8.5 Power Outages

- The 2003 Northeast Blackout highlighted the fragility and interdependence of the country's electrical system.
- The United States power grid is made up of three interconnecting networks. Seattle's power infrastructure is linked to the Western Interconnection, a network of public and private power generators and distributors that serve over 80 million people in the Western U.S., from Mexico to Canada.[480]
- About half of Seattle City Light's unplanned power outages are caused by falling trees or branches.
- Almost 90% of Seattle's power comes from hydroelectric power; 47% of the power Seattle consumes is purchased.[481]
- Seattle could face power outages due to electrical vault fires, windstorms, or an issue in the regional grid. Seattle has the ability to isolate itself from the grid but cannot supply enough electricity for the city on its own.
- The largest impacts of an extended power outage would be economic because most businesses in the affected area would likely shut down.
- Seattle's power depends on the health of generating facilities that lay far outside the municipal boundaries, on snow and rain that are the "fuel" for hydroelectric power and finally on the health of the transmission and distribution lines that move the power.
- Expected climate and hydrologic changes will likely alter the annual patterns of hydroelectric supply, lowering supply during the summer and increasing supply during the winter.
- By 2028, peak demand may not be met in winter without purchasing additional power.[482]

8 5.1 Context

On August 14, 2003, a large part of the upper Midwest, East Coast, and Ontario, Canada went dark. The power outage affected 50 million people. Some parts of the United States waited four days for the power to be restored. Estimated losses ranged from $4 billion to $10 billion. The outage highlighted widespread infrastructure problems in the power grid, and the complexity and consequences of widespread power outages.

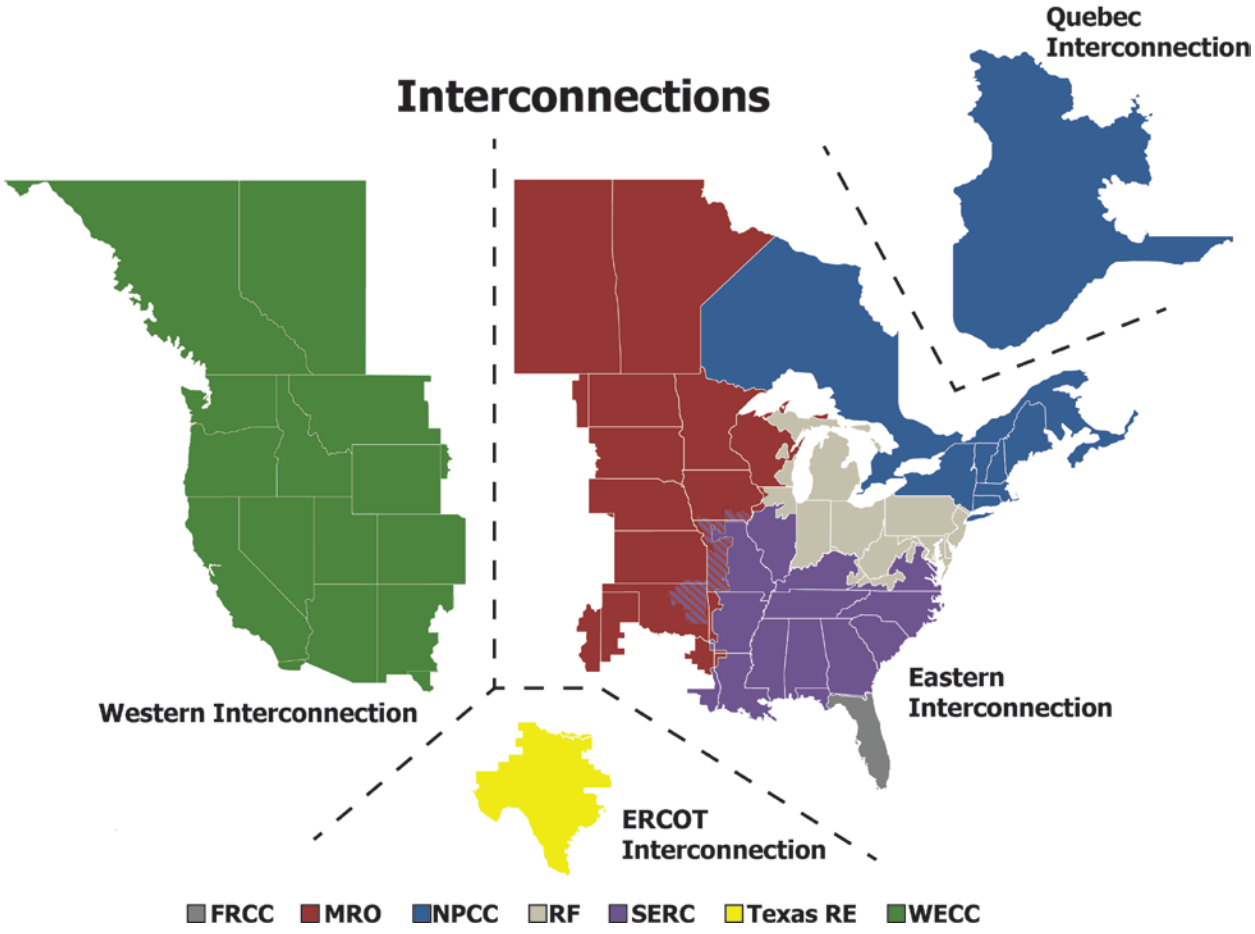
Power is an essential component of modern society and is immediately noticeable when absent. The 2003 outage caused other areas of the country to look at their own networks to analyze the chances of a similar incident and its potential effects on their own networks.

A power outage can affect an isolated area or be widespread. A total loss of power would be considered a "blackout." A "brownout" occurs when the voltage level is below the normal minimum level specified for the system. A brownout may be done intentionally to prevent a full power outage. "Load shedding" or "rolling blackout" is a common term for a controlled way of rotating available generation capacity between various districts or customers, avoiding total, wide-spread blackouts.

The City of Seattle owns its own generating capacity, transmission lines, and distribution system. It is operated by the city's public power utility, Seattle City Light (SCL), and is connected to the Bonneville Power Administration (BPA) network, which is part of the Western Interconnection, an electricity network made up of 11 western states, two Canadian provinces and northern Baja California, Mexico (see Figure [United States electricity networks]). The Western Interconnection has more Balancing Authorities, which make sure that the supply and demand flows of electricity are balanced, than any

other U.S. network, but is served by only one Reliability Coordinator that provides situational awareness and real-time monitoring for the grid.[483]

Figure 8-7. United States Electrical Interconnections



Source: Interconnections. North America Electric Reliability Corporation. Retrieved August 23, 2018, from https://www.nerc.com/AboutNERC/keyplayers/PublishingImages/Interconnections%2024JUL18.jpg

The high voltage transmission system is near capacity in many parts of the West, including the Pacific Northwest. A seasonal power exchange in this system takes advantage of the seasonal diversity between the Northwest's winter peaking and the Southwest's summer peaking loads. Utilities can transfer firm power from north to south during the Southwest's summer load season and from south to north during the Northwest's winter load season, allowing both regions to maintain less generating capacity than would otherwise be necessary. SCL's existing portfolio includes a seasonal exchange with utilities in Northern California.

SCL serves more than 750,000 customers and is the tenth largest public electric utility in the country. SCL owns seven dams, mostly on the Skagit and Pend Oreille Rivers. Almost 90% of Seattle's power comes from hydroelectric power, both from its own dams and those of the BPA.[484] The remaining 10% comes from a variety of sources such as nuclear, wind, and coal. SCL owns no coal or nuclear generation, but a portion of the power SCL purchases from BPA is generated by these sources. SCL purchases about 40% of the power that Seattle consumes.[485] Seattle's power depends on the health of generating facilities that lay far outside the municipal boundaries, on snow and rain levels that are needed for

hydroelectric power generation, and finally on the health of the transmission and distribution lines that move the power. Seattle has powerlines underground in Downtown and other dense areas of the city. More information on Seattle's power supply can be found in the Community Profile section.

8 5.2 History

All power systems experience unplanned outages. Most are small, resolved within a few hours and do no lasting damage. Larger outages occasionally occur. These outages are usually secondary events caused by other hazards, e.g., winter storms. Some larger outages, such as the 2003 outage, demonstrated that power outages can be a primary incident. Two local examples are two fires in underground vaults serving the downtown areas that caused lengthy outages. This section lists major outages in Seattle and several regional events that did not directly affect Seattle but highlight issues with the Western power grid.

1958. Seattle. Wind related outages. Loss of power in many areas of the city, especially in West Seattle and Magnolia.

1962. Seattle. Columbus Day Storm. Biggest storm to hit the Pacific Northwest. It affected utilities throughout the region.

1988. Downtown Seattle Vault fire. Six electrical cables were damaged resulting in a four-day loss of power to a 50-block area in downtown. The area included the Westin Hotel and the Pike Place Market. The cause was a contractor driving a steel piling through a buried cable. Businesses that lost power sued the City and the contractor. Newspaper reports that the City paid more than $1.5 million to settle claims.

1993. Downtown Seattle Vault fire on October 5th. 1,800 customers in about 270 buildings were out of power for up to three days in a 37-block area. Eight large generators were brought in to help the population. Fire destroyed huge underground cables that had to be replaced.

1996. Western Interconnection. Two major outages struck the Western power grid in 1996. On July 2, a localized outage caused by a tree in Idaho led to a cascading regional outage that resulted in 10% of the consumers in the western U.S. losing their power for at least a few minutes. The next month, on August 10, more than 7 million people across the West lost power. Areas were affected intermittently for up to several hours. While the outages weren't long, they highlighted the fragility of the network.

1997. Western Interconnection. Two separate disturbances in the Western grid that interconnects with Seattle City Light's system. Both outages had minor customer impact but could have been worse.

2000 – 2001. California. Rolling blackouts plagued much of California. The Northwest was involved as a power supplier. This event placed strain on transmission lines in the Northwest and caused two major outages during peak demand periods. The energy crisis cost California $40 billion in added energy costs, and customers saw their energy bills double or triple during that time.[486]

2006. Seattle. Hanukkah Eve Wind Storm. Seattle City Light suffered its most extensive outages in the utility's history as a result of a severe regional windstorm. More than 49% of customers lost power. Some customers were without power for more than a week. Neighboring utilities also suffered major damage.

July 2009. Western Washington. While Seattle avoided power outages during record heat, Tacoma and Monroe did not. Typically, summer is a low demand time for Pacific Northwest power but the increasing number of HVAC systems in the area can lead to high energy demands. This event demonstrated that Seattle is also vulnerable to demand spikes during the summer.

August 2015. North Cascades. Goodell Creek Fire. Lightning in the North Cascades National Park started a wildland fire that forced Seattle City Light to shut off transmission lines from its Skagit hydroelectric

project.[487] The loss of transmission capacity cost the utility an estimated $100,000 per day. While the threatened dams and powerhouses typically produced 20% of Seattle City Light power, no outages occurred from the fire.

8 5.3 Likelihood of Future Occurrences

Seattle has never suffered a catastrophic blackout like the Northeast nor has it had rolling blackouts like California experienced during 2000 and 2001, however several events on the Western grid have come close to affecting the city.

Seattle has experienced three large unplanned and multi-day outages in the past 30 years. The most likely sources are underground vault fires, regional windstorms, or an issue in the regional power grid.

A regional cascading blackout is a possibility in this region. A problem could originate outside the SCL system because of its interconnectedness with the BPA system. Seattle has the ability to isolate itself but, because the city can only generate a portion of its power, "islanding" could cause short-term, supply-related rolling blackouts.

Wind will continue to be a hazard to power distribution. Although it has fewer trees that the rest of the county, Seattle has successfully been re-growing its tree canopy. About half of SCL's unplanned power outages are caused by falling trees or branches. SCL has implemented a vegetation management program to trim trees that may grow into or fall on power lines.[488] Vegetation management specialists work with arborists year-round to trim back trees from lines. The whole system is trimmed every four years.

Improvements have been made to underground electrical vaults, including automatic fire suppression and remote vault monitoring capabilities.[489] These improvements have reduced the likelihood and duration of outages. Nevertheless, there have been 20 electrical vault fires in Seattle since 2016. A recent vault fire in the Green Lake neighborhood caused outages for about 5,000 customers, but only for a few hours.[490]

8 5.4 Vulnerability

Power lines are underground in the downtown core and other dense areas. They are vulnerable to vault fires but extremely resistant to wind damage. Locally, more power has been going underground. The underground system is less likely to fail but can be more time consuming and expensive to repair when it does fail. In the rest of the city, wind damage is linked to the number of trees close to power lines. In 2015, SCL began piloting "self-healing" power lines.[491] The technology can detect an outage and isolate the section of the circuit being affected. Power is then restored to areas that are not directly affected by the isolated section. Self-healing lines reduce the number of customers without power as well as pinpoint the outage location more precisely, so workers can respond faster.

SCL relies on BPA mainly for its transmission lines, which are on steel towers that are very resistant to storms. However, an earthquake or wildland fire has the potential to disrupt these lines. Not only can a transmission tower be damaged due to fire, but soot from fires can build up on line insulators and cause electric arcing. Several dams that generate power for Seattle are located many miles outside the city and are vulnerable to wildland fire. Even before the Goodell Creek Fire in 2015, SCL had made fire protection upgrades at its vulnerable dams.[492]

Earthquake vulnerability is not evenly distributed throughout the power system. Historically, transmission towers and lines have fared better in earthquakes than operation centers and substations.[493] SCL has attempted to mitigate this vulnerability by building seismic isolation technology into high voltage transformers.

Communities with older high-rise and commercial buildings are generally more vulnerable to an outage because they often lack backup generators. During the 2006 storms and power outages, it was discovered that many nursing homes lacked back-up power. With many resident's dependent on electrical equipment, these facilities are highly vulnerable to outages.

Hospitals are even more sensitive than nursing homes. However, hospitals have emergency power generators that are typically powered by diesel fuel and configured to start automatically as soon as a power failure occurs. During Hurricane Katrina, hospital patients began experiencing life-threatening conditions within hours of power loss. Seattle is the major concentration of hospitals in the region.

Other life-critical systems such as telecommunications are also required to have emergency power. All Seattle fire stations have emergency generators.

General economic health and social climate has a significant effect on what happens during a blackout. The 1978 New York blackout occurred during a time of political instability and discontent. As a result, there was widespread looting. In the 2003 Northeast Blackout, there was none. The social climate is an important external variable in a widespread outage.

Almost all businesses depend on reliable power. Businesses with perishable inventory, like grocery stores and restaurants, stand to take permanent losses during extended outages. When the power is out only in one community, the retail stores in that community lose customers to neighboring communities. If the outage is short but widespread, then retail stores do not suffer because post-incident sales trend accelerate and make up for the downtime.

8 5.5 Consequences

The December 2006 windstorm demonstrated the importance of power. Some parts of the city were without power for nearly a week during very cold weather. The outages led to several fatalities outside the City of Seattle. The response was the second costliest in the City's history after the Nisqually Earthquake.

The largest impacts of an extended power outage would be to the economy as most businesses are likely to shut down in an extended outage. During the 2006 power outages, City financial records indicate that more than $6.9 million was spent repairing and replacing wires, transformers, and poles. Local transportation networks collapse when traffic signals are out. In 2006, 150 traffic signals went dark.

The maximum credible scenario would probably be some sort of "perfect storm" of disparate elements coming together to create a huge problem. This would probably include a regional outage involving the Western Interconnection during a period of peak power demand in Seattle. Even if Seattle could successfully island its infrastructure, it might not be able to meet all the demand. Since extreme demand tends to be driven by extreme weather, it is likely that Seattle would be facing either very hot or very cold temperatures at the same time. Currently, Seattle's social climate seems very stable, but if it is not, that could be one more potential element in the mix.

8 5.6 Future Challenges

Climate change presents future challenges for the power system. While warming temperatures may increase power demand for cooling purposes, overall energy efficiency is expected to offset this increase in demand. Projected changes in snowpack and streamflow will likely have the biggest impacts on the power system. Hydropower generation in the Columba River Basin is projected to increase 5% in winter and decrease 12 to 15% in summer by the 2040s (relative to 1970-1999). The same seasonal pattern of change is expected to occur in the Skagit watershed, though the exact amount of change is not well

known. If SCL cannot meet demand in the summer due to the decrease in power generation, they may have to purchase additional power. More impacts are discussed in the climate change chapter.

8 5.7 Conclusions

To plan for the acquisition of new resources, which can take many years, SCL forecasts future power consumption or load in its service area 20 years into the future. Load is only expected to grow by 0.4% by 2035.[494] Additionally, some of the power purchase contracts will expire.

Forecasts estimate that the Pacific Northwest will have more than adequate reserves to meet a 12% recommended reserve margin for the next decade under normal conditions, accounting for climate impacts.