PSE&G Infrastructure Program Builds Climate Resiliency to Weather Historic Storms





Executive Summary

Superstorm Sandy raged across the East Coast in October 2012, killing more than 125 people and causing \$60 billion in damage. Rather than hoping a storm like Sandy would never happen again, Public Service Electric & Gas (PSE&G) set a new course and began work to protect its systems from extreme weather. The return on PSE&G's \$4.8 billion investment was apparent in September 2021, when Hurricane Ida slammed into New Jersey, causing deadly flash floods and a rare Category 3 tornado but only minimally impacting PSE&G's grid. PSE&G's initiatives set a new benchmark for modernizing utility infrastructure.



Introduction



In 2012, Superstorm Sandy became the most powerful and destructive storm ever to make landfall in New Jersey. As a result of Sandy's fury, more than 2 million Public Service Electric & Gas (PSE&G) customers lost power – nearly half of the outages were due to switching stations or substations flooded by Sandy's historic storm surge.

In the aftermath of Sandy, PSE&G took decisive action to protect its customers from future extreme weather events. This included modernizing and strengthening its systems in 2014 after the New Jersey Board of Public

Utilities approved an initial investment of \$1.2 billion through the Energy Strong program. The investments included raising, rebuilding and eliminating substations, installing smart grid technologies and replacing 450 miles of gas lines.

While utilities across the country are now setting new records in investment to upgrade aging infrastructure and support the clean energy transition – an estimated \$140 billion this year alone – PSE&G began its work a decade ago, PSE&G's efforts are providing invaluable defenses against climate change and extreme weather and contribute to PSEG's vision of powering a future where our customers use less energy, and it's cleaner, safer and delivered more reliably than ever.

PSE&G's investments have established a new industry standard for hardening and modernizing electrical and gas networks to meet the 21st Century challenges of extreme weather caused by climate change without raising customer bills. In fact, the average PSE&G combined residential electric and gas customer's bill is now 20 percent lower than it was in 2008.

Through Energy Strong and other capital programs, PSE&G raised, rebuilt or eliminated 36 substations or switching stations. Nearly 3,000 pieces of highly specialized equipment were installed or upgraded to reduce outages and enable faster power restoration.

The benefits of this historic infrastructure investments were apparent when the remnants of Hurricane Ida arrived in New Jersey in September 2021, which included deadly flash floods and a rare Category 3 tornado. None of PSE&G's substations experienced service interruptions due to flooding, compared to the 29 substations that experienced service interruptions due to flooding during Sandy or Hurricane Irene in 2011.

The infrastructure improvements kept the electricity connected throughout the storm,



which helped minimize Ida's flood impacts, as customers' sump pumps were able to keep working.

In addition, PSE&G's Gas System Modernization Program (GSMP) – which is replacing 1,300 miles of aging cast-iron or unprotected steel gas infrastructure with more durable plastics – prevented many more customers from experiencing gas shut-offs due to flooding. During Ida, newly replaced gas mains experienced no water infiltration issues, and the safer, more durable plastic equipment helped maintain increased pressure in the system. A new web-based tool specifically designed for gas restoration and construction also helped assure that PSE&G was well-prepared and avoided widespread impact on gas infrastructure.

Hardening New Jersey's electric and natural gas networks against extreme weather events remains a work in progress. We have made significant headway during the past decade, but there is still much work to be done to protect our customers and our energy infrastructure against the impacts of climate change. Future phases of the Energy Strong and GSMP programs are planned, and a newly proposed investment program is intended to increase 'last mile' reliability at the neighborhood level.







Protecting New Jersey Following Superstorm Sandy

On October 29, 2012, Superstorm Sandy raged across the East Coast, killing more than 125 people and causing \$60 billion in damage. The storm caused the largest storm-related power outage in U.S. history, affecting 8.5 million people across 21 states. About 2.7 million people lost power in New Jersey, some for as long as two weeks. More than 2 million PSE&G customers, 90 percent of the utility's electric customers, suffered outages – nearly half the result of storm surge flooding switching stations and substations.

Economic losses in New Jersey totaled almost \$30 billion, including severe damage to utility infrastructure. The destruction from the storm included:

- 346,000 homes damaged, and more than 113,000 trees were damaged or knocked down – many onto power lines.
- About 60% of the state's gas stations were closed, forcing people to wait in line for hours to get fuel for generators and vehicles.
- 94 wastewater treatment plants across the 21 counties PSE&G serves lost power and flooded.
- Failed pumps allowed saltwater intrusion into the systems, destroying electrical equipment.

- An estimated three to five billion gallons of untreated wastewater was discharged into New Jersey waterways.
- 267 of the 604 water systems across the state lost power, prompting 37 systems to issue boil water advisories following the storm.
- One month after Sandy made landfall, seven drinking water systems were still subject to boil water advisories.

For PSE&G, Sandy was an inflection point. The company realized that New Jersey's energy infrastructure needed extensive upgrades to withstand the effects of climate change, which has made severe storms more frequent and ferocious. PSE&G knew that protecting customers from extreme weather would require wide-ranging investments to modernize and harden critical electric and gas infrastructure. PSE&G got to work developing a detailed plan, securing support from multiple local, state and federal agencies to invest billions of dollars, and deploying legions of civil and electrical engineers and construction workers. It was not an easy task.

To succeed, the company knew it would have to overcome three critical challenges:

 Educate regulators and the public about the vulnerability of existing infrastructure



to climate change-induced extreme

weather. This included detailing how existing systems were vulnerable to the frequency and intensity of storms. For example, Sandy and Irene had caused extensive flooding in non-traditional flood zones. Since 2010, PSE&G has experienced the five most disruptive storms in its operating history.

- Raise awareness of the need to update aging infrastructure. At a time when customers' dependence on electricity is increasing while their tolerance for service interruptions is decreasing, the transmission and distribution systems date back generations, making them increasingly vulnerable to extreme weather.
- Demonstrate that PSE&G could modernize its networks to enhance resiliency and reliability without severely impacting rates (ie, modest impact on customer bills).

Taking advantage of the decline in natural gas prices, PSE&G made valuable resiliency and reliability improvements without raising customers' bills. For the typical combined

"While utilities across the country are now setting new records in investment to upgrade aging infrastructure and support the clean energy transition, PSE&G began this valuable work a decade ago."

residential electric and gas customer, bills are now 20% *lower* than in 2008. PSE&G gas bills are the lowest in the region, and electric bills are lower than the region's average, allowing its customers to get better service at a lower cost.



PSE&G's Vision for Change Put Into Action

Ensuring its electric and gas systems are resilient and reliable is a top priority for PSE&G. Our post-Superstorm Sandy infrastructure work has updated and hardened New Jersey's electric infrastructure from the effects of significant weather events. It has improved resiliency, allowing faster restoration of outages and ensuring safe and reliable service by replacing facilities when they reach the end of their service lives.

After Sandy, PSE&G went to work to overhaul infrastructure and safeguard customers from service interruptions caused by weather catastrophes. Beyond preparing for future



natural disasters, PSE&G also began implementing changes that would move the utility to cleaner, more efficient energy sources that would be delivered more reliably. Deploying new technology and modernizing the power grid would help PSE&G create a more resilient and reliable electric and gas infrastructure while future-proofing the networks in preparation for a shift to clean energy.

PSE&G builds climate resilient Infrastructure



The Energy Strong initiative was an unprecedented investment in New Jersey's electric and gas networks, protecting more than 2.3 million customers from lengthy and dangerous service interruptions.

The program set a new industry standard for hardening and modernizing electrical and gas networks to meet the 21st Century challenges of extreme weather without raising costs to customers. It included overhauling substations, modernizing technology systems and modernizing gas lines.

Phase One of Energy Strong began in 2014 and concluded in 2018.

Phase I included:

 Raised, rebuilt or eliminated 36 switching and substations damaged by water in recent storms, including Sandy, benefiting 490,000 customers.

- Upgraded 223 circuits and improved resiliency by adding smart equipment, including 465 reclosers, benefiting 260 critical facilities (police, hospitals, etc.) and 412,500 additional customers.
- Increased system redundancy, reducing outages when damage does occur.
- Installed more than 1,200 microprocessor relays with remote communications at 111 stations serving 1.45 million customers, allowing for the remote indication of outages and quicker restoration through real-time data monitoring, analysis and control.
- Replaced and modernized 240 miles of low-pressure cast iron gas mains in or near flood areas, removing 90,000 customers from the risk of losing gas service due to flooding. Within the program's first three years, nearly 1,800 active leaks were eliminated.
- Protected five natural gas metering stations and three gas storage facilities affected by Sandy or located in flood zones, resulting in no customer outages due to flooding.

Building on the success of the Energy Strong Phase 1 program, PSE&G is investing an additional \$842 million through 2023 to strengthen statewide electric and gas systems further to better withstand storms, improve reliability and significantly enhance resiliency.

Energy Strong Phase II work began in 2019 and will be completed by 2023.

Phase II includes:

- Raising and hardening equipment in 16 additional substations and replacing equipment in up to four stations that are nearing end-of-life.
- Installing more than 1,450 reclosers and 1,700 fuse-savers to reduce customer interruptions by localizing and isolating



distribution circuits problems and allowing switching that shortens outage durations.

- Retrofitting 2,300 existing reclosers with wireless communications for improved operational awareness.
- Upgrading distribution circuits and other infrastructure, reducing power outages by adding measures such as spacer cable that is more resistant to tree damage.
- Expanding the secure, private fiber communications network that interconnects more than 200 electric stations and operation centers.
- Implementing Advanced Distribution
 Management System to make the electric network smarter and improve outage
 response through quicker detection of
 problems and swifter deployment of
 repair crews.
- Modernizing six gas metering stations and replacing equipment nearing end-of-life.

In addition to hardening systems and moving critical equipment out of harm's way, this effort made PSE&G's systems more intelligent and agile, and better able to accommodate solar and other distributed green energy sources.

The Pay Off: Lights On Despite Historic Storms

PSE&G's proactive action and historic infrastructure investments have spared customers from the devastating power losses they experienced during Superstorm Sandy. Critical facilities like hospitals, nursing homes, police and fire stations now experience power restoration 91% faster than those customers not served by the Energy Strong initiative. For first responders, sustained power loss can be the difference between life and death.





Before this investment, the loss of utility services impacted an array of essential services during Sandy and Irene. Emergency services, including police, fire, 9-1-1 call centers, and government buildings, were crippled. Critical social service programs were interrupted

Ida claimed 30 lives and caused a rare
 Category 3 tornado, but only 215,000 PSE&G
 customers lost power, compared to the more than
 2 million who suffered outages during Sandy.

to support hospitals, nursing homes, care facilities, domestic violence shelters, foster homes, and mental health facilities.

However, after the investment interruption has been minimal. For example, during Subtropical Storm Alberto in May 2018, floodwaters covered the site of the Ewing Township substation, but didn't reach new, raised equipment. Thanks to the Energy Strong work, no customer served by this substation lost power unlike during prior storms.

The best example of how PSE&G's historic infrastructure investment is paying off occurred in September 2021, when Hurricane Ida brought historic flooding across PSE&G's territory. Ultimately, Ida claimed 30 lives and caused a rare Category 3 tornado, but only 215,000 PSE&G customers lost power, compared to the more than 2 million who suffered outages during Sandy. None of the improved stations that had previously flooded during Sandy or Hurricane Irene suffered service interruptions during Ida due to flooding.

PSE&G's Somerville substation, remained in service despite floodwaters reaching 56 inches; the utility's New Milford substation remained in service amid 30-inch-high water. Both stations were flooded during earlier storms, causing widespread outages. However this time around, our investments safeguarded critical equipment and spared PSE&G's 2.3 million customers from prolonged power outages and additional damage caused by inoperable sump pumps.



PSE&G's Somerville substation



In addition, PSE&G's GSMP – which is replacing more than 1,300 miles of aging cast-iron or unprotected steel natural gas infrastructure – has provided significant benefits by protecting 90,000 customers from natural gas shut-offs due to flooding. During Ida, newly replaced gas mains experienced no water infiltration issues, and the safer, more durable plastic equipment helped maintain increased pressure in the system.

Regulators and public officials have repeatedly recognized PSE&G's performance in storms that occurred since Sandy, noting that PSE&G had fewer customers impacted by outages and restored power more quickly than other utilities in the state.



NJBPU President Joseph L. Fiordaliso @njbpuprez

I want to thank @GovMurphy because many of the infrastructure enhancements we've recently made held up. None of our substations were flooded, unlike during Sandy. If this storm happened a few years ago, hundreds of thousands would be without power. The enhancements are working.



Governor Phil Murphy
 1:41 PM · Sep 3, 2021 · Twitter Web App

In the aftermath of Ida, the New Jersey Board of Public Utilities president credited the infrastructure program with keeping the lights on in New Jersey.







Looking Ahead to a Brighter Future

Hardening New Jersey's electric and natural gas networks against extreme weather events remains a work in progress. PSE&G has made significant headway during the past decade, but there is still much work to be done to protect customers and energy infrastructure from the impacts of climate change.

PSE&G is committed to sharing its learnings with other utilities and states looking to strengthen their systems and create more reliable, resilient and clean electric service.

Future phases of the Energy Strong and the GSMP are planned, and a newl initiative – the Infrastructure Advancement Program (IAP) – has been proposed. It would improve the infrastructure closest to PSE&G's customers helping to improve reliability and resiliency and meet the state's changing energy needs.

The four-year, \$848 million IAP proposal calls for updates to PSE&G's electric distribution system and modernizing aging electric substations and natural gas metering and regulating stations and charging infrastructure at PSE&G facilities to support the electrification of the utility's vehicle fleet. These investments would create hundreds of well-paying jobs and help stimulate the New Jersey economy.

The IAP's "Last Mile" upgrades represent the largest portion of the proposal and would enhance electric reliability at the neighborhood level, support the rapid transition to electric vehicles (EVs), and enable more renewable energy to reach the grid.

The proposed improvements include:

- Modernizing six electric substations and switching stations that have been in service for more than 50 years and replacing 40 oil circuit breakers averaging 60 years old with modern gas circuit breakers.
- Replacing underground cables, installing spacer cables, and upgrading poles and open-wire secondary lines to improve reliability.



- Investing in secondary line upgrades and capacitor bank upgrades to support the aggressive electrification of the transportation sector and distributed energy solutions such as customer-sited solar.
- Modernizing seven metering and regulating gas stations to enhance reliability and reduce potential methane emissions, and installing enhanced physical security measures.

The IAP is specially designed to meet customers' evolving needs. Homes are more important than ever to people's daily lives, playing the added roles of offices, entertainment centers, classrooms, and even fueling stations for EVs. Meanwhile, businesses have become increasingly reliant on e-commerce and electronic devices, and many want to provide EV charging stations for customers and employees.

PSE&G is also implementing multiple clean energy programs designed to reduce energy consumption and the greenhouse gas emissions that cause climate change. These investments will help the state use 100% clean energy by 2050 and PSEG reach its Net Zero by 2030 goal while building a more resilient, reliable network.

Meeting the 21st-century challenges of extreme and damaging weather is fundamental to PSEG's Powering progress vision to power a future where people use less energy, and it's cleaner, safer and delivered more reliably than ever.

