ENVIRONMENTAL ENERGY INSIGHTS
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# Hardening, Resiliency, and Cost Recovery: Utilities Respond to Extreme Weather

**Summary:** In light of recent extreme weather events, electric power companies, regulators, legislators, and other stakeholders are evaluating options for storm hardening and resiliency to improve electric system reliability and response. This article discusses a range of measures utilities employ to safeguard critical infrastructure and highlights cost recovery mechanisms utilities have used to fund these investments. Case studies from New Jersey and Florida illustrate recent trends in state legislative action and public service commission (PSC) activities following extreme weather events. Hardening the electric grid and investing in resiliency measures is a multi-step process that requires an ongoing commitment to ensure the system is prepared for extreme weather events.

Increasing frequency and severity of extreme weather events pose serious challenges to the nation's generation and distribution infrastructure, while increasing temperatures and drought conditions can restrict the water supplies necessary to cool thermoelectric generation facilities (see *Water Risk and the Electric Sector* in the Summer 2012 edition of *Energy and Environmental Insights*). According to the National Oceanic and Atmospheric Administration (NOAA), 2011 and 2012 sustained the most destructive domestic extreme weather events—sustaining at least $1 billion of damage—with a record 14 weather-related disasters each in 2011 and 11 weather-related disasters in 2012, respectively. To guard against these challenges, the electric sector has begun to assess its vulnerability to extreme weather events and mitigate future risks. These efforts include reinforcing and upgrading aging electric infrastructure to better withstand extreme weather conditions and facilitate rapid response and recovery. In the past, utilities have made significant investments in system hardening and resiliency following a major storm or catastrophic event. Recently, however, utilities and stakeholders are proactively assessing vulnerabilities and implementing hardening and resiliency measures prior to extreme events.

### System Hardening and Resiliency Measures

A 2012 Congressional Research Service report notes that storm-related outages cost the U.S. economy between $20 billion and $55 billion annually, increasing each year (see Figure 1). Table 1 illustrates several investment options to mitigate a variety of infrastructure and distribution risks associated with extreme weather conditions.

Utilities must strategically evaluate which measures are most cost-effective based on unique geographic and physical needs. For example, while burying power lines may reduce the frequency of outages in wind- or storm-prone areas, these systems are much more susceptible to flood damage. In addition, installation of underground lines may cost five to ten times more than overhead lines. Thus, each utility must weigh the cost and feasibility of burying lines against their territory's risks. Many utilities opt to upgrade poles and related structures with stronger materials as well as install structural supports while selectively undergrounding where most effective.

Utilities must also factor in the need to address drought conditions or other water constraints associated with extreme temperatures as they seek to modernize power plants or invest in new infrastructure. For instance, reduced availability of water for cooling equipment or water discharges may constrain power production at existing facilities as well as the location or type of new power plants. Wildfires, exacerbated by drought conditions, also pose significant risks for many utilities. For example, as a result of severe wildfires in Southern California in October 2007, the California Public Utilities Commission began a rulemaking process to improve inspection and maintenance of overhead lines and implement a series of other new requirements to address wildfire readiness. The resulting improvements included replacing wooden utility poles with metal, further insulating wires, placing transmission lines underground in areas of high fire risk, and improving vegetation management. Future improvements are expected to include smart grid functionality to cut off power to lines at high risk of starting fires. Such technologies are gaining increasing prominence as stakeholders focus on outage detection and response related to extreme weather.

### Cost Recovery Mechanisms for Storm Restoration and Hardening Measures

While utilities recover normal operational and capital ex-

### Hardening and Resiliency Defined

As defined by the Department of Energy's Office of Electric Delivery and Energy Reliability, *hardening* refers to physically changing infrastructure to make it less susceptible to damage from extreme storm activity, while *resiliency* refers to measures that enable an energy system to recover quickly from damage. Ultimately, hardening improves the durability and stability of energy infrastructure making it better able to withstand the impacts of extreme weather events without sustaining major damage. In contrast, resiliency measures allow systems to continue operating despite damage and promote a rapid return to normal operations when damages and outages do occur.

penses through customer rates, that process is not always available for recovering unexpected costs incurred as a result of storm recovery and restoration efforts. Thus, many utilities have storm accounts or storm reserve accounts as a type of self-insurance against unexpected costs. (Private insurance is often unavailable to utilities.) However, these accounts, while helpful, may be insufficient when confronted by costly extreme weather events, including those discussed in the case studies below.

In addition to considering the range of costs associated with mitigation and recovery efforts, utilities must also evaluate the various means to recover such costs and the implications for consumers' rates. Often, utilities and regulators phase-in rate increases and time rate increases to coincide with the removal of existing surcharges or the onset of lower fuel prices in order to mitigate the impact to consumers. Table 2 briefly explains several cost recovery mechanisms.

## Case Studies

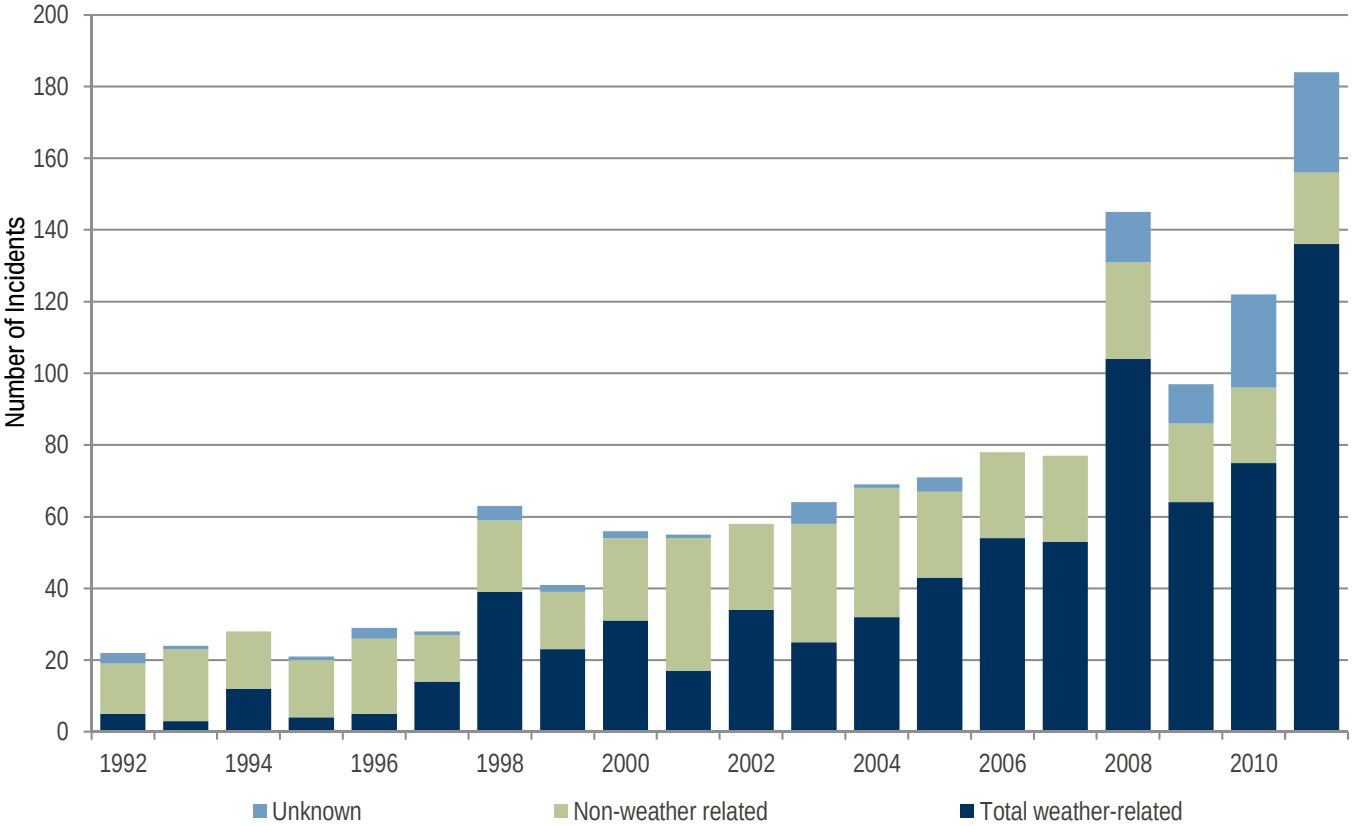
The remainder of this article examines how two states have responded to recent extreme weather events. Florida established new cost recovery tools enabling long-term investment after a series of destructive hurricanes. After a series of storms, New Jersey is working proactively with stakeholders to harden the system while reducing costs to consumers.

*Florida*

A series of eight hurricanes caused record damage in Florida in 2004 and 2005. In the aftermath of these storms, Florida developed requirements for resiliency and utility accountability that emphasized collaboration among state agencies, state universities, utilities, and other stakeholders. As a result, Florida's utilities have developed some of the most comprehensive infrastructure hardening programs to date, utilizing three main mechanisms for utility cost recovery: storm reserve accounts, securitization, and contributions-in-aid-of-construction (CIAC). Specifically, Florida Power & Light's (FPL) experience reflects how state regulatory and legislative efforts have prompted utilities to make significant infrastructure investments while also allowing for unique approaches to cost recovery.

Previously, storm reserve accounts had provided sufficient financing to address storm damage. However, recovery costs in 2004 and 2005 surpassed the reserve funds held by all five of the investor-owned utilities in Florida. In response, the Florida PSC and the Florida Legislature initiated a new approach to funding storm recovery. The state passed legislation allowing securitization (bonds backed by a secure revenue stream) and the PSC initiated a multiyear process to reevaluate storm hardening. The PSC's final rulemaking included new standards for vegetation management, overhead and underground power line construction, and pre-determined cost-recovery. The rule-

**Figure 1: Causes of Electric Grid Disruptions (1992-2011)**




Sources: MJB&A Analysis based on EIA Form OE-417 submittals. Data include disturbances that occur on the bulk electric systems in the US including electric service interruption, voltage reductions, acts of sabotage, unusual occurrences that can affect the reliability of the bulk electric systems and fuel problems.

| Table 1. Electric Sector Responses | | |
|---|---|---|
| Hardening Measures | Flood Protection | Elevating substations/control rooms/pump stations; redesigning elevation of intake structures |
| | | Relocating/constructing new lines and facilities |
| | | Building coastal barriers, dikes or levees |
| | Drought Protection/ Extreme Heat | Consider dry (air-cooled) or low-water hybrid (or recirculating) cooling systems for power plants |
| | | Add technologies to pre-cool water discharges |
| | | Utilize non-fresh water supplies: municipal effluent, brackish or seawater |
| | Wind Protection/Wild Fire Protection | Upgrading poles and structures with stronger materials |
| | | Strengthening poles with guy wire |
| | | Burying power lines underground |
| | Grid Modernization/ Smart Grid Technologies | Deploying sensors and control technologies (e.g., Phasor Measurement Units [PMUs]) |
| | | Utilizing asset tools and databases, advanced mapping technologies, (e.g., Automated Mapping & Facilities Management, SCADA systems, substation automation, and GIS) |
| Resiliency Measures | General Readiness | Extreme weather preparedness planning and training |
| | | Complying with inspection protocols/preventative maintenance |
| | | Vegetation Management |
| | | Mutual assistance agreements/increased labor force |
| | | Purchasing or leasing mobile transformers, substations and generators |
| | | Procuring standby equipment |
| | Event-Specific Readiness | Facilitating employee evacuation and reentry |
| | | Coordinating priority restoration and waivers |
| | | Securing emergency fuel contracts |
| | | Enhanced communication; supplying logistics to staging areas |
| | | Develop flood- and drought-management plans, storm water management plans |

making also required utilities to submit hardening plans every three years for review by the PSC. The PSC directed the state's investor-owned utilities to better protect electricity delivery systems as well as improve power restoration efforts. The PSC further strengthened these rules in June 2006 by directing the utilities to establish guidelines for overhead and underground transmission and distribution lines. In a separate proceeding, the PSC also established a uniform process for utilities to receive CIAC from customers who request new or upgraded electric facilities.

Following the PSC's final rulemaking, in May 2007, FPL, Florida Public Utilities Company, Gulf Power Company,

| Table 2. Cost Recovery Mechanisms for Storm Restoration and Hardening Measures | |
|---|---|
| Rate Adjustment Mechanisms (Customer Surcharges, Trackers, Riders, Adders, Cost Recovery Factors) | Allows a utility to recover specific unforeseen costs, such as from storm damage, and allows utilities to implement special projects such as grid-hardening and smart grid deployment. |
| | May be added as a separate line item on a customer's bill for a specified number of years and may be fixed in advance or vary as costs change, pending PSC review and approval. |
| | Helps avoid the need for frequent rate cases, provide transparency to customers, and provide assurances to the financial community that utilities will not be financially harmed due to slow rate recovery. |
| | May be used to recover a number of expenses, including deferred costs, revenue associated with losing customers during an outage, and purchasing replacement electricity. |
| Formula Rates | Allows a utility to recover unforeseen costs between general rate cases by allowing an adjustment. |
| Securitization | To quickly raise emergency funds, utilities may sell bonds backed by secure revenue streams where state legislation requires repayment of such bonds by customers. |
| | These are typically highly-rated and available at lower interest rates than unsecured financing, which results in lower costs to consumers. |
| Contribution in Aid of Construction (CIAC) | Customers or other entities pay for or contribute to the costs of undergrounding or hardening measures. For example, customers may pay for the difference in costs between overhead and underground lines for new installations or the costs of undergrounding new lines plus the cost of removing existing overhead lines. |
| | Under some circumstances utilities may match customer contributions, but these contributions are not allowed to be recovered in a utility's base rate and may be considered taxable income. |
| Federal Funding | Upon a Presidential declaration of a state of emergency, Federal Stafford Act funding may be available to municipal, state, and rural electric cooperatives, but not to investor-owned utilities. |
| | Under limited circumstances, Community Development Block Grant (CDBG) funding has been made available to investor-owned utilities. |
| | CDBG funds may be used for short-term relief, mitigation activities, and recovery activities. |

Progress Energy Florida, and Tampa Electric Company filed storm hardening plans, each of which were approved. The plans demonstrate that hardening the electric grid is a multi-step process that requires a long-term commitment by many stakeholders. For example, between 2007 and 2013, FPL invested nearly $460 million to strengthen its electric infrastructure. On May 2, 2013, FPL announced a three-year plan to further strengthen the system against extreme weather events. FPL's program includes making local critical infrastructure facilities, including hospitals, fire and rescue stations, and 911 communication centers, more resilient to severe weather. The program also includes improvements to power lines and associated equipment. In 2013, FPL expects to trim vegetation from more than 15,000 miles of power lines in addition to the 15,000 miles completed in 2012. Overall, FPL plans to invest approximately $500 million between 2013 and 2015. The costs of these improvements are covered by the utility's current four-year rate agreement.

*New Jersey*

New Jersey has also begun to proactively address storm damage preparation and recovery. In response to an unprecedented recent number of storms, New Jersey and its utilities have begun considering how to best respond and prepare for extreme weather events.

For example, the response by Public Service Electric & Gas (PSE&G) demonstrates how one utility is seeking to implement a comprehensive plan to address major infrastructure needs while working with key stakeholders to build support. In 2011, two back-to-back storms resulted in prolonged outages across the state. As a result, the Board of Public Utilities (BPU) launched an investigation into electric utilities' handling of large-scale weather events. By the end of 2011, the BPU adopted the Hurricane Irene Electric Response Report, identifying numerous recommendations for improving utility storm response and preparation, and authorized further investigation into various issues highlighted in the report. Less than a year later, Superstorm Sandy hit the state, resulting in the loss of power to almost three million people for nearly two weeks and highlighting the need for these investments.

As a response to the recent storms, the BPU issued an order on January 23, 2013, to harden regulated utility infrastructure and prepare for future storms. The order also contained various requirements, including running preparedness drills and trainings for outages; making an estimated time of restoration available within 24 hours of a major outage; providing daily updates to municipalities on the number of customers without electricity and the daily estimated restoration numbers; conducting further study and analysis for flood planning and vegetation management; and creating and filing a smart grid plan.

Shortly after the BPU's order, on February 20, 2013, PSE&G unveiled its "Energy Strong" plan, calling for $3.9 billion for the following investments over 10 years:

- Raising, relocating, or protecting 31 electric switching stations, nine natural gas metering stations, and one liquefied natural gas station affected by recent storms or vulnerable to future ones;
- Replacing and modernizing gas mains vulnerable to flooding;
- Introducing smart grid technologies and increased redundancy into the electric grid;
- Strengthening utility pole infrastructure; and
- Undergrounding electric lines in areas where it will provide the most benefit.

PSE&G's initial filing with the BPU requests the addition of a surcharge to customer bills to fund the first five years of the program, beginning on July 1, 2013. PSE&G is also evaluating hardening efforts and financing for its unregulated generation assets. PSE&G has estimated the impact to customer bills would be minimal due to the concurrent phase-out of other existing surcharges. To date, 33 local governments have approved resolutions or written letters in support of the Energy Strong plan.

## Insights

To date, stakeholders have focused on state-specific drivers for investment in resiliency and system hardening. However, the federal government is increasingly encouraging such investments. For example, the Obama Administration is considering issuing an Executive Order to create incentives for investments in resilient infrastructure for extreme weather, including requiring the use of best practices to site critical infrastructure away from major flood plains. Federal legislators and agencies are also exploring the specific vulnerabilities facing electric infrastructure as a result of extreme weather activity and industry responses.

Given that electrical infrastructure lasts for decades, resiliency planning adds an additional variable to the factors developers of new generation and transmission must consider. However, unlike some variables for which there is historic information or common assumptions for the future, little reliable information exists regarding the specifics of future extreme weather events. This uncertainty must be considered with information regarding water supply, land availability, and other environmental concerns as the industry assesses future energy demand and production in a changing climate undergoing extreme weather events. For example, technology choices regarding land and water may constrain options with regard to other goals, such as reductions in carbon emissions. These kinds of tradeoffs will need to be considered by the electric power industry as future investments in energy infrastructure are made.

Implementing strong and effective resiliency measures as well as a comprehensive communication and engagement strategy with customers and regulators prior to extreme weather events can facilitate utilities' ability to successfully recover prudently-incurred costs once an event occurs.