL pipes, gas pipes are completely hollow, which allows for internal inspection (using mobile cameras). In GIL pipes, such inspection is impossible due to the presence of the conductor, pressure bulkheads, and spacers. The only experiences gained with longer GIL connections are from industrial estates where GIL technology is applied above ground, which allows for external inspection.

This shows that the application of GIL technology over longer distances in open excavations has not proven itself, and that pilot projects are needed first to gain such experience. Experience should be gained especially with recovery times in open excavations which – as with underground 380 kV cables – are expected to be lengthy. Without such experience, GIL technology cannot be used in TenneT's transmission grid, where security of supply is a primary precondition, as demonstrated by current projects such as Randstad 380 kV, South-West 380 kV, North-West 380 kV, and Doetinchem – Wesel.

International developments are monitored closely in order to gain more knowledge of experiences with GIL technology. In Germany, German TSO Amprion is currently constructing a pilot connection of around 1 km length without curves or drillings. Experience gained in this project over the coming years will be shared with TenneT for future grid development.

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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