OVERHEAD VS. UNDERGROUND

INFORMATION ABOUT BURYING HIGH-VOLTAGE TRANSMISSION LINES

INFORMATION SHEET
MINNESOTA

High-voltage transmission lines are a reliable, affordable, easily maintained and established way to deliver bulk electricity from generation sources to customers, often over long distances. As of 2021, there were approximately 385,000 miles of high-voltage transmission lines (above 100 kilovolts) in the United States. Just 0.5% of those were located underground.

In the Upper Midwest, Xcel Energy operates more than 5,300 miles of high-voltage transmission; only 15 miles of that infrastructure is located below ground, all of which is either 115 kV or 161 kV.

Burying transmission lines may be appropriate in densely populated urban settings, near airports, or when sufficient right-of-way is not available for an overhead line.

When considering overhead vs. underground 345-kV transmission lines, such as the MN Energy Connection project, we review the following factors.

Costs

An underground 345 kV line costs at least 10 to 15 times the cost of an overhead line due to time, materials, processes, the need to include transition substations, and the use of specialized labor. An overhead double-circuit 345 kV line is estimated to cost about $3 million per mile. Part of the added costs to bury lines may include routing and boring to avoid other underground utilities, such as water, natural gas and sewer lines.

Construction impacts

Buried transmission lines have more environmental impacts than those built overhead. A proposed single-pole 345 kV overhead line requires erecting tall structures that are spaced about 1,000 feet apart. Landowners can generally use the property as they had in the past, such as for agriculture, with minimal issues.

Underground lines generally require a continuous trench at least ten feet wide and eight feet deep. Considerable clearing and grading is necessary, and construction can last many weeks longer than with overhead construction. Large concrete garage-like splice vaults or access structures are needed every 2,000 feet.

Line-length challenges

High-voltage underground lines may require additional equipment to ensure proper electrical performance along the distance of the transmission line. The additional equipment translates to a higher overall cost, limits the length of the underground line, and increases the likelihood of reliability issues because of those additional components.

Power restoration

Damage to underground transmission lines is difficult to pinpoint, and repairs may take a few weeks to several months to complete. Damage to overhead lines is easy to locate and can generally be repaired in hours or days. Xcel Energy line crews have outstanding performance and safety records at repairing and maintaining the extensive overhead infrastructure that serves our customers.

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Capacity requirements

For underground transmission, a large number of cables are often required to match the capacity of the overhead circuit. Additional components increase the underground cost as a 'duct bank,' vaults, splices and wire terminations are required, which can also reduce overall system reliability.

Multiple cables and cooling options

As electricity flows through the transmission lines, heat is generated. In overhead construction, those lines are cooled by the air as heat naturally dissipates, and lines are widely spaced for safety. Underground cables are installed in concrete-encased PVC duct banks. Heat generated by the cables is dissipated through the earth to the surface. Additionally, underground lines may need artificial cooling, adding significant costs to building lines underground.

Easement requirement

While an overhead line typically requires a wider easement, underground line easements have more restrictions. Underground lines must be kept completely clear of buildings, soil additions, trees and vegetation so that underground cooling is not affected. Additionally, the easement must be kept clear in case the duct bank needs to be excavated to make repairs.

Life expectancy

Underground high-voltage transmission lines generally need to be replaced every 50 years, while overhead lines have a life expectancy of more than 80 years.

Transition substations

High-voltage underground transmission lines may require small substations—called transition substations—wherever the underground cable connects to overhead transmission. Transition substations require grading, access roads, storm water management facilities, fencing and lighting.

Site restoration

Site restoration for underground construction is a much larger endeavor than for overhead construction because soil is disturbed along the entire route. Top soil must be restored and returned to vegetated areas, and all hard surface areas must be re-established to meet local codes.

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