



INTEGRITY INTO EVERYTHING

THE VALUE OF GRID/SYSTEM HARDENING MEASURES FOR ELECTRIC UTILITIES

It doesn't really matter what part of the country your utility is located, it is virtually guaranteed that you will be subject to potential grid damage from at least one of a number of natural occurrences. These can include hurricanes, tornadoes and/or windstorms, wildfires, floods, earthquakes, and blizzards and/or heavy snows.

NATURAL DISASTERS

In addition, not only are the numbers and intensities of these events increasing year after year, but the costs associated with the damage continue to climb. According to a report from the National Oceanic & Atmospheric Administration (NOAA), **there were over 300 disasters between 1980 and 2022 that led to costs of over one billion dollars in damage each.** (These were floods, severe storms, hurricanes, wildfires, and winter storms.) During the 1980s, there were about 30 such events. During the 2010s, there were over 120.

In terms of hurricanes:

According to the NOAA, between 1991 and 2020, there were an average of 14 names storms, seven hurricanes, and three major hurricanes per year.

In terms of wildfires:

According to the National Interagency Coordination Center, there were an average of between 70,000 and 80,000 wildfires per year during the 1980s and 1990s, with an average of three million acres burned each year. From 2015 to 2021, there were only an average of 60,000 wildfires per year. However, the average acres burned each year during that timeframe was approximately eight million – almost three times as much acreage.

In terms of tornadoes:

According to NOAA's Storm Prediction Center, between 1991 and 2020, there were an average of 1,225 tornadoes per year. During the 1950s and 1960s, that average was only about 700, and, during the 1970s and 1980s, the average was about 900 per year. In other words, the numbers per year continue to increase.

In terms of earthquakes:

According to the U.S. Geological Survey (USGS), there are approximately 16 major earthquakes per year – with 15 in the magnitude 7 range, and one magnitude 8 or greater.

THE NEED FOR UTILITY RESPONSE

“Enhancing the Security of the North American Electric Grid,” a 2020 report published by the Congressional Budget Office, noted that:

“A secure and reliable supply of electric power is a key component of modern economies. Not only are other energy sources often poor substitutes, but essentially every industrial and commercial process in the United States requires its use, and nearly all homes rely on it.”

The report went on to note that even short-term interruptions in the delivery of electric power result in economic losses or inconveniences for consumers and businesses. “Longer outages can result in spoilage of food and other perishables, forgone sales, the idling of resources in production processes, disruptions to the supply of water and fuels, and other threats to health and safety,” it said.

According to the report, the electric grid is responsible for delivering power to some 150 million customers (households, businesses, and government facilities), sometimes across considerable distances. Those deliveries are usually very reliable. For example, in recent years, the average annual loss of power for a typical customer has ranged between three and eight hours, which is roughly one-tenth of one percent of the time or less.

The higher end of the range occurred because of what the industry classifies as major events: snowstorms, hurricanes, and others. However, according to the report, the cause of an outage is usually something affecting local delivery, such as less severe weather or an equipment problem, and the outage affects a small area and is not long-lasting.

However, the report went on to note that the overall stability of the electric grid has also been punctuated by rare, wide-ranging outages of greater magnitude. Those outages are often caused by severe coastal storms or by system failures on especially hot days.

“The likelihood of wide-ranging and long-lasting outages is small, but the consequences could be severe,” said the report. “Some estimates suggest that losses in the economy could be in the hundreds of billions of dollars or even more than a trillion dollars in some scenarios. Losses could also be considerably less depending on the extent of the disaster or attack; the condition of the system, including whether the grid retained enough power to handle emergencies; and the effectiveness of existing protections and recovery measures, among other factors.”

Utility Response Options – Hardening the Grid/System

The electric grid
delivers power to
**150 MILLION
CUSTOMERS**

SO WHAT CAN UTILITIES DO TO PREVENT, OR AT LEAST REDUCE THE FREQUENCY AND SEVERITY, OF SUCH EVENTS?

There are several options. Some of the most notable are strategies and projects designed to improve the reliability of the grid, such as backup generation, microgrids, utility-scale battery storage, and/or DER (distributed energy resources).

Admittedly, some of these can be very costly. In the meantime, there are other strategies that utilities can explore that come under the label of “grid/system hardening.” Some of the most popular of these strategies are not nearly as costly as microgrids, battery storage, DER, etc. However, they can still often “do the job” in terms of improving grid/system resilience. Finley’s engineers are well-versed in these options, and can help you not only decide which ones make sense, but also help you implement the most appropriate strategies.

AMONG THEM ARE:

A - EQUIPMENT

1 - Poles:

Routine pole inspection is vital. Research shows that utility poles can get damaged from various causes, including storms and lightning, earthquakes, destruction by wild animals, vehicle accidents, or even falling trees.

It is also worth considering a program that involves gradually switching from wood poles to steel poles. They are not only stronger, but they are fire-resistant.

2 - Conductors:

Conductors can become damaged or slowly corrode over time. In most cases, conductors can be replaced as needed, not all at once, unless the line is being rebuilt for more capacity.

One option is to replace standard “bare” overhead conductors with covered conductors, which are covered with special layers of insulation materials to protect them from contact with foreign objects.

3 - Monitoring and Control Technologies:

One option here is to focus on limiting potential faults from igniting wildfires by adding (or replacing, as necessary) certain devices on the system to mitigate fault-related ignition risks. It can also make sense to install additional fuses that activate quickly to reduce the energy transmitted due to faults and, accordingly, further reduce the risk of ignitions from faults.

Another option is to install remote-controlled automatic reclosers and circuit breakers with high-speed, “fast curve” settings to enable recloser relay blocking during high fire risk times, which may be able to reduce the frequency and duration of some public safety power shutoff events.

4 - Structural Upgrading:

While the most common hardening practice for electric transmission and distribution systems is upgrading poles and structures with stronger materials, it can also make sense to install guy wires and other structural supports, such as upgraded crossarm materials. In fact, transmission and distribution poles subject to storm surges and flooding require guy wiring. Costs and procedures for installing guy wires vary according to the height of the pole or structure, soil characteristics, assembly configuration, and design wind speed. Again, Finley engineers can help with the details [here](#).

5 - Span/Wire Changes:

Sometimes, shortening span lengths can improve the storm-withstanding capability of distribution lines. The span length can be shortened by adding more poles to an existing line.

In addition, some older distribution lines have old small copper wire (for example, #6 and #4 Cu) or copper-clad wire and aluminum wire with a steel core. Replacing this old wire with larger-sized wire could avoid some outages during major storms.

6 - Reconducting Power Lines with Low-Sag, Advanced Conductors:

A number of utilities are increasing the capacity and efficiency of existing transmission and sub-transmission lines with advanced conductors, which can increase the capacity of existing transmission corridors by 50 to 150 percent. This class of conductors allows utilities to increase existing corridor capacity using existing structures, which minimizes environmental impact, reduces permitting challenges, and substantially reduces project costs and construction timeframes.

While advanced conductors are designed to carry more current and reduce thermal sag, their lighter weight composite cores also allow incorporation of up to 30 percent more conductive aluminum, which reduces electrical resistance and associated line losses under any load flow condition.



B - SPACING CONSIDERATIONS

1 - Relocating Power Lines:

Relocating lines to less damage-prone areas or building extra lines as backups may be options for strengthening the system in many places.

2 - Vegetation Management:

Trees and other vegetation growing in or adjacent to the power line right-of-way need to be trimmed to prevent power outages caused by tree contact with a transmission line. Any power line contact with a tree can cause a short circuit which may lead to a blackout or threaten public safety.

It is a good idea to prune trees and other vegetation beyond the minimum clearance distance, in order to account for the fact that they continuously grow and sway with the wind.

Power lines can also sag due to high usage, heat, or snow/ice build-up. As such, prudent right-of-way maintenance necessitates a greater clearance distance between power lines and trees than may occasionally appear to be necessary.

Vegetation management also helps to reduce wildfire risk that increases if and when lines come into contact with the vegetation.

3 - Undergrounding:

Undergrounding has a number of benefits, such as reduced outages from trees and tree limbs. However, it also has some drawbacks, not the least of which is the expense.

That is, placing utility lines underground eliminates their susceptibility to wind, ice, and lightning damage. In the U.S., undergrounding has been proposed many times as a way of hardening, but it's often been set aside as a serious solution because of the cost.

Although undergrounding of existing overhead infrastructure is expensive, some utilities target specific undergrounding projects, especially for lines serving critical infrastructure and selected backbone circuits.

While most underground facilities are immune to wind-related damage, they are prone to flooding. Undergrounding also presents another challenge - longer repair time and much higher repair costs.

Again, Finley engineers can help you through possible plans for partial undergrounding – where such projects may make sense, how to plan the projects, etc.



C – SPECIAL SITUATION STRATEGIES

1 - Fire-Resistant Technologies:

As noted above, replacing wooden poles with steel poles reduces potential damage from wildfires. And, again, vegetation management reduces fire risk.

2 - Flood Hardening:

Flooding is often considered to be the most significant extreme weather event because of the long-term effects of flood water damage on substations and underground electrical services. Floods can be generated by river floods, flash floods, and/o ocean storm surges/tides. Flooding affects many aspects of the power system, but it is a major concern to substations. Flooding becomes a problem for substations when the amount of water reaching the drainage network exceeds its capacity. It can cause severe damage to substation equipment and may lead to interruptions in service continuity and widespread outages. Large amounts of water, rust, and mud left trapped behind a flood in a substation can make repair of the equipment a lengthy and expensive restoration task. Finley engineers can help you determine where flooding may be a risk to your system, and what steps you can take to take to reduce such risks.

3 - Heat Waves and Dry Spells:

There are several ways to harden a power system from heat waves and summer peaks. These include: inspecting substations for peak load readiness, identifying load-relief projects with projected overloads, identifying potential thermal overloads and low voltages, developing or updating emergency load-transfer and contingency switching plans, and verifying the availability of capacitor banks.

As a precaution, it is also a good idea to upgrade distribution transformers before the summer season. One plan is that every transformer that experiences a fuse trip during the year should be considered for upgrade as required before summer.



STRONG ON IDEAS.
STRONG ON DETAILS.

D – SPECIAL STRATEGIES

1 - Design for Quick Restoration:

This concept has to do with designing the system for quick restoration. This more pragmatic approach admits upfront that no amount of reinforcement and preparation will completely avoid damage from certain events, be they Category 4 hurricanes or F5 tornadoes. Economic steps can be taken to make key elements of the system, particularly the societally critical circuits, faster to repair and restore when downed.

These can include: relocating switching and overhead equipment to minimize possible damage and make it more accessible for quick repair, using more and better-placed lateral fusing to reduce cascading outages from fallen lines and the like (which is common where higher-than-normal tree outages can be minimized to a specific branch or lateral instead of the entire circuit), conducting general reexaminations of circuit arrangement and locations with an eye toward making it easy and quick to repair if lines are downed and equipment is ruined, limiting the number of customers affected by a line outage through circuit configuration, and minimizing long overhead line exposure (given that shorter overhead circuits tend to have fewer outages than those with long overhead exposure because of less exposure to trees, vehicles, wind and other factors that cause outages).

Here, Finley engineers can help you create a comprehensive plan for how to proceed in this area.

2 - Identify Circuits That Warrant Special Hardening Efforts:

Often, the aftermath of a storm with a widespread impact is particularly hard on the surrounding community because basic required services are not available for days after a storm, such as hospitals having to run on emergency power, gas stations having no power to pump gas, etc. In these situations, substantial consideration should be given to hardening these societally-critical circuits.

Overall, again, it makes sense to meet with a Finley representative to discuss all of the potential risks your system faces where hardening may make sense, and which hardening strategies will be the most useful and cost-effective for you.