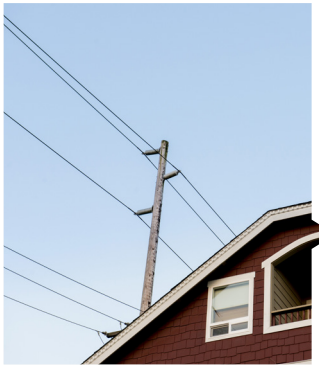

PUGET SOUND ENERGY

PSE's electric power system

Comparison of overhead and underground transmission lines

Puget Sound Energy has more than 2,100 miles of high-voltage transmission lines throughout PSE's 6,000 square mile service area. These lines safely transport electricity generated by hydropower, natural gas, coal, wind and solar sources to transmission and distribution substations in local communities. Nearly all of PSE's high-voltage transmission lines are either 115 or 230 kilovolts (kV) and are typically supported on wood or steel poles.

Often we're asked whether we can underground transmission lines. PSE can build transmission lines underground. However, doing so requires cost sharing between PSE and the local community that requests it. That's because undergrounding is typically considered a local benefit, and it costs significantly more to build a power line underground. As a result, it is up to the local community to decide whether to invest in an underground line. In addition, there are several hurdles that must be overcome when it comes to undergrounding transmission lines.

230kV transmission lines

Underground and cost sharing

State regulations require PSE to first consider building overhead transmission lines because of their combination of reliability and affordability, both of which are important to our customers.

Underground transmission lines are considered a "local option" under applicable regulations, meaning the local community must pay the cost difference between building overhead and underground lines (rather than having the cost shared by PSE's 1.1 million customers). The requesting community would share the cost of the project from the preliminary feasibility and design to construction and maintenance.

Following is a comparison of overhead and underground transmission line costs.

Costs	
Overhead cost estimates*	**Underground cost estimates^**
• 115 kV: $600K to $2.9M per mile to construct • 230 kV: $3M to $4M per mile to construct	• 115 kV: $9M to $15M per mile to construct • 230 kV: $20M to $28M per mile to construct
Other overhead cost considerations	**Other underground cost considerations**
• Ongoing maintenance costs for vegetation • Costs less to maintain, repair, upgrade and relocate • Damages from car-pole accidents, trees and equipment failure occur more frequently, but cost less to repair • Costs are covered by all customers; no additional area costs to local customers is necessary	• Initial costs for vegetation removal and nominal ongoing maintenance costs • Costs more to maintain, repair, upgrade or relocate • Damages from tree roots and equipment failure occur less frequently, but cost more to repair • Local customers must pay the cost difference of undergrounding via area rates, including ongoing maintenance and repair

*These cost estimates include design, engineering, materials and construction. Additional costs, such as relocation of existing utilities, permitting and property rights are not included. Rebuilding existing overhead lines results in costs at the lower end of this range, while building new overhead lines results in costs at the higher end of this range.

^These cost estimates include design, engineering, materials and construction, and the ranges provided are for new underground transmission lines. Additional costs, such as relocation of existing underground utilities, permitting and property rights are not included, and all undergrounding costs can vary greatly depending on project-specific factors.

Other undergrounding challenges

While most communities decide not to invest in undergrounding based on the significant costs and competing investment priorities, there are other challenges to undergrounding transmission lines:

- **Environmental and neighborhood impacts:** Putting power lines underground can have significant environmental and neighborhood impacts. Undergrounding requires extensive vegetation removal, trenching and installation of large (typically 20 feet by 30 feet for 230 kV lines and 10 feet by 20 for 115 kV lines) access vaults every quarter to half mile, which can be very disruptive to neighborhoods and the environment. While some vegetation can remain under or beside an overhead line, vegetation must be completely removed along an underground transmission line route to ensure trees' root systems do not grow into the line.
- **Length of time for outage restoration:** Underground lines typically take longer to repair, and repairs are more difficult. When an overhead line fails, our crews can often repair it within hours. Repair of underground transmission lines can take days and even weeks, depending on the repairs that need to be made.
- **Maintenance challenges:** Overhead transmission line maintenance typically includes visual inspections, pole treatment and vegetation management. Underground transmission lines are more difficult to maintain due to their unique design and operating conditions. Underground cables are sensitive to changes in soil cover and aboveground changes, and patrolling is necessary to assess changes in soil depth, cover type, vegetation changes, or other issues that could impact the ability of the line to dissipate heat effectively.
- **Aesthetics:** While the majority of an underground transmission line is not visible above ground, vaults are typically installed every quarter to half mile and above-ground steel termination structures are installed at each end of the underground cable route.

Example of a steel underground termination structure. Photo courtesy of POWER Engineers, Inc.