

Treasure Valley Electric Plan - Community Advisory Committee

Transmission Line Briefing Paper

What is a transmission line and why are they necessary?

- A transmission line is used to conduct electricity between two points. Without high voltage transmission lines, generation would have to be located at or near where the energy is used.
- The electrical energy must go through numerous transformations between the generator and its end use
 - For example, a generator might produce electricity at 15,000 volts. A transformer will step this voltage up to a suitable transmission voltage, say 345,000 volts. Once the energy reaches a load area such as the Treasure Valley, the voltage is stepped back down at a source substation to a lower voltage (230,000 volts) for transmission within the load area.
 - The 230,000-volt electricity is transmitted to hub substations throughout the area where it is transformed to 138,000 volts
 - The 138,000-volt electricity is transmitted to lower voltage distribution substations located closer to the end use where it is again stepped down to a lower voltage (13,800 volts)
 - From this substation, the electricity is transmitted via distribution feeders (low voltage transmission lines) to individual transformers where the voltage is stepped down to its end use voltage and then fed into homes and businesses

What are the different types of transmission lines and how do they work?

- **Extra-high voltage (230,000; 345,000; 500,000 volt)** – Used for transmitting electrical energy over great distances
 - Higher voltage lines are more efficient than lower voltage lines. A higher voltage transmission line will result in fewer losses than a transmission line with a lower voltage.
 - Higher voltage lines often have “bundled” conductors, meaning that multiple wires are hung from the same insulator. This increases the amount of power that can be carried on a single circuit.
 - The Idaho Power system loses between 2 and 3 percent of its energy due to line losses on the extra-high voltage transmission

- **Sub-transmission lines (69,000; 138,000; 161,000 volt)** – Used for transmitting electrical energy between substations that are close to one another (up to approximately 100 miles). These lines will typically not carry as much energy as the extra-high voltage lines.
- **Distribution lines (13,800; 34,500 volt)** – Used for transmitting energy to its end use, including commercial facilities, small factories or a small transformer outside a group of houses

Where does the Treasure Valley’s current supply of electricity come from and how does it enter the valley?

- The electricity delivered to the Treasure Valley arrives via eight 230,000 (230 kV) transmission lines
- Five originate at the Hells Canyon hydro complex and three originate at the Midpoint Substation near Shoshone
- Most of the power comes into the southeast area of the valley. One line comes in near Ontario, Oregon, and then through Caldwell.

Where will future (2030) electricity enter the valley and from where does Idaho Power plan to have it come?

- More power will have to enter the west and northwest area of the valley, so that power flows properly
- The location of new generation will determine where the power comes from

Are transmission lines safe for people to live near?

- Yes, but there are some safety concerns to be aware of:
 - Line breaking – This can happen at any voltage level but is very infrequent and is generally the result of a vehicle colliding with a power pole. If protective devices (circuit breakers) fail to open the circuit, a line lying in the road can be live and pose a serious risk of injury or death if someone comes in contact with it.
 - Fires caused by malfunctions or animal contact with power lines – Infrequently, a connection device will fail on a power pole and cause it to burn, resulting in a brush fire. More frequently, a small animal or bird will contact live distribution or transmission lines causing a brush or forest fire.

- **Electromagnetic Fields (EMF)** – EMFs are invisible forces created by any electric charge. The word “electromagnetic” is a combination of two words; electro (electric) and magnetic. Electric fields are the result of the strength (voltage) of the electric charge. Magnetic fields are the result of the motion (current) of the charge. Wherever electricity is used, EMFs are present. Since the early 1970s, extensive research has been performed to determine if EMFs pose health risks. Idaho Power agrees with the overwhelming body of research that shows that EMF is not detrimental to human or animal health.

What are the advantages and disadvantages of transmission lines?

- **Advantages:**
 - Allows generation to be built remotely from the Treasure Valley and outside of the valley’s air shed. This would be important if the valley is ever in a non-attainment (air quality) situation.
 - Provides access to generation that can only be located remotely from the Treasure Valley, such as hydro, wind, geothermal and coal
 - Allows interconnection with other utilities for buying and selling power, and also increases the reliability of Idaho Power’s system
- **Disadvantages:**
 - Many people don’t like the way transmission lines look
 - On a long distance, high-voltage transmission line, between 2 and 3 percent of the generated power is lost before it gets to the substation, due to the inefficiencies of the wire
 - A high voltage transmission line requires considerable right-of-way that could be used for other purposes

How does Idaho Power determine where to place transmission lines?

- The optimal location of a transmission line is the shortest distance between the two substations to which you are connecting
- Locating a transmission line along a public transportation right-of-way is an ideal location. Idaho Power prefers to obtain private easements next to the public ROW for transmission lines.
- Idaho Power condemns only as a last resort

What is the cost of replacing or upgrading and how often is it necessary?

- The cost of replacing is essentially the same as a new transmission line, except the right-of-way might be reused
- Upgrade costs depend on what type of upgrade that is occurring
- Frequency of replacement or upgrade depends on load growth, damage to the line or technology change

How do you determine whether transmission lines will be above ground or below ground? What is the cost and maintenance difference? Why is underground transmission so expensive?

- Idaho Power does not install transmission lines underground due to the cost. It is significantly more expensive to install 138 kV (and above) transmission underground than it is to construct it overhead.
 - An underground 138 kV line is about 10 times more expensive than an overhead line. For 230 kV and above, this cost difference can be much higher.
- Maintenance can be lower for an underground line, though some repairs can be much more expensive because of the difficulty of finding the fault and then digging to get to it. The actual time to repair an underground line is much greater than for an overhead line.
- An overhead line is not insulated. It is bare wire with no outer covering. If the line is placed underground, a non-conducting insulation must encase the wire. The material for this insulation is quite expensive.

What is the capacity of transmission lines?

- There are many factors that go into determining how much power a given transmission line can carry
- For general purposes, we can say:
 - A 500 kV transmission line can carry between 1,000 and 1,500 megawatts (MW)
 - 345 kV transmission line can carry between 700 and 1,000 MW
 - 230 kV transmission line can carry between 300 and 500 MW
 - All of these lines will normally be operated in parallel (electrically alongside) with another line of equal size or a set of lower voltage lines. If the line with the highest capacity goes out, the remaining lines must still be capable of carrying their loads plus the load that was on the line that went out.

What conditions and other infrastructure are necessary to support transmission lines? What are the restrictions on where they can be located?

- 500 kV, 345 kV and 230 kV lines must obtain a variance from some cities because they are taller than allowed by city ordinance
- If located in areas with trees, the trees must be cleared in the right-of-way so the wires will not contact them

How much right-of-way is necessary for each size of transmission line?

- The amount of right-of-way necessary depends on many factors. As a rule of thumb:
 - A single 500 kV transmission line needs 150 feet of right-of-way. This is equivalent right-of-way width of Eagle Road. (Right-of-way includes traffic lanes as well as roadway shoulders.) If two 500 kV transmission lines are put in the same right-of-way but on separate towers, the width would increase to 300 feet. If placed along road right-of-way, a single 500 kV transmission line will need at least 70 feet outside of the road ROW.
 - A 345 kV transmission line needs 130 feet of right-of-way. If two 345 kV transmission lines are put in the same right-of-way but on separate towers, the width would increase to 300 feet. If placed along road right-of-way, a single 345 kV transmission line will need at least 60 feet outside of the road ROW.
 - A double circuit 230 kV transmission line strung on the same towers needs about 80 feet of right-of-way. If placed along road right-of-way, a double circuit 230 kV transmission line will need at least 40 feet outside of the road ROW. Note: in urban areas, a 230 kV structure will almost always be designed to carry two circuits.

Note: For comparison purposes a typical traffic lane is 12 feet.

Can you place more than one size of transmission line in a corridor?

- Yes. Sometimes a wider corridor is used and multiple transmission lines are placed alongside each other. Additionally, a lower voltage line is often placed below (closer to the ground) a higher voltage line on the same tower.

How can building transmission lines in the Treasure Valley be avoided?

- To avoid building a major transmission line (500 or 345 kV), you can:
 - Reduce load through energy efficiency or demand reduction technologies
 - Install local generation within the Treasure Valley large enough to displace the need for a line
 - Limit growth
- Future 230 kV transmission lines will generally be used for transmitting energy between hub substations. To avoid a 230 kV line, the need for electricity must be reduced.

Can we build more of the smaller transmission lines and fewer large lines?

- Yes
 - Advantages: Less right-of-way would be needed
 - Disadvantages: Lower voltage lines incur higher losses than higher voltage lines; more transmission corridors would be required

Can we build more large lines and fewer smaller lines?

- Yes
 - Advantages: More efficient transmission; fewer corridors needed
 - Disadvantages: Very expensive, especially if you were replacing existing lower voltage lines with higher voltage lines; requires wider right-of-way
- In practice, Idaho Power will upgrade a lower voltage transmission line to a higher voltage when the capacity requirements increase to a point that it makes it cost efficient.

Can we build fewer of the hub substations if we use more small lines?

- No. The hub substations will still be needed to distribute energy throughout the valley.

Can we build fewer substations if we use more large transmission lines?

- No. These lines will still need substations to distribute the electricity they carry.

What is reliability as it pertains to a transmission system?

- Idaho Power must be able to reliably serve its customers under all normal operating conditions and under expected abnormal operating conditions (events that are statistically likely to occur fairly often)

Does Idaho Power have to answer to some authority for reliability?

- Yes, Idaho Power voluntarily complies with reliability standards put forth by the Western Electricity Coordinating Council (WECC) and, by signatory agreement, concedes to the WECC the ability to impose financial penalties for reliability violations.
 - The federal Energy Policy Act of 2005 legislates that a reliability organization be formed that has statutory ability to impose penalties.
 - The specific organization that will be formed to do this has not yet been identified.
- Idaho Power must periodically submit reports on varying reliability topics to both the WECC and the North American Electric Reliability Council (NERC). WECC and NERC will also periodically verify that Idaho Power is operating by the in-place reliability standards.
 - If Idaho Power is found to be out of compliance with reliability standards, WECC can impose monetary penalties.
- Additionally, the Idaho Public Utilities Commission has some oversight authority and can force Idaho Power to improve its system if reliability degrades enough

Describe reliability as it pertains to extra-high voltage transmission.

- Idaho Power's transmission system must be able to survive the single worst contingency (abnormal condition) on the system
 - No one event on a major transmission line can disrupt the system, making it unable to supply all the end users
 - To accomplish this, certain transmission lines are not loaded to their full capability – they hold some of their capacity in reserve
 - Additional capacity is held in reserve so that energy can be imported from surrounding utilities should Idaho Power lose generation
- Idaho Power must also adhere to what's known as an "n-1" criterion
 - For multiple major transmission lines delivering power to the same point, if one of the lines goes out of service, the remaining lines must be able to carry both the load they were carrying before the event, plus the load carried by the line that is out of service.
 - This is true even if the line with the highest capacity is the one that goes out of service
 - Note: this requirement only holds true for major transmission lines

Does every transmission line have a backup transmission line?

- No. Many times, a lower voltage transmission line will be the only transmission serving a sparsely populated area. If the line goes out of service, the customers being served by that line lose power. In urban settings, lower voltage transmission lines do have backup.

How does Idaho Power measure reliability at the customer level?

- Idaho Power looks at two primary measures of reliability. One measures the number of times (frequency) the power goes out over a given time period and the other measures how long (duration) each of the outages lasts during the same time period.
 - Generally, these two measures are evaluated at the low voltage (12.47/34.5 kV) feeder level
 - Idaho Power evaluates these measures on an ongoing basis and uses the results to indicate which feeders are in need of upgrade
 - These can also be indicators of problems at the major transmission line level

Does everyone on the Idaho Power system see the same level of reliability?

- No, it would be prohibitively expensive to ensure all customers had the same reliability
 - Customers who are located in urban areas generally have the ability to receive power from more than one feeder, thus limiting their exposure to power outages
 - More remote customers have only one feeder serving their area, so if that feeder is out of service they lose power
 - In mountainous areas, snow and wind will cause more outages