Con Edison Electric Distribution System
NEW YORK CITY and WESTCHESTER

- Population 9,263,869
- 604 square miles
- Electric customers 3,338,729
- 62 Area Substations
- 2,194 Distribution Feeders
- Peak Load – 13,322 MW
- 13% of Capacity is Overhead
  - 154 Autoloops
  - 232 4kV Substations
- 87% of Capacity is Underground
  - 64 (N-2) Networks
  - 19 (N-1) Networks
Blue Sky Day Reliability Comparison

Frequency of Service Interruptions per 1000 Customers

- National
- New York *
- ConEd-Overhead
- ConEd-Overall
- ConEd-Network

* Without Con Edison
Pre-Sandy Hardening and Resiliency Investments

- **Since 1992 nor'easter**
  - Raised critical equipment to enhance flood protection
  - Upgraded pumps and flood gates
  - Installed protective moats

- **Since Hurricane Katrina**
  - New transformers and network protectors in flood zones must be submersible or installed above flood level
  - New submersible equipment tested to operate under 25 feet of brackish water

- **Limiting Damage to Overhead System**
  - Aggressive tree trimming to reduce storm damage to power lines
  - Monthly aerial inspections and semi-annual ground patrol inspection of transmission line rights-of-way

- **Additional Investments**
  - Control centers can remotely monitor power flow, feeder status, and switches
  - Operators can remotely operate breakers and switches to manage the grid and improve restoration lines
Storm Preparations: Guided by Corporate Coastal Storm Plan

- Plan triggered October 24, 2012 based on National Weather Service forecasts

- Includes:
  - 24/7 staffing plans
  - Inventory Check
  - Equipment vulnerability
  - Protection plans for equipment in flood zones
  - Need for outside assistance
  - Operation Modifications
  - Communication Protocols
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>
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<tr>
<td>Hurricane Irene</td>
<td>Aug. 28, 2011</td>
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<tr>
<td>Nor'easter</td>
<td>Mar. 13, 2010</td>
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<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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<td>Tropical Storm Ernesto</td>
<td>Sept. 2, 2006</td>
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<tr>
<td>Snow</td>
<td>Feb. 25, 2010</td>
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<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>
</tr>
</tbody>
</table>

* includes outages caused by Nor'easter on Nov. 7, 2012
Sandy’s Impact:
Significant Damage to Overhead System

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

Substation Circuit Breaker

Supply Feeder
Con Edison Overhead Auto-Loop

13 kV Substation
Circuit Breaker

Feeder
Recloser

Midpoint
Recloser

Transformer
Supplying
Customer Load

Tie Recloser (N.O.)

Fuse

13 kV Supply
Feeder

13 kV Supply
Feeder
Con Edison Primary (4kV) Network

- Substations are interconnected as a network
- Reliable because alternate supply provided by other stations
**Overhead System Hardening**

- Selective Undergrounding
- Reduce Segment Size
- Advanced Equipment
- Sacrificial Components
Overhead Distribution Initiatives

- Extend new feeder
- Armonk loop into two loops
- New storm hardened cable
Con Edison Underground Network System
Underground Distribution System Impact

- Preemptively shutdown 3 networks due to exposure to non-submersible 460V equipment primarily residing in customer premises
  - Bowling Green (Manhattan)
  - Fulton (Manhattan)
  - Brighton Beach (Brooklyn)

- Preemptive removal of 24 distribution feeders from 8 networks because of 460v equipment
Network Impact
Fulton and Bowling Green

Restoration Effort

• 5 days to restore with minimum number of energized feeders

• Manually blocked open 261 NWPs

• Live-end capped 51 transformers

Defective Equipment

• 28% of all NWPs in each network were damaged

• 43 installations were affected

Note: "•" indicates affected installations
Underground Network Initiatives

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

Bowling Green: 123 MW
Fulton: 115 MW

New Sub-Networks
Underground Network Initiatives
Submersible 460 Volt Network Protector
Underground Network Initiatives

*Isolation Switches*

- Disconnects Customer Installation from Con Ed System
  - Con Edison Feeder remains active
  - Remote Control operation
  - Quick Connect / Disconnect
  - Faster Restoration Times

- 70 Installations for High Tension Customers
- 20 Used for Network Configuration
- 13 Used in Brighton Beach
The Fiber Optic Network
Fiber Optic Communication Ring
Flooding at Avenue D and East 13th Street
Loss of Supply

Substation Impact

- E.13th Street Complex
  - Affected 7 area substations that supplied 10 networks (221,103 electric customers)

- Seaport
  - Affected 1 area substation that supplied one network (2,010 electric customers)
Station Storm Hardening Objectives

- Prevent de-energization of power supply equipment due to flood water intrusion
- Maintain relay protection integrity
- Maintain remote control and situational awareness (metering and indication)
- Minimize equipment damage from salt water
- Allow for rapid recovery
Immediate Hardening Scope
June 1st, 2013

- New walls/barriers around critical equipment
- New sump pumps
- Sealed conduit penetration points with RTV
- Shrink wrap important control boxes
- Install backup nitrogen pumps
- Raised equipment where feasible and economic
- Valve-off sewer drains

Governing flood control elevation, higher of:
1. SLOSH 2010
2. 2007 FEMA 100-yr flood +2 feet
3. Witnessed Sandy level
Collaborative Stipulation
June 2013 FEMA Map, 100-yr floodplain +3’

Raise existing walls to meet new criterion
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
Consolidated Edison Company of New York, Inc.

Electric Grid Hardening and Resiliency Initiatives

Griffin Reilly
Electric Distribution Engineering
April 17th, 2015