

Transmission Line Routing information session

Underground Transmission Line Summary

August 16, 2021

Overview

Puget Sound Energy (PSE) hosted an online underground transmission line information session on August 16, 2021. The meeting's purpose was to provide information on the benefits, challenges, and processes involved with underground transmission lines.

The meeting was held online via Zoom due to PSE and public health requirements restricting in-person gatherings at this time. Attachment 1 contains the list of meeting participants.

Opening remarks

Karen Brubeck (PSE) welcomed the audience, shared a safety moment, provided an overview of PSE's solutions package to improve electric service on Bainbridge Island, and gave a recap of PSE's progress on the Missing Link Transmission Line Project leading up to the information session on underground transmission lines.

Undergrounding transmission lines

Lowell Rogers (Oak Strategic, Inc.) presented an overview on underground transmission lines. The presentation gave a synopsis of comparing overhead transmission lines and underground transmission lines, including materials, cost, structures, needed right-of-way for installation and maintenance, and limitations (i.e., environmental impacts, routing criteria, etc.). While underground lines can provide higher reliability (fewer service outages) compared to overhead transmission lines, utility companies and jurisdictions need to carefully consider opportunities and constraints of underground transmission before determining if undergrounding transmission lines is feasible. The presentation discussed some of these considerations.

Cost-sharing of underground transmission lines

Andy Swayne (PSE) provided a short presentation on the cost-sharing component of underground transmission lines. As a utility agency that funds projects through customer dollars, PSE is proposing an overhead design for the Missing Link Transmission Line Project because of the combination of reliability and affordability. If a city is interested in pursuing an underground transmission line, the city and PSE will have a conversation on the potential impacts, routing, costs, and challenges associated with an underground installation. Assuming that the city is still interested in considering an underground transmission line, PSE will conduct a preliminary feasibility study at the expense of the city. If the city remains interested in pursuing an underground transmission line after the results of the preliminary feasibility study, PSE and the city will make a formal agreement on the engineering, design, routing, construction and other agreements for an underground transmission line with funding from the city for costs above those estimated for an overhead transmission line solution.

When a new transmission line is constructed overhead, project costs are distributed evenly between all of PSE's 1.1 million customers. If a city asked PSE to install a new transmission line underground, it would be considered a "local option" as it would not be equitable for all of PSE's customer base to pay for a piece of infrastructure that only benefits a small area or group this way. As a local option, the local community would pay the cost difference between overhead and underground transmission lines. So far,

no city within PSE's service territory has approached PSE with the request for underground transmission lines.

If the City of Bainbridge Island (COBI) is interested in underground transmission lines, PSE is happy to start the process to explore the option. As the Missing Link Project nears a preliminary preferred route, a decision to pursue the option for underground transmission lines would be prudent to make as soon as possible so it does not cause any project delays.

Question and Answer

After the presentation, Lowell answered questions from the audience on underground transmission lines. Andy answered general questions that were related to the Missing Link Transmission Line Project. Responses and key discussion points are noted below. Attachment 2 contains the questions that were not asked due to time constraints during the information session and their respective responses.

We live on Crystal Springs and are slated to have our power undergrounded. Will telephone and Comcast lines be buried as well? If not, why not?

- Andy shared that as part of PSE's Crystal Springs/ Point White Reliability project, a section of overhead distribution lines will be relocated underground. While the planning and design of the project was underway, PSE invited telephone and cable companies to underground their existing line with PSE's planned underground distribution facilities. So far, no telephone or cable companies have expressed interest in undergrounding their lines. If the community wants their telephone and cable lines put underground, reach out to City Council telling them you want underground telephone and cable lines.

What is the relative service life of the two types of conductors within underground transmission lines?

- Lowell shared the service life for underground transmission line cables ranges between 25 – 50 years. The cables within underground transmission lines experience two types of use that affect their service life, to serve a continual 'normal' load of power usage and an emergency load for short durations. The increased load typically occurs for three to five hours just a few times a year when there is a need for additional power to serve customers.

PSE's 2021 Wildlife Mitigation Response Plan states at page 16, quote: "Underground lines are not likely to trigger a wildfire event, unless there is an equipment failure in an access enclosure or above ground transformer." The Plan continues on the same page, quote: "Undergrounding lines can greatly reduce the chance of an outage caused by external sources such as trees or animals." Does Mr. Rogers agree with these statements?

- Lowell agreed with the statements and continued to elaborate that the places where underground transmission lines can be accessed is where there is the potential for a fire to be started. There are typically four ways overhead lines can cause fire:
 - 1) Trees, shrubs, and other vegetation grow upward, touch the line, and can catch fire.
 - 2) A tree or limb falls on the line and can catch fire.
 - 3) A high wind event or storm blows debris into the line which can catch fire.
 - 4) Equipment failure.

Points 1 and 2 are preventable with good vegetation management practices. Point 3 is challenging to prevent because the utility does not control the space outside of its easement area, which is why some utilities have elected to shut off overhead lines during high wind / fire risk events. Equipment failure can be prevented through good maintenance practices.

PSE elaborated that on Bainbridge Island, new overhead transmission lines don't present a new risk of a fire comparable to the other existing overhead lines on the island. Andy briefly touched on PSE's Wildfire Mitigation Response Plan. PSE has identified areas that have an increased potential for wildfires and are working with communities to decrease the possibility of wildfires. Bainbridge Island was not identified as an area at risk of wildfires. PSE's wildfire mitigation plan is an on-going effort to monitor at-risk areas for wildfires and plan for ways to mitigate or decrease the possibility of wildfires.

What is the difference between setback in feet from right-of-way in overhead transmission lines versus underground transmission lines? Can underground transmission lines be sited, for example, in the middle of an arterial?

- Lowell stated the right-of-way setback for overhead transmission lines and underground transmission lines is dependent on location. If the transmission line is a cross-country line, the utility provider will have a dedicated use for the line corridor and will get easements for that use. If the transmission line is in an area where there are other service providers like water or sewage, the setback will be coordinated with the service providers that are using that corridor.

For a single underground transmission line circuit, a separation from other utilities is in the magnitude of five feet, depending on a utilities' standard practices. This separation is mostly to facilitate maintenance or repair. This separation distance will need to increase if the other utility creates heat, which in turn can increase the right-of-way setback. On an arterial street, the setback is dependent on the transmission line location and adjacent properties.

For an overhead transmission line, the easement and setback are based on a few factors. Not only is there an easement on the ground, but there is also an aerial easement because overhead transmission conductors sway somewhat under wind conditions. For a 115 kV overhead transmission line, an easement is typically 50 to 100 feet wide for a line not located along a road right-of-way.*

**Clarifying note – Much of PSE's transmission lines on the island are located along public road rights-of-way under a franchise agreement with the City of Bainbridge Island. Some parts of transmission lines are located in cross-county corridor easements across private properties. Cross-country corridor easements are typically about 50 to 100 feet wide to provide needed operating and maintenance space including necessary vegetation management.*

How does a city typically pay for underground transmission lines?

- Andy responded that a city could pay for underground transmission lines through local bonds or by taxing the community that would benefit from the infrastructure. The local jurisdiction has the final say in how they want to fund design and construction of an underground transmission line. To date, no city has worked with PSE on underground transmission lines, so the funding options listed are speculation and for example purposes only.

Are there options to underground parts of the line only? For example, by the fire station or by the school?

- Lowell shared that it is possible for parts of an overhead transmission line to be put underground. Transition structures are used to move a transmission line from above ground to underground. One noteworthy point about the transition structure is that if you have multiple transitions along one transmission line, the effectiveness of the transmission line and ability to determine where an outage is begins to decrease.

How expensive are transition poles? Are their costs bundled with the overall underground cost of 2.5X to 7X vis-a-vis overhead?

- Lowell shared the cost range of a transition pole for an underground transmission line is \$50,000 to \$100,000 dollars. The cost estimate of a transition pole is dependent on factors like, how much weight the pole needs to support, the types of soils the pole will be placed on, etc. The cost of transition poles is included in the 2.5 times to 7 times higher cost of underground transmission lines versus overhead transmission lines.

Please go over the length of time that a typical restoration of an underground line might take. During the City Council Study session, a PSE representative said perhaps two to five weeks!

- Lowell described the repair time of an underground transmission line could take anywhere between two to five weeks which includes the preparation for the repair and actual repair time. There are various factors: the time to locate and assess the damaged area, procuring and transporting required materials and equipment to the site, accessing the area, and scheduling specialized staff for the repair. Once the preparations are complete, the specialized crew can begin working to repair the damaged line. The actual repair time is dependent on the extent of the damage to the underground transmission line.

Could you talk about the Missing Link Project's transmission line as it relates to the helipad?

- Andy shared that the Bainbridge Island Fire Department brought the location of the helipad to PSE's attention during a Community Sounding Board Meeting. PSE reached out to the Federal Aviation Administration (FAA) for guidance on helipad safety as it relates to transmission line poles. The FAA and its operators saw no issue with any of the three potential transmission line route options that pass by the helipad.

If a route option that travels near the helipad is selected, the tops of the transmission poles could have warning systems in place like red beacons on the tops of the poles to notify helicopters of the location of the poles. PSE could also consider moving the overhead distribution lines underground so the height of the transmission line could be lower.

Closing remarks and next steps

Karen thanked the audience for attending the information session. PSE is planning another information session on electric and magnetic fields in September. PSE is currently working on identifying a preferred route option and will preview it at the sixth and final Community Sounding Board meeting in fall 2021. Soon after the last Community Sounding Board meeting, PSE will hold a community announcement

meeting and formally present the preferred route option for the Missing Link Project. The information session concluded just after 6:00 p.m.

Attachment 1: Meeting staff

Underground transmission line expert

Lowell Rogers, P.E., Oak Strategic, Professional Engineer

PSE Staff

Andy Swayne, PSE Municipal Liaison Manager

Karen Brubeck, PSE Community Engagement Representative

EnviroIssues Staff

Faiza Hassan, EnviroIssues, Zoom host

Kristine Danzinger, EnviroIssues, technical support

Nyles Green, EnviroIssues, Note taker

Skip Johnson, EnviroIssues, Facilitator

Listening staff

Barry Lombard, PSE Project Manager

Gretchen Aliabadi, PSE Communications

Kerry Kriner, PSE Land Planner

Kierra Phifer, PSE Local Government Affairs

Kirk Moughamer, HDR

Shelby Naten, PSE Communications

Attachment 2: Question and answer (post-information session)

The following questions were asked at the information session but were not able to be answered in the time allotted for the meeting. Where possible PSE has sent answers directly to the person who asked the question.

Can you elaborate on the amount of brush and tree clearing needed for underground lines? Especially interested in long term; is low-height vegetation allowed to regrow or be planted? (Response provided by Lowell Rogers)

- When it comes to vegetation management while undergrounding transmission lines, the amount of brush and tree removal can vary greatly project to project. Many factors must be taken into consideration when it comes to brush and tree clearing, including utility standards, project location, site access, and existing foliage.

Generally, only vegetation with root systems that do not put the underground line at risk would be allowed, including in regrowth. This means that grass or low ground cover would be allowed over the lines, as they can facilitate a quick response for repairs to the lines.

How much vegetation would be removed for an underground line? (Response provided by Lowell Rogers)

- In order for a utility to install lines underground, you can expect existing vegetation along the transmission line corridor to be removed or otherwise impacted during construction. Vegetation, particularly tree roots, may also specifically be disrupted during the direct excavation of the trench or by equipment use.

If the transmission line needs to be repaired, it can be out of service longer and is more costly than overhead lines. Correct? How much more to repair? Double, triple? And overhead is generally more reliable, fewer repairs? (Response provided by Lowell Rogers)

- Costs and repair timelines can vary greatly between overhead and underground transmission lines. Therefore, reliability and associated costs can vary situationally, and it is difficult to make an accurate comparison. Generally, a repair on an underground transmission line is more expensive than an overhead transmission line.

Underground lines are generally more reliable than overhead lines as they are not susceptible to the same types of interference, including storms, fallen trees, and car collisions.

Can you comment on the relative cost and environmental impacts of underwater cable as compared to undergrounding? (Response provided by Lowell Rogers)

- Installing a transmission line underwater or underground are many times more expensive than a traditional aerial line. There are a variety of factors that could drastically change cost estimations including line distance, location, makeup of the seafloor, construction method, and the environment in which it would be located.

Similarly, there are many variables relating to environmental impacts which make it difficult to compare the two. In terms of environmental impacts some things to consider for an underground line would be vegetation removal and replacement opportunities, presence or absence of sensitive areas such as wetlands or steep slopes. For an underwater cable, vegetation removal would not always be a factor, but the underwater environment would need to be taken into

consideration including the potential to disturb contaminated soils, the type of species that use the area that could be temporarily disrupted during construction, impacts to shipping lanes during construction, expected anchor drop areas and the need to build infrastructure on either side of the waterway to transition the underwater cable to land-based infrastructure, etc.

Which type of line is less likely to fail in an earthquake? What have other communities experienced with underground/aboveground lines after an earthquake? How long was power out before they were repaired? Were there multiple failure points – more for one type vs another? (Response provided by Lowell Rogers)

- Overhead lines are less likely to fail in the event of an earthquake because they are more flexible than underground lines, more so if the line crosses the fault zone. For transmission lines, the structural requirements necessary for the transmission line to carry loadings from wind and ice conditions exceed that what the line is expected to endure during a seismic event. To simply state, the loads induced on poles from anticipated earthquake ground motions are not greater than other conditions such as wind and ice loads and therefore do not control the design. Historically, transmission poles have performed well under earthquake events, and transmission pole loadings caused by wind/ice combinations and broken wire forces exceed earthquake loads.

The survivability of underground transmission lines during an earthquake depends on many factors, including soil type, if the fault crosses the line, earthquake magnitude, and the configuration of the line. This makes it difficult to compare and contrast the reliability of underground lines' durability during earthquakes across the system.

What is the efficiency of Overhead vs Underground? I am asking about electrical efficiency; Overhead vs Underground. (Response provided by Lowell Rogers)

- The efficiency of overhead and underground lines is the same by design, but the cost of the underground line will be multiple times more expensive. Key items that influence the cost are the environmental conditions, soil properties, depth of trench, conductor spacing, conductor size, and length of the line.

Can splice vaults be located above ground? (Response provided by PSE)

- PSE has not researched this option. It is likely that splice vaults could be located above ground, but we would need to better understand the ability of the vault to dissipate heat first before moving forward with such a solution.

If the route near Station 21 is selected, would it be possible to underground just that part of the line to protect the helipad access/safety and leave the rest overhead? (Response provided by Lowell Rogers and PSE)

- It is technically feasible to underground only a portion of a line. This would require poles that transition the line between above and below ground at either end of the underground portion of the project. These transition poles can range from 85 to over 100 feet above ground, are made of steel, and are generally much larger in diameter than a typical aerial transmission line pole.

PSE reached out to the Federal Aviation Administration (FAA) to understand any potential issues with siting an aerial transmission line near the helipad, including potentially overbuilding the existing distribution lines in the area. The FAA concluded that a transmission line near the helipad would not interfere with safe use of the facility.

Given this "link" is for redundancy; expect the utilization to be low and therefore expect very long-life expectancy? Or does PSE forecast that this link is needed to meet future demands?

(Response provided by PSE)

- The "missing link" transmission line is for redundancy and reliability of the electric system and does not add capacity to the transmission system on the island. We currently don't forecast a future need for additional transmission line capacity on the island. Once in service in a looped configuration, power flows on the new line will vary over time as power loads at the substations vary. If one of the existing transmission lines goes out of service, power flows on the new line will increase to continue temporary single supply to the relevant substation until the other line can be returned to service. Life expectancy of this line would be similar to other 115kV transmission lines, expected to be in the range of 40+ years (largely dependent on the material condition of wood poles as they age).

Is there a community that did this, what were their reasons, and how much more did it cost them?

(Response provided by PSE)

- No jurisdiction within PSE service territory has opted to cost share and place transmission lines underground. PSE is keeping the door open for a community to be the first to pursue undergrounding feasibility. PSE wants to ensure that the City and the community are aware of the undergrounding feasibility study process to decide if it is something they want to pursue.

What is Oak Strategic Inc? Credentials and why used? (Response provided by PSE)

- Oak Strategic is a consulting firm that specializes in the development of electrical transmission lines and other energy infrastructure. Lowell Rogers, a principal with Oak Strategic, is a licensed engineer that has extensive experience in many aspects of the construction of overhead and underground transmission lines including engineering. He has worked all over the country, and with a variety of utilities, on a wide range of projects.

Thank you for your answer to my question with regard to wildfire risk potentially arising from overhead lines. With that information provided, and considering other potential risks, benefits, and costs factors, would PSE see more potential benefits in having the community/City pursue undergrounding of the new "missing link" transmission corridor or selected existing distribution overhead lines on the Island? (Response provided by PSE)

- An aerial transmission line meets our identified reliability and safety requirements, but if the community and City Council are interesting in undergrounding the "missing link" transmission line, PSE welcomes the conversation. Available is PSE's [fact sheet](#) for more information about PSE's process for working with the community to underground transmission lines.

Over 50% of distribution lines on the island are underground already but should there be community interest in undergrounding other existing distribution lines, PSE has a process for doing so. Costs for underground installation of distribution lines are far below those of underground transmission. Generally, for the cost of a mile of underground transmission, many miles of underground distribution could be installed. Many more miles of overhead distribution lines are exposed to trees and other potential outage causes compared to transmission lines. Given available financial resources, it is likely that a community could see more reliability benefit by undergrounding more distribution lines compared to a single transmission line.