Risk Assessment for Storm Hardening

DOE Technical Workshop on Resilience Metrics

April 29th, 2014

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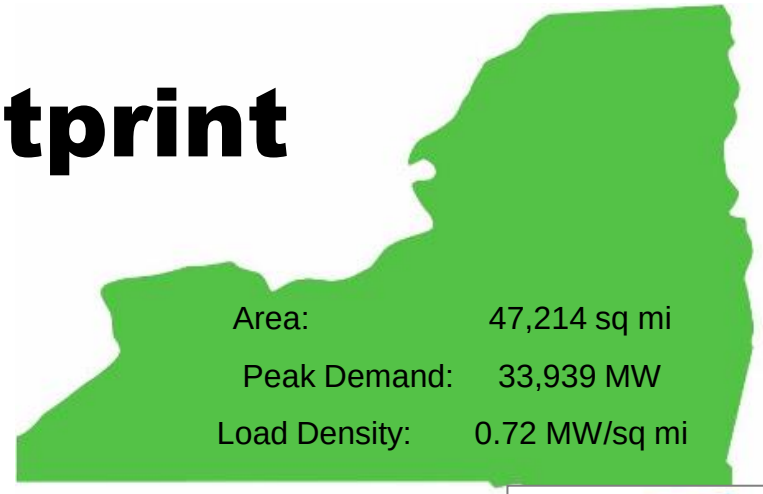
Risk Assessment for Storm Hardening Agenda

- Overview Con Edison System
- Storm Impact
- Hardening and Resiliency
  - Philosophy
  - Modeling
  - System Projects

Con Edison Footprint



Con Edison of New York (CECONY)

Electric

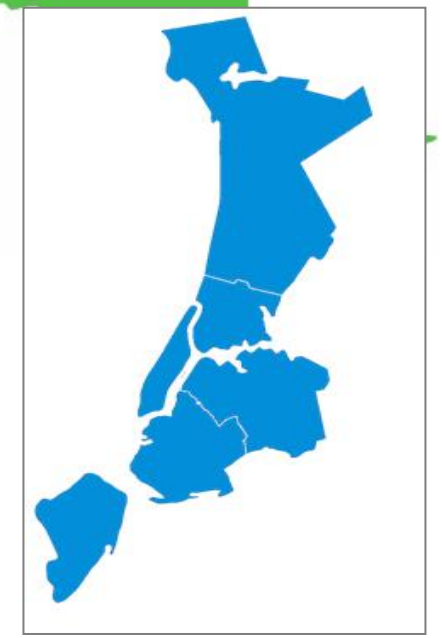
- 3.3 million electric customers
- Peak Demand: 13,189 MW
- Load Density: 21.8 MW/sq mi
- Underground network distribution: 86%
- 690 MW of regulated generation
- 36,000 miles of overhead transmission and distribution lines
- 94,000 miles of underground transmission and distribution lines

Gas

- Manhattan, Bronx, Queens and Westchester
- 1.1 million gas customers
- 4,300 miles of gas mains

Steam

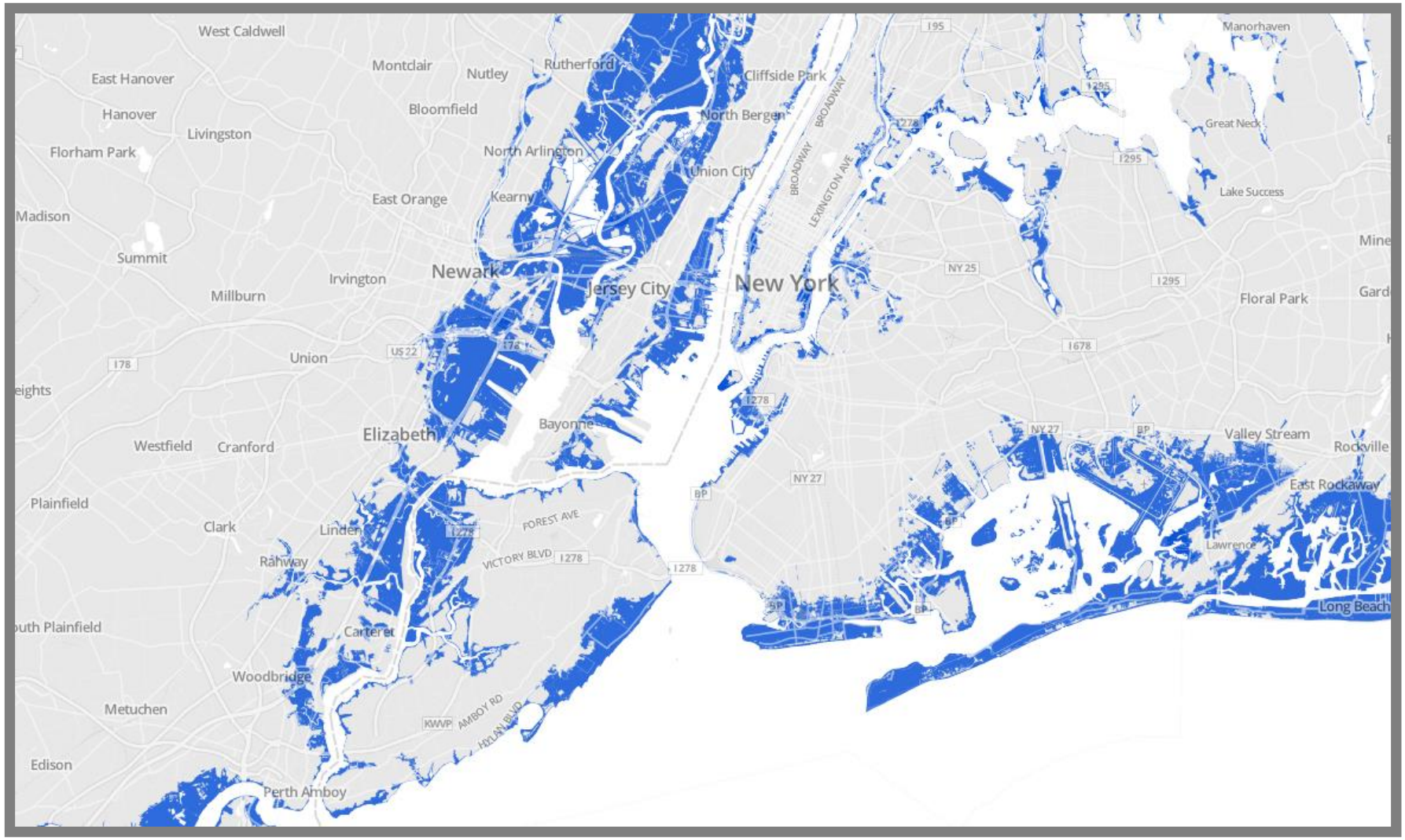
- Manhattan – below 96th Street
- 1,760 steam customers
- 105 miles of steam mains and lines



604 sq mi

Lower Manhattan

Superstorm Sandy
Areas that Flooded



Source: http://project.wnyc.org/flooding-sandy-new/index.html#11.00/40.6846/-74.0224

Impact of Sandy on Con Edison Facilities

Impact of Sandy on Con Edison Facilities

Storm Hardening and Resiliency Guiding Principles

- Protect infrastructure – Relocate and envelope equipment to minimize exposure to wind and water infiltration.
- Harden components – Strengthen equipment to withstand water inundation and tree damage.
- Mitigate impact – Improve flexibility to allow for advanced flow controls around damage equipment.
- Facilitate restoration – To identify location and description of damaged equipment, install remote monitoring and improve communications to expedite information flow.

Hardening and Resiliency Philosophy

Threat
Wind/Tree Caused Damage
Coastal Flooding / Storm Surge

Approach
Protect Infrastructure
Harden Components
Mitigate Impact
Facilitate Restoration

Wind / Tree Damage Hardening and Resiliency

Approach	Solution
Protect Infrastructure	Tree Trimming Selective Undergrounding
Harden Components	New Pole Designs Resilient Cable Designs
Mitigate Impact	Increased Automation Reduced Customer Density per Circuit Smart Switches Isolation Devices Sacrificial Components
Facilitate Restoration	Enhanced Communications Remote Monitoring and Control Automatic Meter Infrastructure

Coastal Flooding / Storm Surge Hardening and Resiliency

Approach	Solution
Protect Infrastructure	Elevate Equipment Flood Barriers
Harden Components	Waterproofing Submersible Equipment Fiber-optic Cable Float Check Valves
Mitigate Impact	Network Reconfiguration Increased Automation Sectionalizing Switches
Facilitate Restoration	Enhanced Communications Remote Monitoring and Control

Hardening and Resiliency Modeling Risk

- The likelihood of a significant storm occurring was based on historical information
- For the transmission and distribution network systems susceptible to storm surge flooding estimates of the likelihood of specific surge level impacts on those systems were derived from historical New York City surge data.
- For Overhead distribution assets storm damages are essentially driven by wind. Probability estimates of this damage based across a range of wind speeds were calculated and applied as impact likelihoods for the OH system assets.
- Combining the likelihood of a storm event, the probability of that event resulting in flooding or wind damage, and the population and infrastructure potentially impacted by those occurrences results in an estimate of the total relative risk for the specific asset under consideration.

Hardening and Resiliency Modeling
Risk Prioritization

The storm hardening prioritization methodology estimates the vulnerability of electric system assets based upon the:

- Likelihood of a significant storm occurring;
- Probability of assets being affected by either flooding or wind damage based on their location;
- Ultimate impact of that electric system damage to population and supporting critical infrastructure.

Storm Hardening and Resiliency Risk and Risk Reduction Metrics

- Risk Assessment Methodology
  - Vulnerability
  - Duration
  - Hardening initiatives.
- Factors
  - Population
  - Critical infrastructure
  - Outage duration

Storm Hardening and Resiliency Risk Model

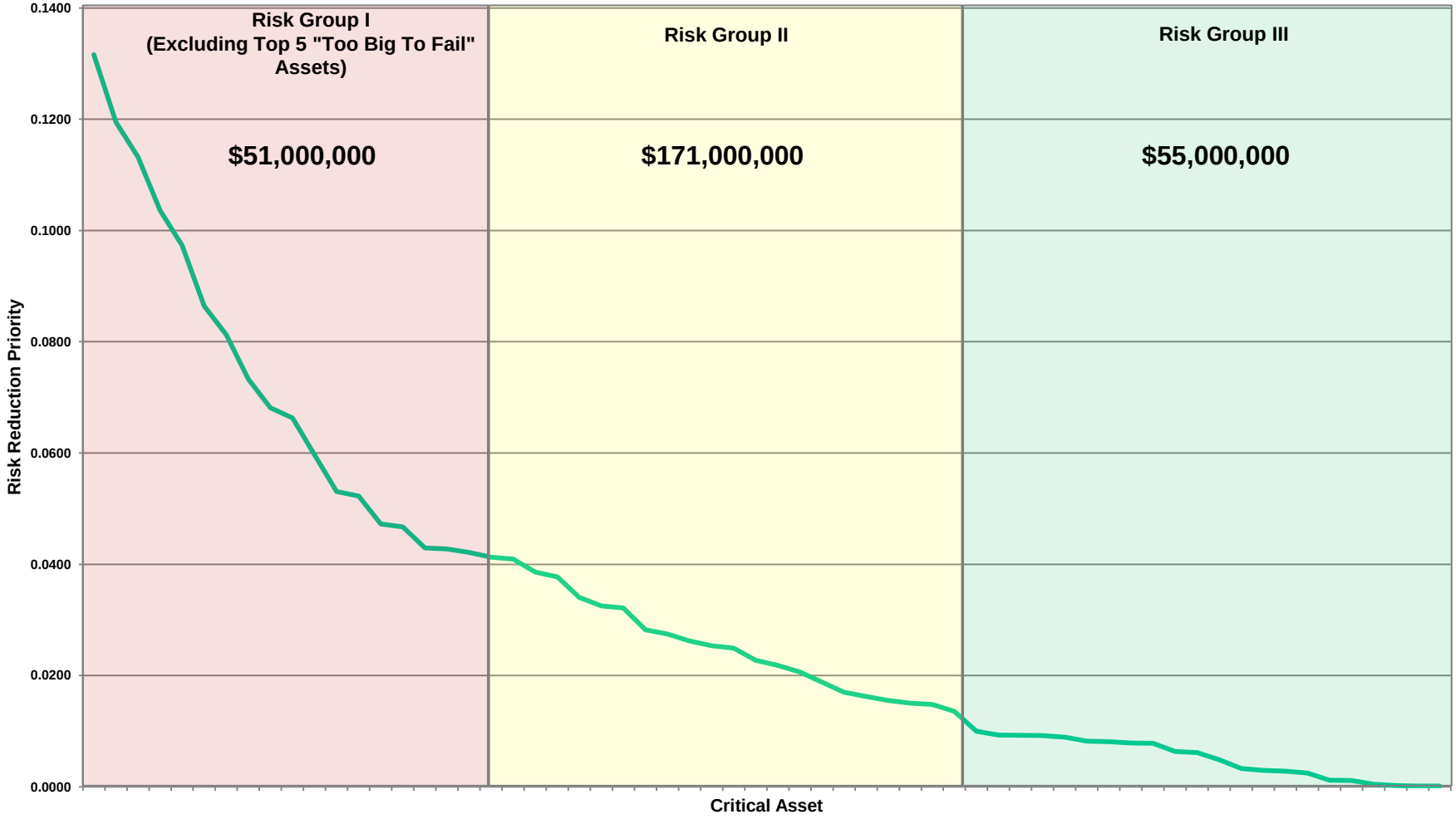
- Model's goal
  - To gauge in terms of risk reduction to customers and critical infrastructure
  - Model quantifies and ranks the reduction in risk associated with each of the storm hardening projects related to the Company's transmission, substation, underground network, and overhead distribution systems.
  - Demonstrate a cost causality linkage between capital funding allocated for storm hardening and the reduction in risk obtained via that investment.
  - Rank all of the asset level risk reductions in highest to lowest order results in an indication of the relative risk reduction benefits across all resiliency programs.

Storm Hardening and Resiliency Economic Analysis

- Economic cost value analysis
  - to quantify, in monetary terms, the benefits of each storm hardening project including, internal cost savings and avoided societal costs.
- Key Expectation
  - help identify the resiliency measures that will have the most impact and be the most cost-effective,
  - select an optimal combination of measures, and prioritize the order of completing them

Mitigation of Impacts (Risk Reduction)

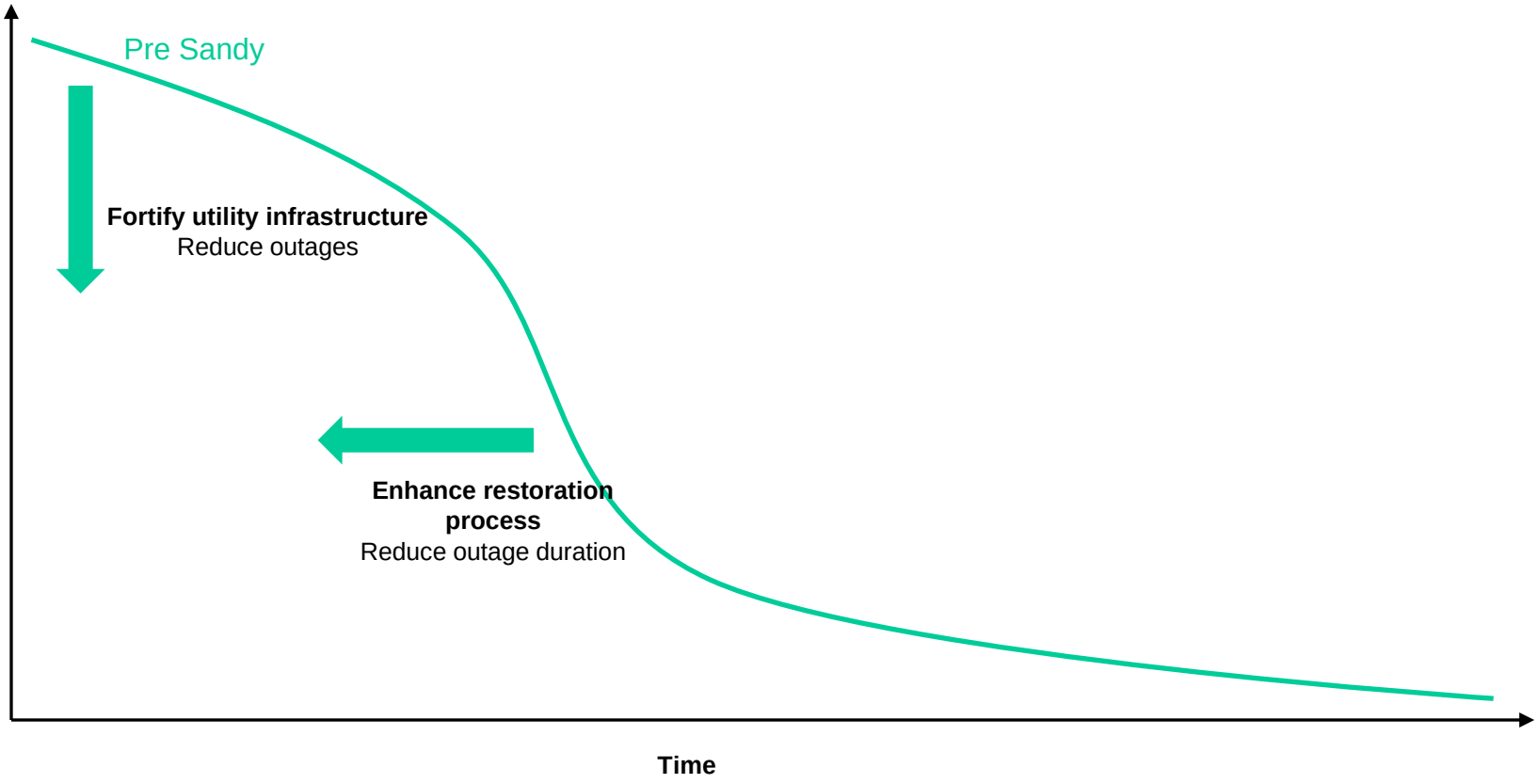
Storm Hardening
Risk Prioritization
with Proposed Capital Funding



REDUCE SYSTEM RISK: WEATHER

Reduce total outage hours

Con Edison is executing a two-fold strategy to reduce outages and outage duration



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Hardening and Resiliency Projects

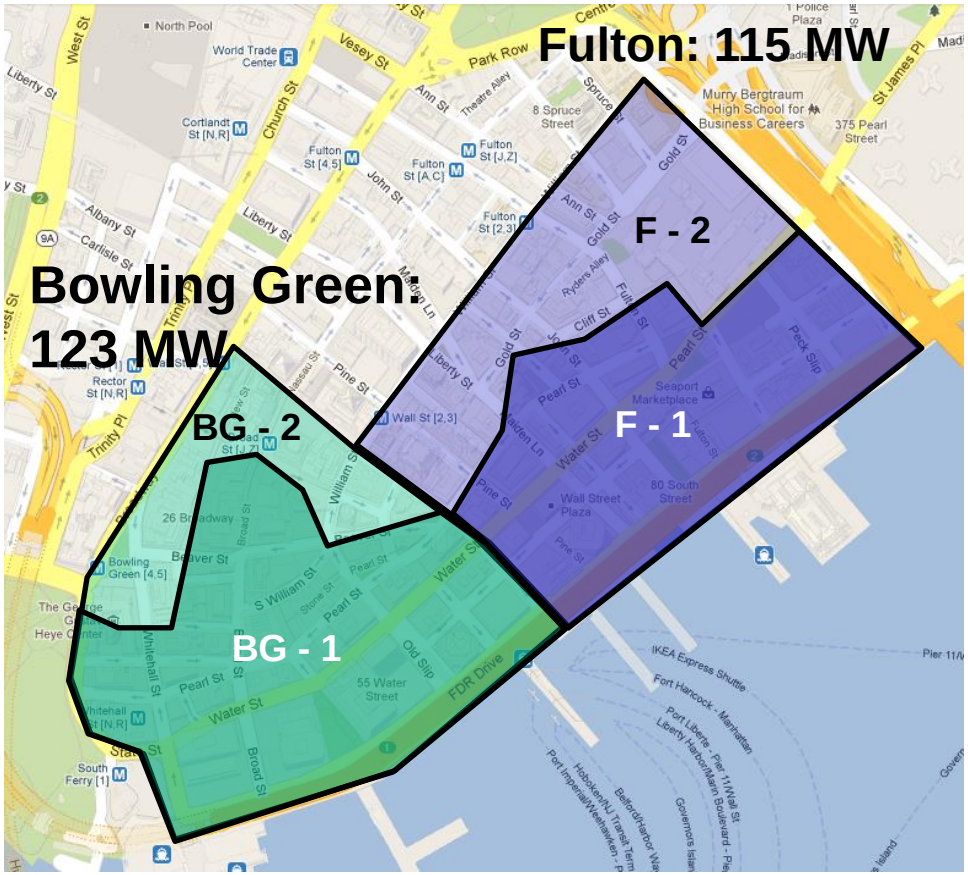
Overhead System

- Advanced Equipment
- Selective Undergrounding
- Reduce Segment Size
- Sacrificial Components
- Enhanced Technology

Underground Network System

Network Reconfiguration

- Utilize Latest Technology
- Harden Components
- Mitigate Impact
- Facilitate Restoration



New Sub-Networks

Substations and Generating Stations

Protect Infrastructure

- Establish New Design Flood Elevation for Each Station
- Control Flood Waters
- Raise Critical Equipment
- Harden Operating Circuits

Steam Generation Plants

Flood Gates

Before

After

Gas Distribution System

Harden Components

- Replace Cast Iron & Bare Steel in Flood Prone Areas
- Install Float Check Valves
- Evaluate Options for 62 Regulator Stations in Flood Zones

Con Edison Developed Float Check Valve

Tunnel Hardening

Protect Infrastructure

- Water Intrusion Management
  - Install Two Additional High Flow Rate Pumps Per Tunnel
  - Install Backup Diesel Generators
- Build Reinforced Concrete Head Houses
  - First Avenue
  - Ravenswood
  - Astoria
  - Hudson Avenue

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