

Underground transmission lines

Environmental, cost, construction and operational issues limit use of underground lines

Many people ask if transmission lines can be placed underground rather than overhead. Currently, there are no underground 500-kilovolt lines of significant length in North America. While many lower voltage, local electric distribution lines are placed underground, particularly in newer neighborhoods, almost all high-voltage electric transmission lines are overhead for four general reasons:

- environmental impact,
- cost considerations,
- construction measures and
- operational issues.

Because of these issues, underground transmission lines typically are justified only where there is no viable overhead corridor, such as in densely populated urban areas or in the vicinity of airports.

Underground lines can have greater environmental impact

While lower voltage distribution lines that connect to homes and businesses can be buried directly in the ground with less invasive construction, underground transmission lines require substantial underground infrastructure and design considerations. DATC acknowledges that there are different environmental impacts of underground and overhead lines based on the environmental setting and construction techniques and works to propose projects that minimize environmental impacts.

Cost considerations are significant

Installation costs for underground transmission lines can range from 10 to 25 times the cost of an equivalent 500-kV overhead line. A major part of this cost is associated with the massive amount of excavation required for underground trenches. Factors influencing the cost include, but are not limited to, the following:

- **Routing** – Right-of-way, easement and permitting costs and whether the line will be placed in the road right-of-way
- **Terrain and obstacles** – Other underground utilities, streams and railroad crossings, embankments, bridges, major roads, traffic and soil conditions
- **Permitting** – Traffic and lane restrictions, noise, time of day and other construction restrictions
- **Design** – Mitigating soil thermal characteristics

Specific construction measures are required

Building an underground transmission line requires many special considerations. Underground cables have to be spliced many times along a transmission line route since there are limitations on how long sections can be manufactured and weight limitations on shipping. A 500-kV underground cable is typically 5.5 to 6 inches in diameter and will weigh more than 25 pounds per foot.



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Cables are typically installed in conduits, and rough terrain would limit the amount of cable that can be pulled at one time. Conduits are grouped in duct banks and encased in concrete. The duct bank would then be buried under about 4 feet of thermal fill to dissipate the heat to the surrounding ground. Cables are spliced in vaults to allow access for any needed testing and repairs. These vaults would be located in every 800 to 2,300 feet, depending on terrain.

Each high-voltage direct current cable would be spliced in a separate vault to limit heat generation and risk of a splice failure affecting the other cable. The vaults would be around 10 feet wide by 10 feet high by 35 feet long.

Additionally, when a high-voltage transmission line transitions from overhead to underground, a transition station is required. These would appear similar to a substation with a large steel structure to hold high-tension conductors, a control house for line monitoring, protection equipment, terminations to connect the overhead conductors to the underground cable and security fencing around the perimeter. A typical transition station would cover about an acre.

Operational issues, outage times significantly different

All electric lines produce heat and therefore have a limit on the amount of power that they can carry. Underground lines cannot dissipate heat as well as overhead lines. Factors such as electrical insulation, the type of surrounding soil, adjacent underground utilities and the depth of installation all affect the wire's ability to dissipate heat.

New underground lines can have higher thermal ratings than outdated overhead lines they are replacing; however, there is far less flexibility to make improvements as needed on underground lines. When lines are above ground, replacing wires or making other improvements can often be done without significant disruption. In contrast, repairing an underground line requires excavation, which significantly disrupts the surface landscape.

Failures on underground transmission lines are infrequent. However, when they occur, they are extremely costly and time-intensive to repair. Line outages can last up to a month or more as a result of the difficulty in determining the exact location that needs repair and the logistics of long lead times for replacement materials. In contrast, required repairs to overhead lines can usually be completed within 24 hours.

2013APRIL2

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