
Electric Distribution Resiliency for Major Storm Events

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PSE&G Overview

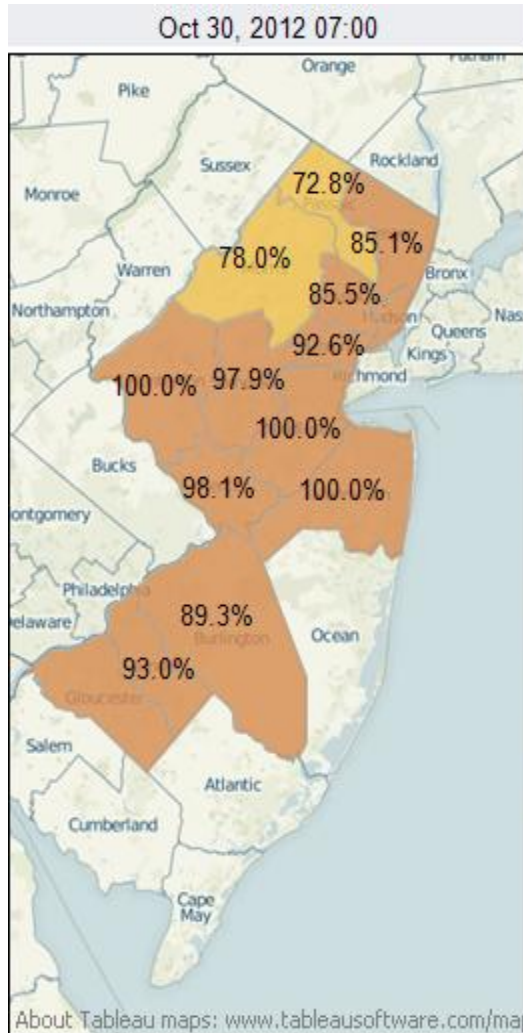
- Demographics
 - Approximately 2.2 Million Electric Customers
 - Service Territory 2,600 square miles
- Electric System
 - 274 Switching and Substations
 - 68% of Customers in 13kV Automated Loop Scheme
 - SCADA Control at 32% of Customer Circuits
 - OMS, GIS and Crew Mobile devices since 2002
- PA Consulting Awards
 - National Reliability Rewards 5 of the last 8 years
 - ReliabilityOne Award Mid-Atlantic Last 11 years

Recent Major Storm Events

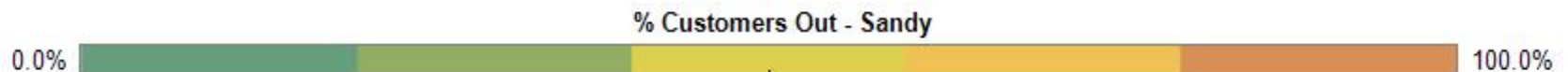
4 Largest Storm Events have occurred in the last 4 years

<i>Start Date</i>	<i>End Date</i>	<i>Storm Name</i>	<i>Rank</i>	<i>Extended Customers Interrupted</i>
10/27/12	11/15/12	Hurricane Sandy	1	2,014,516
08/27/11	09/04/11	Hurricane Irene	2	872,492
10/29/11	11/06/11	Wet Snow Storm	3	674,512
03/13/10	03/20/10	Nor'Easter	4	607,403

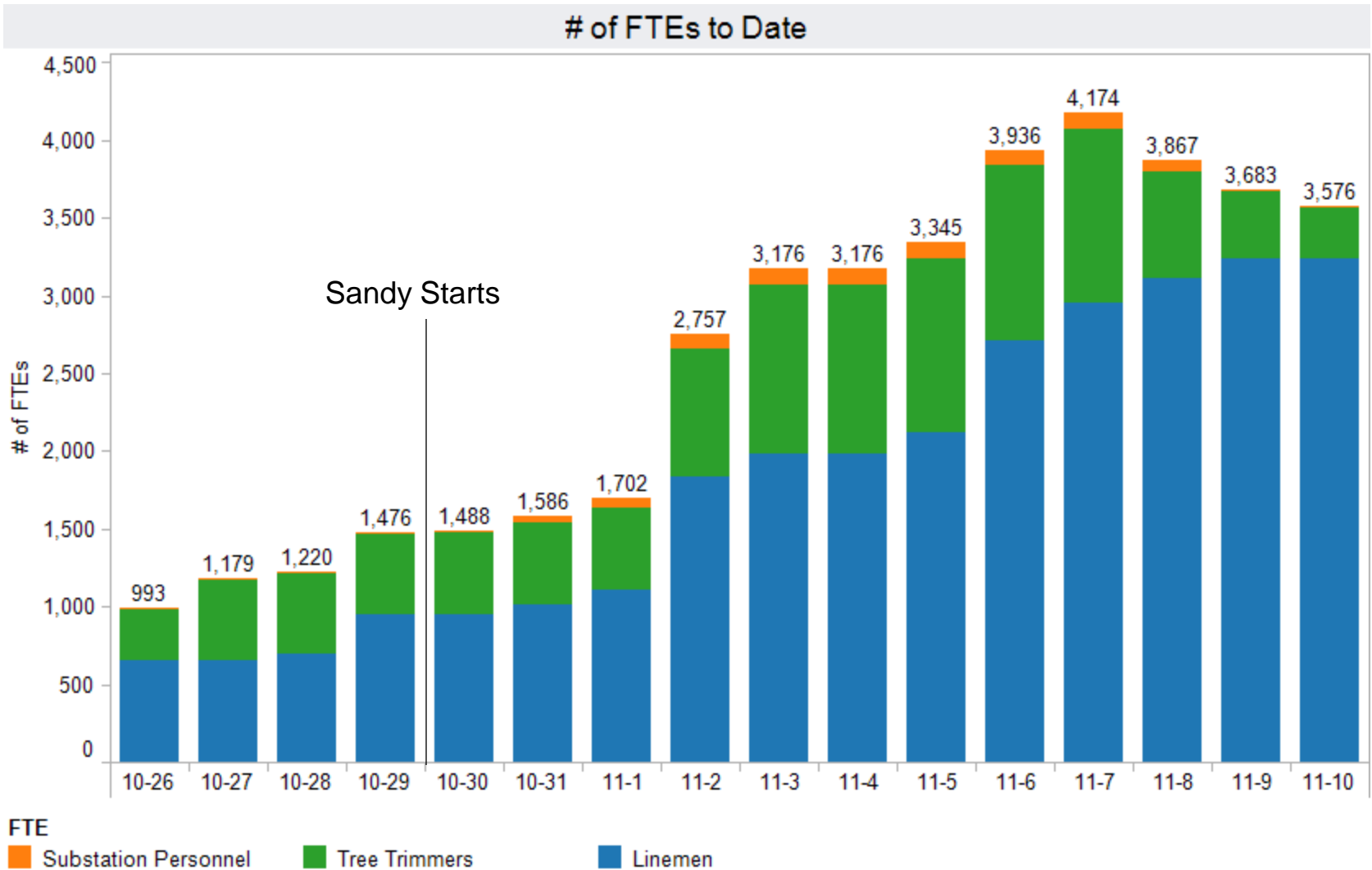
Hurricane Sandy - Impacts and Response



- Sandy Impacts
 - 2 million Customers impacted
 - 90% lost power during the event
 - 14 Switching Stations affected – 33%
 - 7 Flooded, 6 Out, 1 Bus Section Failure
 - 51 transmission lines out, all Station Issues – 33%
 - 96 PSE&G Substations affected – 39%
 - 20 Flooded, 76 Out
- Planning immediately was focused on prioritizing transmission lines to be reenergized to restore switching and substations with the largest customer counts
- Work began immediately after flood waters receded at the stations and once wind gusts dropped below 40 mph in the divisions



Logistics Challenge – Sandy Mutual Assistance Timeline



Major Storm Events – Common Themes

- Multiple Damage locations on Circuits
 - 48,000 tree locations in Hurricane Sandy
 - Loop scheme ineffective
 - Damage behind fuses/devices after initial power loss
- Scalable logistics key to restoration
 - Work identification, Assignment and Execution with mutual aid crews
- Loss of device communication
- Customers demand improved communications

The aftermath.....Energy Strong Proposal

- PSE&G filed its Energy Strong Program with the NJBPU on February 20th.
- In the filing, proposed investments to maximize our ability to respond to and recover from future severe weather events through system hardening and resiliency measures.
- System hardening will make electric and gas infrastructure less susceptible to storm damage, such as that which results from high winds, flying debris, storm surge and flooding.
- Resiliency programs increase the electric system's ability to recover quickly from damage to its components.

PSE&G's Energy Strong Filing – Hardening

Electric Facilities

- \$1.7 billion to protect switching and substations damaged during the storm surges in Irene and Sandy from the impact of future storms by raising some facilities; building storm walls and other remedies.
- \$400 million to make the overhead distribution system stronger. This would include upgrading distribution wires to higher voltage, installing fiberglass and composite poles, selective undergrounding and installing overhead spacer cables that are resistant to tree and limb damage

.....Even with this level of investment, significant outages would still occur in a major storm event.

PSE&G's Energy Strong Filing – Resiliency

Electric Facilities

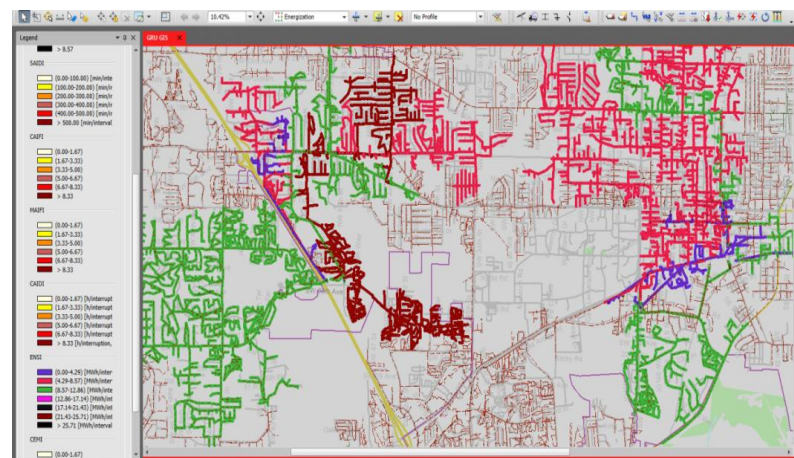
- \$451 million to deploy smart grid technologies. This would allow for better monitoring of system operations, making it faster to identify problems and reducing repair times.
- \$200 million to establish contingency reconfiguration strategies by creating multiple sections, utilizing smart switches, smart fuses, and adding redundancy within our loop scheme



Visual Geographic Awareness

The foundation of the technology recommendations is to create a **Master Storm Center Map** that allows us to visually depict “where”:

- Circuits have been locked out
- Fault locations have been predicted
- Look-ups need to be performed
- Plant Damage has been identified
- Crews are restoring service
- Pending repairs still need to be made



Contingency Reconfiguration Strategies

- Focus on Priority Customers
 - Hospitals, Infrastructure, Government, First responders
- Minimize outages and increase restoration options
 - Increase sections on 13kV loops
 - Increased use of branch reclosers
 - Increase tie points

Energy Strong – The Debate, Resolution and Lesson's Learned

- The Debate
 - Included NJBPU, Rate Council, AARP, NJLUC,
 - 15 Months to reach a settlement
 - Over 1,000 Discovery Requests
- The Resolution
 - Hardening investments for substations only
 - Resiliency Investments reduced by 2/3
- Lesson's Learned
 - Need better means to align costs (well defined) and benefits (viewed as speculative)

Areas for R&D

- Define “value” of resiliency
 - Expand Value of Lost Load to extend outages
 - Impacts of critical infrastructure
- Need better definition of future storm impacts
 - Forecasting storm frequency and severity
 - Simulation of damage and customer impacts
- Storm response simulation
- Ability to identify and model vegetation through automated mechanisms.