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Hurricanes and Electricity Infrastructure Hardening

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This Insight discusses the measures undertaken by electric utilities to prevent or mitigate power outages resulting from severe weather events. Power lines and transformers used to provide electricity to customers are particularly susceptible to damage due to their exposure to the elements. (See CRS Report R42696, *Weather-Related Power Outages and Electric System Resiliency*.) The loss of life and extensive damage seen so far in the 2017 hurricane season has refocused the attention of Congress on the destructive potential of such storms. High winds, rain, and coastal surges can combine to create floods which exacerbate damage from hurricanes. Other severe weather events such as ice storms can be equally as destructive as hurricanes and tropical storms, and can also affect entire U.S. regions.

Infrastructure Hardening

Winds and rain from hurricane-type events tend to cause different types of power system failures than snow and ice events. Power outages from hurricane-type events are most often a result of damage to electric distribution lines caused by high winds or flooding. Transmission lines typically have wider rights-of-way clearings than distribution lines, and are therefore less susceptible to impacts from flying debris and vegetation. Many utilities have sought to reduce storm-related outages by "hardening" their systems to storms, by making the electric lines, poles, and distribution transformers less susceptible to damage. This might include simple yet generally effective strategies, such as increased tree-trimming schedules to prevent branches or trees from falling on power lines. To protect against high winds, wooden poles can be replaced on distribution lines with metal or concrete poles, and use supporting "guy" wires or structural supports to keep poles upright. Flood mitigation can lead to substations and system control rooms in flood-prone areas being moved to higher ground, or berms or floodwalls being built to protect facilities which cannot be moved.

Undergrounding Power Lines

Among the more expensive options for hardening is placing distribution lines and transformers underground, which can be 5 to 10 times (or more) than the cost of an overhead line depending on topography and subsurface conditions. Underground lines may require special insulation, and can be

encased in conduits or steel pipes. While underground lines may be less prone to many severe weather impacts, the power lines and equipment access vaults may not be completely impervious to damage, especially due to flooding from storm surges. Maintenance costs for underground facilities may also be higher, as a line may have to be dug up to make repairs.

The perceived benefit of burying power lines sometimes comes at a cost which some communities are not willing to accept. Costs of undergrounding are usually passed along to electricity customers, and collected over an assumed average 25-year service life. Some utilities are also willing to share the cost with communities, as they may derive some benefits from undergrounding. However, plans to underground power lines are not always approved by regulatory bodies in some jurisdictions, as electric utilities and transmission builders are often required to consider "least cost" options.

Making Electric Systems More Weather Resilient

Resilient electric systems are able to maintain some level of operations during hurricanes or storms, and quickly recover from storm-related damage. To promote system efficiency and resilience, many electric utilities are deploying "smart grid" sensors and control technologies, which can pinpoint line segments with power failures and reroute power flows, thus helping to speed restoration efforts. Utilities also plan for storm-related events, and conduct preparedness drills involving their fellow utilities under existing or improved mutual assistance agreements. The question of how much more system hardening is appropriate must be addressed in the context of the perceived risks from climate change. While some distribution poles and electric power facilities have been hardened in coastal areas to withstand a category 3 hurricane, consideration may be warranted for upgrading certain facilities to withstand a category 5 event.

Congress may consider options to help reduce storm-related outages. These range from improving the quality of data on storm-related outages to help risk assessments, to a greater strategic investment in the U.S. electricity grid under an infrastructure improvement program. Congress could also empower a federal agency to develop standards for the consistent reporting of power outage data. Improved data collection at the distribution level could lead to better assessments of and improved reliability for distribution systems, as this is where most power outages occur. While responsibility for the reliability of the bulk electric system is under the Federal Energy Regulatory Commission (as per the Energy Policy Act of 2005), no central responsibility exists for the reliability of distribution systems. Distribution system reliability is typically under the regulatory purview of state public utility commissions (PUCs). State PUCs largely have authority over rate processes for cost recovery by utilities for their investments in infrastructure. Another possible option could be for a federal agency or the Electric Reliability Organization (i.e., the North American Electric Reliability Corporation) to develop a "best practices" database focused on improving electric distribution system reliability.