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Overhead Lines or Underground Cables? It Depends on the Details

The question of whether power lines are better laid above or below ground depends on numerous factors. These must be weighed against one another for each project, according to a joint position paper by VDE ETG, CIGRE Germany (DK-CIGRE), and DK-CIRED.

(Frankfurt am Main, November 18, 2026) Overhead lines are not universally superior or inferior to underground cables. This is the conclusion reached by experts from academia and industry in a recent assessment of the technical, economic, regulatory, and environmental requirements of grid expansion. In a joint position paper by the Power Engineering Society within VDE (VDE ETG), CIGRE Germany (DK-CIGRE), and the German Committee (DK) of CIRED, the three professional organizations oppose blanket stipulations and advocate for technology-neutral decisions on a case-by-case basis. Which solution is preferable depends on the specific technical, economic, regulatory, and environmental conditions of each project.

“The question ‘Overhead lines or underground cables?’ cannot be answered in general terms. The decisive factors are the specific conditions of the project, the voltage level, and the requirements for economic efficiency, security of supply, and environmental compatibility,” explains Dr.-Ing. Uwe Kaltenborn, DK-CIRED Chair and Director of Business Development at HIGHVOLT Prüftechnik Dresden GmbH.

A Holistic Approach Rather Than Isolated Individual Criteria

Neither a comparison of investment costs nor the exclusive consideration of individual criteria such as public acceptance, environmental impacts, or resilience leads to sound decisions. Instead, investment and operating costs, availability and reliability, resilience to extreme weather, natural events, and other disruptions, as well as project-specific site factors, must be evaluated collectively. In addition to the voltage level, these include, among other things, the

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choice between alternating current (AC) and direct current (DC) technology, local right-of-way conditions, and the target commissioning date.

The two technologies each have different advantages and disadvantages:

- In many cases, **overhead lines** are characterized by lower investment costs, decades of operational experience, and comparatively easy access for maintenance and repair work. Damage can often be quickly located and repaired.

- **Underground cables**, on the other hand, offer advantages because they are better protected against direct weather conditions and have virtually no lasting impact on the landscape. In certain projects, they can also increase public acceptance and reduce planning risks. However, these advantages are offset by higher material and civil engineering costs, more disruptive construction work, and more time-consuming fault location and repair.

In partially cabled or mixed systems, the additional transition facilities and technical interfaces must be taken into account, as they significantly increase the complexity of the overall system.

“The most economical solution is not automatically the one with the lowest construction costs. What matters most are the costs over the entire life cycle of the system,” says Uwe Kaltenborn. These are influenced, among other things, by losses, maintenance costs, service life, project progress, and potential delays. Added to this are non-monetary costs, such as those resulting from a lack of acceptance, environmental impacts, or the influence of large infrastructure projects on the local civil society.

Regulatory Framework Plays an Important Role

In addition to individual technical and economic considerations, regulatory factors also play a major role. While most extra-high-voltage projects can be planned with an open approach to technology, the Energy Industry Act (EnWG) stipulates for high-voltage systems (110 kV) that new transmission lines must be constructed as underground cables if their costs do not exceed 2.75 times those of a comparable overhead line. “Regulatory requirements also significantly influence the choice of technology. That is why technical feasibility, economic viability, and the legal framework must be considered together,” says Uwe Kaltenborn.

Overhead lines account for by far the largest share of the transmission network in Germany. There are more than 100,000 kilometers of overhead lines compared to just over 15,000 kilometers of underground cables. Of these, approximately 12,000 kilometers are high-voltage lines.

Both overhead lines and cable systems are undergoing continuous technological development. Innovations such as high-temperature conductor cables, extruded 525-kV cables, and digital monitoring solutions often originate in Germany and are used internationally.

The position paper is the first joint paper by VDE ETG, CIGRE Germany (DK-CIGRE), and DK-CIRED. The latter two are the national committees of the International Conference on Electrical Distribution Networks (CIRED) and the International Knowledge Platform for Electrical Power Systems (CIGRE), respectively, and will be organizationally integrated into VDE ETG beginning in early 2027. “This joint position paper demonstrates that the three expert organizations are already working in unison,” says Dr.-Ing. Britta Buchholz, Chair of VDE ETG. The VP of Active Distribution Grids at Hitachi Energy is also a CIGRE Fellow and a member of DK-CIGRE. “With this position paper, we are creating a solid foundation for an objective discussion on the use of overhead lines and underground cables,” explains Dr.-Ing. Ralf Petri, Managing Director of VDE ETG and DK-CIGRE. Pascal Daleiden, CEO of Hitachi Energy Germany AG and Chair of DK-CIGRE, adds: “The question of ‘overhead lines or underground cables’ has many facets. This makes it all the more valuable that we are bringing together input from experts in various fields.”

About the Power Engineering Society within VDE (VDE ETG):
The Power Engineering Society within VDE (VDE ETG) promotes the development of energy systems in Germany. It combines expertise in the generation, storage, transmission and distribution of electrical energy and the relevant interdisciplinary technologies, as well as the many different ways in which this energy is used. Integrated into the VDE interdisciplinary network, ETG is a widely recognized and respected technical and scientific association. The volunteer experts create a common platform for knowledge exchange in science and industry, contribute to accelerating the energy transition and to promoting an understanding of sustainable energy technology in society, and identify areas of action for policymakers. ETG connects people, different generations, start-ups and established institutions, science, business and society with performance and energy.

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