Consolidated Edison Company of New York, Inc.

Electric Distribution Storm Hardening Initiatives

Paul V. Stergiou
Distribution Engineering
October 14th, 2015
Energy For New York City And Westchester

- 3.3 million electric customers
- Record System Load: 13,322 MW
- 36,000 miles of overhead transmission and distribution lines
- 94,000 miles of underground transmission and distribution lines
- 1.1 million gas customers
- 4,300 miles of gas mains
- 1,800 steam customers
- 105 miles of steam mains and lines
- 690 MW of regulated generation
Storm Preparations:
Guided by Corporate Coastal Storm Plan

- Plan triggered Oct. 24 based on National Weather Service forecasts

- Reviewed:
  - 24/7 staffing plans
  - Equipment vulnerability
  - Inventories
  - Protection plans for equipment in flood zones
  - Need for outside assistance
Mutual Aid
Base Camp at Rye Playland
Superstorm Sandy Details

- Storm Classification: Hurricane/Extratropical
- Sustained winds of 64 mph at LaGuardia Airport with a peak gust of 90 mph on Staten Island
- NYC experienced approximately 30 hours of storm conditions
  - Storm tide recorded at the Battery – 14.06'
  - Largest Atlantic storm on record, spanning more than 1,000 miles
  - More than 8.5 million power outages across 21 states
Impact of Sandy

- 1.1 million customer outages
- Lost 4,000 MW of generation
- 60% of 345 kV feeders lost
- 5 transmission substations
  - 11 Manhattan networks
  - 3 Staten Island area stations
- 2 steam stations and 561 steam customers impacted
- 398 gas services interrupted
System Performance
Historical Storm Comparison

Electric Customers Interrupted

<table>
<thead>
<tr>
<th>Event</th>
<th>Date</th>
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<tbody>
<tr>
<td>Superstorm Sandy*</td>
<td>Oct. 29, 2012</td>
</tr>
<tr>
<td>Hurricane Irene</td>
<td>Aug. 28, 2011</td>
</tr>
<tr>
<td>Nor'easter</td>
<td>Mar. 13, 2010</td>
</tr>
<tr>
<td>Nor'easter</td>
<td>Oct. 29, 2011</td>
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<tr>
<td>Hurricane Gloria</td>
<td>Sept. 9, 1985</td>
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<tr>
<td>Tropical Storm Ernesto</td>
<td>Sept. 2, 2006</td>
</tr>
<tr>
<td>Snow</td>
<td>Feb. 25, 2010</td>
</tr>
<tr>
<td>Wind / Rain</td>
<td>Jan. 18, 2006</td>
</tr>
<tr>
<td>Nor'easter</td>
<td>Mar. 31, 1997</td>
</tr>
<tr>
<td>Nor'easter</td>
<td>Oct. 19, 1996</td>
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</tbody>
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* Includes outages caused by Nor'easter on Nov. 7, 2012
The East River: 14th Street and Avenue C
Loss of Supply
East River Complex
Datum Diagram (Not to Scale)

Typical Top of Foundations

7.3’ Historical (Sept 21, 1938)
10.1’ Historical (Nov 25, 1950)
9.0’ Irene Estimated (Aug 28, 2011)
11.2’ Lowest Elev of Computer
11.4’ Battery
11.2’ Sandy Estimated
11.1’ Sandy Observed
13.8’ Mean Lower Low Water Datum

14.06’ @ Battery
14.06’ Actual
11.7’ Sandy Actual
11.7’ Sandy Forecast

New York Harbor

MLLW
Final Hardening Measures
2014 through 2016

- Distributed and elevation adjustable relay panels
- Elevate control house
- Elevate static terminal boxes
- Change controls to fiber optic
- Future design basis will accommodate new level for future projects
Storm Hardening UG Networks

Goals & Strategy

- Minimize preemptive feeder outages system wide
- Reduce damaged to equipment in the flood zone
- Reduce customer impact in flood zone networks
- Increase restoration speed for network shutdowns
Storm Hardening Initiatives

Underground Distribution

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

New Sub-Networks
Underground Network Initiatives
High Tension Vaults - Isolation Switches

- Disconnects Customer Installation from Con Ed System
- Con Edison Feeder remains active
- Remote Control operation
- Quick Connect / Disconnect
- Faster Restoration Times
120V Network Protector Design Evolution

- Replaces & phases out ventilated cabinets

Ventilated End Mounted Cabinet

Submersible End Mounted Housing
Underground Network Initiatives
Overview

• Reconfiguration of Fulton and Bowling Green networks
• Installation of isolation switches for Brighton Beach network
• Installation of isolation switches for High Tension Vaults in 2013 FEMA 100 Year + 3 Feet Flood Zone
• Replacement of all non-submersible 120/208V equipment in Flood Zone
• Development of submersible 265/460V housing
Benefits of New Partitioning System

• Minimize customer interruption
  – 1,789 Residential households
  – 441 Commercial
  – 46,745 Employees

• Faster Restoration
  – Substations remain online
  – Ability to restore individual circuits

• Transmission Planning Tool

• Year round benefit for feeder processing
Sandy’s Impact:
Significant Damage to Overhead System

- 70 percent of customers served by overhead systems lost power
- Primary concern of safety
- Worked with city and municipalities to clear roads of trees and debris

<table>
<thead>
<tr>
<th>Storm Recovery Pole &amp; Transformer Usage</th>
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<tbody>
<tr>
<td></td>
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<tr>
<td><strong>Sandy Total CECONY</strong></td>
</tr>
<tr>
<td>Poles: 972</td>
</tr>
<tr>
<td>Transformers: 922</td>
</tr>
<tr>
<td>Cable [miles]: 143.46</td>
</tr>
<tr>
<td><strong>Irene Total CECONY</strong></td>
</tr>
<tr>
<td>Poles: 91</td>
</tr>
<tr>
<td>Transformers: 163</td>
</tr>
<tr>
<td>Cable [miles]: 31.11</td>
</tr>
</tbody>
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Improve Autoloop Reliability

- Additional supply feeders
- Divide large autoloops into smaller loops
- Upgrade wire and pole sizes to improve resiliency
- Use of more resilient aerial cable
- Sacrificial components to minimize damage
Overhead Distribution Initiatives

Auto Loop - Overview

- Extend new feeder
- Split Auto-loop into two loops
- New storm hardened cable
Storm Hardening Initiatives

Overhead Distribution

- Advanced Equipment
- Selective Undergrounding
- Reduce Segment Size
- Sacrificial Components
Spacer Cable

- Low profile design reduces risk of tree contact
- High strength messenger provides greater resilience against falling limbs
- Cable jacket reduces momentary outages from wind or incidental tree contact
- Compact configuration reduces tree trimming
Breakaway Connectors

- Service connection breaks away at pole when force exceeds 500lbs
- Service cable is disconnected and deenergized
- Separate breakaway for each individual service
- Accommodates single, double or triple service configurations
Isolation Devices (Fused Bypass)
Selective Undergrounding

- Meeting with Municipalities to determine critical circuits to harden.
Harden Components: New Pole Designs
Enhanced Line Clearance Program

• Foundation program continued to ensure 10 X 10 X 15 Clearance every three years is achieved on High Voltage Feeders.

• Increased removal of damaged or unhealthy hazard trees near High Voltage feeders

• Obtain additional clearance on High Voltage Feeders that have higher outage rates and affect customers more frequently

• Obtain additional clearance on Feeders where we are performing significant Storm Hardening work
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