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## Treasure Valley Electric Plan – Community Advisory Committee

### *Substation Briefing Paper*

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#### **What is a substation and why is it necessary?**

A substation is used to transform one voltage to another and for protecting and controlling transmission and distribution lines.

For efficiency, Idaho Power tries to minimize the electrical losses (inefficiencies) on the transmission system. The higher the electrical current, the higher the losses. Therefore, it is in the power company's best interest to transmit power at the lowest current possible.

To do this, the voltage must be as high as possible. Substations are used to raise voltages for long distance transmission and to lower transmission voltages for distribution to the end users. Without substations, generation would have to be located very close to the customer load.

#### **What is inside a substation?**

Most of what is inside a substation is support structures to terminate the transmission line, large metallic pipe called bus work, circuit breakers, switches and transformers.

The bus work inside the substation is connected directly to the transmission (standard electrical industry practice is to use a rigid metal conductor inside the substation rather than a wire or cable).

Circuit breakers and switches are used to take lines out-of-service for operational and safety purposes, and transformers step up or down the voltage.

A substation also contains a control house that protects the electronic equipment that controls the devices inside the substation.

#### **What are the types and sizes of substations?**

- **Source** – Act as the receiving point for energy produced at distant generation. They are typically 230 kV and higher and can be co-located with hub and distribution substations – meaning a source substation can also contain the infrastructure to serve as a hub substation and as a distribution substation. Idaho Power's Boise Bench Substation serves all three purposes.
- **Hub** – Converts high voltage transmission to a lower and more manageable sub-transmission voltage to transport around the valley to distribution substations.

- **Distribution** – Consists of 2-3 sub-transmission lines, and one or two transformers. The transformers step the sub-transmission voltage (138 kV) down to a distribution voltage (12.5 kV) so that electricity can be delivered to the customer.

In general, power flows from source substations to hub substations then from hub substations to distribution substations.

As an analogy, electricity flows through substations in the same way a commuter might go home from work – first the commuter leaves the interstate by way of an off-ramp (source substation), then moves down a smaller state highway, leaving the highway at a major intersection (hub substation) onto a city road, and finally turns off the city road via a minor intersection (distribution substation) into his or her subdivision.

## **Source Substations**

**How many source substations are located in the Treasure Valley? Can they get larger? What is the cost to build and maintain them?**

Currently, there are two source substations feeding the Treasure Valley – one in the east and one in the west.

Some capacity additions are possible in each of these substations and land may be available to enlarge at least one of the substations. The limiting factor may be the lack of right-of-way corridor available for the additional transmission lines that would be required.

Source substations might cost as much as \$25 million. Source substations require more maintenance than distribution substations and are visited several times per week by maintenance crews.

**How many source substations will be needed to meet future (2030) load?**

It is estimated that the Treasure Valley will need four source substations in addition to the existing two to supply energy at buildout. By 2030, the Treasure Valley will likely need two new source substations.

**Where does the electricity come from that enters the source substations? Where is it expected to come from in the future?**

Energy comes from generation throughout the region, including the Hells Canyon hydro complex and from Midpoint substation near Shoshone.

During summer peak, much of the electricity serving the Treasure Valley comes from:

1. Hydroelectric dams located in Hells Canyon and elsewhere on the Snake River

2. Mountain Home's gas fired generators
3. Imports from adjacent utilities
4. Idaho Power's coal fired facilities located in Oregon, Nevada and Wyoming

Most future new energy resources are likely to be located to the east of the Treasure Valley. However, resources located to the west are also possible.

**What conditions and other infrastructure are necessary to support source substations? What are the restrictions on where they can be located?**

Source substations require between 5 and 10 acres of land. The land doesn't need water unless landscaping is required around the substation.

Multiple transmission corridors must be available around the substation for the transmission lines that must enter it.

A county or city must zone the land appropriately to allow a substation. This zoning sets the restrictions.

## **Hub Substations**

**How many hub substations are located in the Treasure Valley? Can they get larger? What is the cost to build and maintain them?**

There are currently three hub substations in the Treasure Valley – one in Caldwell, one in Meridian and one in East Boise.

Our current hub substations can and will become larger in the future. This usually means more infrastructure inside the fence, not more land.

Idaho Power strives to buy adequate land for a hub substation so that it can be expanded in the future to meet its planned buildout requirements. Usually, the additional land will be contained within the original fence so as not to surprise neighbors when additions are made.

The primary hindrance to expanding a hub substation is gaining right-of-way for the transmission that must enter and leave the substation.

Depending on the size of a hub substation, the cost is generally several million dollars. Hub and source substations require more maintenance than distribution substations and are visited several times per week by maintenance crews.

**Where does the electricity come from that enters the existing hub substations?**

The electricity entering the existing hub substations comes from source substations located around the Treasure Valley.

**How many hub substations will be needed to meet future (2030) load?**

At build-out, Idaho Power will require about 15 hub substations total. The Treasure Valley will probably have 11 by 2030.

Many of the new substations will have excess capacity when they are built, but will more fully utilize the installed equipment as load grows.

**What conditions and other infrastructure are necessary to support hub substations? What are the restrictions on where they can be located?**

Hub substations generally need at least five acres of land and will have three or more 230 kV lines and four 138 kV lines into the substation. The land doesn't need water unless landscaping is required around the substation.

In order to get all of these lines into a substation, the ideal location of the substation is on a street intersection.

A county or city must zone the land appropriately to allow a substation. This zoning sets the restrictions.

**Distribution Substations**

**How many distribution substations are there in the Treasure Valley? Can they get larger? What is the cost to build and maintain them?**

In the Treasure Valley, there are currently about 40 distribution substations. In most cases these substations are not at capacity (fully utilizing the capability of the installed equipment), meaning they can and will add more load in the future.

In general, Idaho Power doesn't make substations larger, because land is rarely available to do so. Idaho Power attempts to buy all the necessary land for future use when the substation is first built. The land doesn't need water unless landscaping is required around the substation.

A distribution substation costs around \$2 million to build and will become one of many substations maintained by a full-time maintenance crew.

Distribution substations do not require as much maintenance as large hub and source substations.

### **Where does the electricity come from that enters distribution substations?**

The electricity for distribution substations comes from a sub-transmission line, generally 138 kV or 69 kV. Sub-transmission comes from hub substations, which are served by high-voltage transmission that generally comes from a source substation or a generator.

### **How many distribution substations will be needed to meet future (2030) Treasure Valley load?**

At build-out, Idaho Power will require about 95 substations total in the Treasure Valley. This number will probably be somewhere between 70 and 80 by 2030. Many of the new substations will have excess capacity when they are built, but will more fully utilize the installed equipment as load grows.

### **What conditions and other infrastructure are necessary to support distribution substations? What are the restrictions on where they can be located?**

Distribution substations require about two acres of land and at least two 138 kV transmission lines into the substation and generally about eight distribution feeders out of the substation.

In order to get eight feeders out of a substation, the preferred location is an intersection of two roads. This will allow two feeders in each direction to serve customer load.

A county or city must zone the land appropriately to allow a substation. This zoning sets the restrictions.

### **How far apart are substations?**

- **Source** substations are generally located many miles apart and a small city may only have one. Source substations for the Treasure Valley will likely be located 10 to 20 miles apart.
- **Hub** substations normally double as distribution substations. Their locations are chosen in order for them to be able to serve several distribution substations. They can be as close as four miles apart, or as far as 8-10 miles apart if the load is not as dense.
- **Distribution** substations are generally about four miles apart, but are closer together in higher density areas.

## How can building substations be avoided?

Local generation and demand side management can reduce the number of substations necessary. However, even these measures cannot completely do away with the need for substations.

- To avoid the need for a **source** substation, the valley can either reduce its energy use or install generation within the valley.
- It is possible to avoid a **hub** substation by placing more infrastructure in another hub substation. But this would result in a large amount of transmission and sub-transmission located in a single area. And the remaining hub substation would also have to be much larger than 5 acres.
- To reduce the need for **distribution** substations, the Treasure Valley would need to reduce sprawl and increase densities closer to existing substations.

If population and load density is high enough, the size of a distribution substation can be increased and fewer might be needed. For example, if Idaho Power could increase the capacity of two 80 MW substations to 120 MW each, it might alleviate the need for a third substation so the actual number of substations in that area might decrease by one-third.

## Why do substations have to be located in or near neighborhoods?

Distribution substations need to be located near the center of their service area and each distribution feeder can only serve a certain number of houses before it reaches electrical capacity.

Placing the substation close to the center of the load also decreases the amount of power losses on the system. The farther electricity travels, the more is lost, especially at low voltages.

Hub and source substations must be located within appropriate proximity to serve the distribution substations. They do not need to be located within neighborhoods.

## Are they noisy in neighborhoods?

Transformers can have a humming noise to them. Idaho Power tries to minimize this noise, especially in neighborhoods. Often times, a berm will be placed around a substation to reduce this noise.

Also, when a circuit breaker is operated, it can make a somewhat loud snapping or cracking sound. Circuit breaker operation occurs infrequently.

**Are they safe for people to live near?**

Idaho Power is careful to ensure a substation is safe to live or locate a business near.

One of the biggest safety measures Idaho Power takes is to make sure the fencing is maintained so that children cannot crawl through or under it.

The main threat outside the fence is from fire and explosion that can occur within the substation if equipment malfunctions or fails. For this reason, enough land is purchased so that structures and people outside the fence won't be affected by a fire or explosion inside the fence.