Power for the Plains

Underground Transmission Lines

High-voltage transmission lines are a reliable, low cost, easily maintained and established method to transport bulk electricity across long distances. In 2006, there were approximately 160,000 miles of 230 kilovolt (kV) or greater high-voltage transmission lines in the United States. The percentage of existing underground transmission is estimated at between 0.5 and 0.6 percent of this total. Line crews have a top-notch performance and safety record at repairing and maintaining this extensive overhead system.

Construction of high-voltage transmission lines underground can be appropriate in densely populated urban and suburban settings, or in some instances where sufficient right-of-way is not available for an overhead line.

Garage-sized concrete access structures must be placed underground every 1,500 to 2,500 feet for maintenance and repair of an underground line.

Cost

Building transmission lines underground significantly adds to the overall project cost. A single circuit 345 kV underground transmission line is expected to be 10 to 15 times the cost of an overhead line due to time, materials, process and the use of specialized labor. Southwestern Public Service Company (SPS), a subsidiary of Xcel Energy, estimates the cost of one mile of 345 kV single circuit overhead transmission line at $700,000.

An underground line must also be routed to avoid other underground installations, such as water, gas and sewer lines. Unstable slopes, hazardous material sites, wetlands and bedrock must be avoided. Going under a road, highway or river requires expensive construction techniques such as directional boring. All these aspects of underground transmission construction lead to a much higher cost than overhead line construction.

At either end of an underground section of the line, large one-acre transition structures (mini-substations) need to be constructed.

Right-of-way and structures

345 kV transmission lines generally require a 150-foot easement that can continue to be used for most existing activities, such as farming. Underground transmission structures require a completely clear right-of-way (ROW) of approximately 60 feet (no farming activity within the 60-foot ROW).

Technical issues

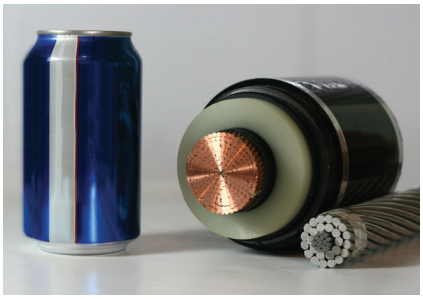
Cable. The most commonly used underground cable systems are solid dielectric and high-pressure fluid-filled. Solid dielectric cable is buried in wide trenches about six feet deep and installed in concrete-encased duct banks. For a fluid-filled system, once the cable has been installed in a steel pipe, the pipe is filled with a synthetic oil or gas and pressurized. This type of system is also trenched and covered with specialized backfill, sand or other type of soil.

Heat. Transmission lines generate heat when conducting electricity. Overhead lines are naturally cooled by air. Special effort must be taken to cool underground lines. If oil is used in a fluid-filled cable system, the oil helps cool the cable. All underground transmission lines should be covered by an engineered thermal backfill to help dissipate heat.

Repair and maintenance. Underground transmission lines can take much longer to repair than overhead lines. Estimates show that locating and repairing faults can take between two and six weeks. Overhead lines can generally be repaired in a matter of hours or days after a fault occurs.

Electric and magnetic fields

Like overhead transmission lines, underground transmission lines also emit electric and magnetic fields. At three feet above ground, the magnetic field within an underground transmission line's 60-foot ROW is comparable to the magnetic field 75 feet from an overhead transmission line.



A solid dielectric underground cable is significantly larger than a standard conductor that hangs from an overhead structure.

Transmission lines are installed in concrete-encased duct banks.