conEdison
a conEdison, inc. company

Martin F. Heslin
Assistant General Counsel
Consolidated Edison Company of New York, Inc.
4 Irving Place, Room 1815-S, New York NY 10003
212-460-4705 Fax: 212-677-5850
Email: Heslinm@coned.com

December 4, 2013

Electronic Filing:
secretary@dps.ny.gov

Hon. Kathleen H. Burgess
Secretary to the Commission
New York State Public Service Commission
Agency Building 3
Albany, NY 12223-1350

RE: Cases 13-E-0030, 13-G-0031, 13-S-0032
In the Matter of Consolidated Edison Company of New York, Inc.
Electric, Gas and Steam Rates

Dear Secretary Burgess:

Consolidated Edison Company of New York, Inc. is presenting to the Public Service Commission the enclosed *Storm Hardening and Resiliency Collaborative Report*. From August through October 2013, the Con Edison, the Department of Public Service Staff, and a number of other parties met in a collaborative manner under the guidance and facilitation of the Hon. Elizabeth Stein to review Con Edison's storm resiliency plans and to consider additional initiatives. This Report describes the resiliency work that that Con Edison has performed during 2013, presents for the Commission's consideration Con Edison's proposed plans for resiliency work to commence during the period of 2014 to 2016, summarizes the work of the Collaborative, and recommends further initiatives for the Collaborative in 2014. Pursuant to the process established by Judge Stein, the parties to the Collaborative will file comments on this Report by December 20, 2013.

Sincerely,

Martin F Heslin

c: Hon. Elizabeth Stein
Hon. Paul Agresta
Hon. Julia Bielawski
All Active Parties

Storm Hardening and Resiliency Collaborative Report

Consolidated Edison Company of New York Inc.

December 4, 2013

Contents

I. Introduction

A. Con Edison's Resiliency Plans

On October 29, 2012, Superstorm Sandy (Sandy) struck our region, devastating communities and our energy systems. The storm brought historic flooding and sustained high speed wind. The damage to the electric system caused service outages to over 1,115,000 customers. Sandy was an unprecedented storm, one that may be part of a new weather pattern changing the way our region and Consolidated Edison Company of New York (Con Edison or the Company) plans for and responds to natural disasters. To protect our customers, the region, and energy systems from future natural disasters, Con Edison's electric, gas, and steam rate cases, filed on January 25, 2013 (Cases 13-E-0030, 13-G-0031, and 13-S-0032) (rate cases) include proposals for a $1 billion investment in new capital initiatives for years 2013 through 2016 to mitigate impacts of future extreme weather. These initiatives (resiliency plans) will improve the resiliency of Con Edison's electric, gas, and steam and electric generation systems by making delivery and generation structures and equipment more resistant to weather-induced failure and by reducing the time for restoring service to customers.[1]

B. Purpose of Collaborative

In the rate cases, a number of parties filed expert testimony urging Con Edison to expedite storm hardening investments and to incorporate new climate change information into system planning. In addition, Staff's Policy Panel recommended that Con Edison convene a collaborative of interested parties to consider: the Company's storm hardening proposals as well as similar efforts being planned by infrastructure owners in the Company's service territory; the design standard for various aspects of the Company's system; if and how climate change impacts should be incorporated into that standard; and the best ways to build flexibility into the Company's designs. Staff proposed that Con Edison provide the New York Public Service Commission (PSC or Commission) with a report that contains a plan and additional details related to the storm hardening projects to be carried out in the rate year (2014) and beyond, addresses concerns regarding the Company's proposals raised in Staff's rate case testimony, and incorporates input from the Collaborative. Staff proposed that if a multi-year rate plan is adopted in the rate cases, periodic reports should continue, detailing the continued development of the longer-term storm hardening initiatives. The Department of Public Service designated the Honorable Eleanor Stein to preside over the work of the Collaborative. A list of the parties that have participated in the Collaborative (the Collaborative Parties) is provided in Appendix A: Collaborative Parties.

The Collaborative Parties participated in a series of meetings beginning on July 8, 2013 to exchange and discuss information, ideas, and proposals on many of the resiliency-related issues that the parties presented in testimony filed in the rate cases. The Collaborative formed four working groups that were tasked with the following specific objectives:

- Examine the 2014 storm hardening projects proposed in the rate cases and the contested issues raised by Staff;

[1] Throughout this report, the word "resiliency" refers to resistance of the Company's facilities to weather–induced failure or the ability to restore service following a weather-induced service outage.

- Further develop the basis and cost implications of the flood protection design standard proposed in the rate case;
- Explore the need to include climate change and its effects on future design standards;
- Examine proposals to reduce gas pipeline vulnerability in flood zone areas and mitigate the climate impacts of distribution system methane losses;
- Examine alternative resiliency strategies to hardening the grid, including microgrid projects, sited distributed generation, energy efficiency, demand response, and alternative meters; and
- Develop analytical models for risk assessment and cost/benefit analysis, taking into consideration critical Company equipment, climate change, economics, societal benefits, critical City facilities, customers, and the workforce.

Con Edison is presenting this Report to the Public Service Commission to summarize the work of the Collaborative, to recommend further initiatives for the Collaborative in 2014, to describe resiliency work that has been performed during 2013, and to present for the Commission's consideration Con Edison's proposed plans for resiliency work to commence during the period of 2014 to 2016. The Collaborative Parties will file comments on this Report on December 20, 2013.

II. Executive Summary

A. Recommendations

Con Edison proposes that the revenue requirement established in the Commission's Rate Order to be issued in the Company's pending rate cases (Rate Order) reflect the Company's proposed capital expenditures for storm hardening measures during the period of the rate plan established in the Rate Order.[2] In addition, Con Edison proposes that the Commission's Rate Order consider and authorize continued initiatives from the Collaborative Working Groups and clarify the scope of work in the context of other initiatives pending before or planned by the Commission.

B. Collaborative Process and Proposals

The Collaborative process offered Con Edison, Staff, and interested parties an opportunity to discuss Con Edison's storm resiliency plans in parallel with the examination of the Company's plans in the rate cases. Consistent with the request from the Staff's Policy Panel, Con Edison, Staff, and the interested parties held meetings from July 2013 through October 2013.

Through the Collaborative process, the parties discussed topics and impacts that broadened the scope of the collaborative beyond storm hardening, into the wider scope of resilience in the face of changing conditions and the exploration of the Company's plans to address climate change impacts. These included:

1. **Review of Design Standards and Projects** - Con Edison and the parties reviewed Con Edison's resiliency plans and alternative options and discussed the design standard basis for the projects that comprise the resiliency plans
2. **Discussion of Climate Change Impacts** - The parties, led by the City of New York (the City), Columbia Center for Climate Change, and NGOs, raised concerns regarding potential climate change impacts to the resiliency plans, with Con Edison providing current views on its approach and how the current approach could evolve.

In addition, Staff and other parties toured Con Edison's facilities to further their understanding of facilities and equipment affected by Sandy and the Company's resiliency plans. Other parties proposed alternatives to traditional storm hardening planning. Many parties examined measures to assess the costs and benefits of the Company's resiliency plans.

Con Edison received feedback and insights that it believes will strengthen its resiliency plans and improve its service to the communities the Company serves in the following key areas:

1. **Design standard for protection of equipment and locations affected by flood** – Con Edison will design flood protection projects to be commenced during 2014 through 2016 based on the 1% annual flood hazard elevation (100 year floodplain) established by Federal Emergency

[2] The Company's capital expenditures for storm hardening measures installed in 2013 and for measures proposed to be installed from 2014to 2016 are discussed in this report and are summarized in Table 1 below.

Management Administration's (FEMA) June 2013 Preliminary Work Maps 100-year floodplain plus three feet of freeboard (FEMA plus three).

2. **Modification of Con Edison risk assessment model for storm hardening projects** – Con Edison has amended its risk assessment model to incorporate a storm surge inundation prediction model developed by the New York City Mayor 's Office of Long Term Planning and Sustainability.
3. **Consideration of the impact of climate change on storm resiliency plans** – Con Edison will conduct a Climate Change Vulnerability Study. The study seeks to synthesize current views on climate change, identify the design basis/infrastructure that might be affected, and develop a shared understanding among Collaborative participants.
4. **Design resiliency into capital investments and operating practices –** Con Edison will continue to consider resiliency in its design, installation, operation, and maintenance of facilities and equipment.

In addition to the areas above, the Collaborative Parties recognized the need to continue the discussion on several topics in a second phase of the Collaborative following the preparation of this report on the Collaborative' s activities to November 2013. The Collaborative has developed a future agenda[3] including:

1. **Working Group 1 (WG1): Storm Hardening Design Standards and 2014 Projects** in Phase 2 will sponsor Con Edison's 2014 Climate Change Vulnerability Study as outlined in this Report and examine Con Edison's storm hardening project plans under development for initiation in 2015, including undergrounding of electric overhead distribution facilities, tunnel hardening, gas main replacement in flood zones and steam distribution projects.
2. **Working Group 2 (WG2): Alternative Resiliency Strategies** in Phase 2 will (1) consider potential alternative strategies to achieve resiliency or mitigation of the impact of future extreme weather, including heat and storms, on Con Edison's customers. WG2 has identified the following potential approaches to resiliency: distributed energy resources, which includes distributed generation (DG) (such as combined heat and power generation (CHP) and renewable generation), microgrids, energy efficiency (EE), demand response (DR), electric vehicles (EVs), energy storage, and time-differentiated pricing (such as time-of-use (TOU) rates); (2) seek to undertake a quantitative examination and rank cost-effectiveness of strategies in coordination with related work underway in Working Group 4; and (3) develop a proposal to Commission regarding alternative resiliency solutions.
3. **Working Group 3 (WG3): Natural Gas System Resiliency** in Phase 2 will (1) study and attempt to quantify the leakage rate of known Type 3 leaks and (2) develop and propose to the Commission a program for reducing the backlog of those leaks.
4. **Working Group 4 (WG4): Risk Assessment / Cost Value Analysis** in Phase 2 will continue its work on economic cost/value analysis by attempting to develop a formal economic cost/value model that can be applied to the storm hardening projects that were examined in the working group's risk assessment and prioritization model developed during Phase 1.

[3] Phase two scope of work for each working group are summarized in Appendix C, D, E, and F.

Con Edison remains committed to improving resiliency of its infrastructure and looks forward to the Collaborative process in gaining additional insights and perspectives outside the Company.

C. Con Edison's Storm Hardening Projects from 2013 through 2016

During the period of 2013 through 2016, Con Edison is proposing to invest approximately $1 billion to improve the resiliency of the electric and gas delivery systems and the electric and steam generating stations. An overview of these expenditures is provided in Table 1: CECONY Capital Expenditures for Storm Hardening.

Table 1: CECONY Capital Expenditures for Storm Hardening

($ Millions)	2013	2014	2015	2016	Total
Electric Substations	30.0	60.0	70.0	80.0	240.0
Electric Network Distribution	21.0	72.5	60.5	52.0	206.0
Electric Overhead Distribution	19.6	15.0	115.0	112.0	261.6
Transformers	10.0	12.5	11.3	11.4	45.2
Electric Transmission	3.9	4.9	2.0	2.0	12.8
Electric and Steam Generation	18.4	42.8	51.5	52.3	165.0
Gas and Tunnels	2.1	6.8	41.6	51.7	102.2
Telecommunications	0.0	1.3	2.7	2.6	6.6
Facilities	0.0	0.0	5.0	5.0	10.0
Total	**105.0**	**215.8**	**359.6**	**369.0**	**1,049.4**

Substations

Five transmission substations were shut down due to Sandy. In total, 14 Manhattan networks, one Brooklyn network, and three Staten Island load areas were shut down by the storm. Many of these outages were the result of flooding at substations. By fortifying our substations, we mitigate the impact of weather events across multiple networks.

The following nine substations were operationally impacted by the storm: East 13th Street, East River, East 15th Street PURS, East 36th Street, Seaport, and Trade Center in Manhattan; Gowanus in Brooklyn; and Goethals and Fresh Kills in Staten Island. These stations have been fortified already with immediate hardening measures in preparation for the 2013 hurricane season.

Our 2014 to 2016 storm hardening plans include 16 substations. These substations are Avenue A, East 13th Street, East River, East 15th Street PURS, East 36th Street, Leonard Street, Seaport, Sherman Creek, and Trade Center in Manhattan; Farragut and Gowanus in Brooklyn; Rainey and Vernon in Queens; Hellgate and Bruckner in the Bronx; and Goethals and Fresh Kills in Staten Island.

To harden our substations in the 2014-2016 timeframe, we are:

- Installing new relay cabinets at the location of the equipment that they protect;
- Installing additional fiber-optic-based communications equipment which is more resistant to flood damage than copper cable;
- Defining purchase specifications to ensure new equipment includes raised critical flood-protection controls and cabinets;
- Raising critical control cabinets in pressurization and cooling plants;
- Installing new emergency diesel generators elevated above the flood-control level;
- Installing new high-capacity flood control pumps;
- Relocating other critical station equipment above the flood-control elevation;
- Installing submersible or protecting critical equipment that remains in the flood zone;
- Installing additional height on accommodating foundations and other immediate installations to meet new flood control levels;
- Installing moat walls and raising existing walls to meet new flood-control elevations; and
- Installing new sheet-pile surge walls.

Capital expenditures for these substation initiatives are projected to total $240 million, which includes $30.0 million in 2013, $60.0 million in 2014, $70.0 million in 2015, and $80.0 million in 2016. The specific work required to implement storm hardening measures at each substation is currently being refined and designed, and project scopes are becoming more developed. Accordingly, project-specific expenditures may be adjusted from original projections, but rate case funding requests for 2014 remain constant as filed in the Company's rate case update.

Electric Network Distribution

In the event of a major storm, flooding caused by rain and coastal storm surges could cause major damage to our network electric infrastructure in flood zones. During Sandy, three networks were preemptively shutdown to prevent catastrophic damage to energized equipment, but repairs and replacement of flood-damaged, non-submersible equipment extended the service restoration period. In other networks, feeders de-energized due to flooded high-tension customer equipment.

To harden our electric network distribution system during 2013 to 2016, we are:

- Replacing non-submersible equipment, including installing 265/460 Volt submersible network protectors and 120/208 Volt submersible transformer/network protectors;
- Reconfiguring Bowling Green and Fulton networks using smart-grid switches in order to limit the impact of flooding to isolated parts of the networks; and
- Protecting the networks in flood zones by installing smart switches to isolate high tension customers whose equipment is subject to flooding.

Submersible technology protects equipment against water damage and enables us to quickly restore service once floodwaters recede. Smart grid switches will de-energize and isolate high-tension customer equipment that could be flooded and jeopardize the sustainability of networks during a high-demand period.

During 2013, we completed the isolation of high tension customers in the Brighton Beach network, and we began work on reconfiguring the Bowling Green and Fulton networks. Capital expenditures for these electric network distribution initiatives are projected to total $206 million, which includes $21.0 million in 2013, $72.5 million in 2014, $60.5 million in 2015, and $52.0 million in 2016.

Electric Overhead Distribution

As a result of Sandy, the Company's overhead distribution system was impacted by wind and tree damage that interrupted service to 604,603 (about 70%) of the 868,347 non-network customers supplied from the overhead distribution systems in the Bronx, Brooklyn, Queens, Staten Island, and Westchester County operating areas. The most critical threat to the overhead electric distribution system is the impact of falling trees on Company infrastructure. By protecting our overhead electric distribution system, we will minimize the number of customer outages and improve restoration times to those customers.

Prior to the initiation of the storm hardening program, the Company undertook an extensive program to expand the use of smart switches and smart grid technologies on its overhead distribution system and expand the communication infrastructure to support additional devices. The Company has developed and installed recloser technology that automatically controls every recloser on auto-loop circuits preventing additional faults. The Company is expanding and continuing this effort with the storm hardening program. To reduce the number and duration of weather-related outages, we are enhancing the resiliency of our electric overhead distribution system during 2013 to 2016 by:

- Reducing the number of customers per circuit segment to minimize the customers impacted by damage;
- Installing isolation switching to minimize upstream outages on main feeders from damage on open wire spurs;
- Improving auto-loop circuit reliability by upgrading poles and cables, and installing breakaway devices; and
- Selectively undergrounding overhead components to protect critical and/or susceptible circuits; and
- Enhancing the vegetation management program.

Capital expenditures for these electric overhead distribution initiatives are projected to total $261.6 million, which includes $19.6 million in 2013, $15.0 million in 2014, $115.0 million in 2015, and $112.0 million in 2016.

Generating Stations

The 59th Street and 74th Street Complex steam generating stations incurred significant damage during Sandy causing station shut down. The East River electric and steam generating station was preemptively shut down. As a result about 90% of steam supply capacity was not operating for several days while repairs were made. During 2013, we installed storm hardening measures at these stations to address the potential impact of a storm comparable to Sandy.

In addition to the immediate measures, we have developed a longer-term storm-hardening plan for East River, 59th Street, and 74th Street stations, as well as for the 60th Street and Ravenswood A House Steam Stations that were also flooded during Sandy, but their operations were not severely impacted.

Our 2014 to 2016 initiatives for storm-hardening our generating stations include plans to:

- Install sluice gates in the intake and discharge tunnels to control the inundation of floodwaters (installation will require de-silting of the tunnels);
- Relocate critical mechanical and electrical equipment above the defined flood-control elevation;
- Install submersible equipment within the flood-control elevation;
- Reinforce station perimeter walls to withstand higher flood levels;
- Install pressure resistant/submarine type doors to protect deep basements or structures;
- Install permanent, high-capacity flood-control pumps in additional areas of the stations;
- Install new emergency generators to power flood pumps and to provide additional support to the stations during an emergency; and
- Raise existing moats and walls where possible to meet the flood-control elevation.

Capital expenditures for these generating station initiatives are projected to total $165 million, which includes $18.4 million in 2013, $42.8 million in 2014, $51.5 million in 2015, and $52.3 million in 2016.

Gas

As a result of Sandy, nearly 400 service outages affected over 4,200 customers in the Bronx, Manhattan, Queens, and Westchester. Our post-storm assessments have identified the potential for significant damage if our region were to experience a significant coastal storm in the future. The most critical threat to the gas system is the introduction of water into gas-distribution equipment, which can damage pipes, lead to over-pressurization, or result in service interruptions for extended periods.

To harden our gas distribution system during 2013 to 2016, we are:

- Accelerating plans to install vent line protectors, also known as float check valves, to prevent water from entering high-pressure service lines through the venting system;
- Establishing plans to replace cast iron and bare steel pipe in flood-prone areas; and
- Elevating critical equipment at liquefied natural gas facilities.

Capital expenditures for these gas distribution system initiatives are projected to total $42.2 million, which includes $2.1 million in 2013, $6.8 million in 2014, $16.6 million in 2015, and $16.7 million in 2016.

Tunnels

During Sandy, water entered several tunnel facilities, including the First Avenue, Ravenswood, Astoria, Hudson Avenue, Flushing, and 11th Street tunnels. These tunnels contain steam mains, gas mains, and/or high voltage electric feeders that may need to be de-energized for safety if the tunnels are significantly flooded. Most of our tunnels have “head-house” entrances that are in close proximity to bodies of water but not designed to withstand coastal flooding.

To harden our tunnels during 2015 to 2016, we are:

- Constructing hardened and reinforced concrete structures to replace certain head-houses and hardening others with flood doors and floodgates;
- Constructing barrier walls and the sealing of cracks and other penetrations in the interior tunnel walls to prevent water infiltration;
- Improving pumping operations to pump out water that infiltrates; and
- Installing remote cameras and lighting for remote monitoring.

Capital expenditures for these tunnel initiatives are projected to total $60 million, which includes $25 million in 2015 and $35 million in 2016. During 2013, we are investing about $0.5 million to storm harden the First Avenue Tunnel.

D. Conclusion

Con Edison has presented its resiliency plans in its pending electric, gas and steam rate cases and has reviewed these plans with the parties to the Storm Hardening and Resiliency Collaborative. The Company continues to look for ways to improve its resiliency initiatives through input from our customers, stakeholders and regulators. The Collaborative has provided Con Edison a valuable forum for obtaining such input and examining an array of solutions to better protect our region, and to prepare for our future.

Con Edison is presenting this Report to the Public Service Commission to summarize the work of the Collaborative to date, to recommend further initiatives for the Collaborative in 2014, and to present for the Commission's consideration Con Edison's proposed plans for resiliency work to commence during the period of 2014 to 2016.[4]

The Company looks forward to participating in Phase 2 initiatives of the Collaborative as may be approved or directed by the Commission. The Company's participation in these ongoing efforts is premised on the reasonable expectation that any Commission approval or direction associated with new initiatives would provide for full recovery of any incremental capital and O&M expenditures associated with such efforts, by surcharge, adjustment to base rates, deferral or as otherwise determined by the Commission.

[4] The Collaborative Parties will file comments on this Report on December 20, 2013.

III. Background

A. Formation of Working Groups

Judge Stein convened the initial meeting of the Collaborative Parties on July 8, 2013. In advance of the meeting, Judge Stein outlined the following scope of collaborative issues:

1. Design standards;
2. Approach to risk assessment and cost/value analysis;
3. Recommendations regarding specific proposed 2014 projects;
4. Assessment of some additional proposed projects - Con Edison's and other parties; and
5. Setting further milestones for collaborative consideration of the 2015-16 projects.[5]

Judge Stein and the parties exchanged ideas on the scope, structure, and scheduling of the Collaborative. In view of the parties' focus on preparation for the hearing scheduled to commence on July 22, 2013 in the rate case, the Judge and Collaborative Parties agreed to adjourn and re-convene promptly following the end of the hearings.

On August 1, 2013, Judge Stein sent a memorandum to the Collaborative Parties proposing a schedule and scope for a first phase of the Collaborative. On August 2, 2013, the final day of the rate case hearing, Judge Stein conferred with the parties and confirmed the following schedule for meetings of all Collaborative Parties and presenting the Company's report to the Commission:

Meeting dates:

August 8, 15, and 27, 2013, September 12, 2013; and October 8, 2013.

Report to the Commission:

November 1, 2013.[6]

Judge Stein stated her expectation that the parties would use the time between meetings of the full Collaborative for work by parties, individually, or in subgroups. Meetings of the full Collaborative have been in person with teleconference availability or by teleconference alone.

At the August 8, 2013 meeting of the Collaborative, the parties organized into working groups and listened to presentations on current resiliency initiatives. A representative of the City of New York made a presentation on the City's approach to resiliency issues in the utility field and tools under development to assess storm-impact risk related to utility infrastructure. A representative of Con Edison made a presentation on storm hardening measures that the Company had established in certain substations by

---

[5] Administrative Law Judge Letter regarding the collaborative (July 2, 2013).

[6] The Collaborative Parties also met on October 23, 2013 to discuss a draft of Con Edison's report that the Company had circulated to the parties. At that meeting, Judge Stein and the Collaborative Parties agreed to change the date for Con Edison to file its report to December 4, 2014, consistent with the extension of the suspension period for one month in the rate case. Judge Stein also authorized the parties to file statements regarding the Storm Hardening and Resiliency Collaborative and Con Edison's report by December 20, 2013.

June 2013 and the measures to be established to achieve additional hardening protection at substations commencing in 2014.

Following the presentations, Judge Stein conducted an organizational meeting. Judge Stein discussed guidelines for the Collaborative process including issues of confidentiality, ex parte rules, party participation, goals in terms of reaching consensus, and communication protocols.

Judge Stein and the parties discussed a scope of work for a first phase of the Collaborative. Four working groups were established to examine and make consensus proposals on specified topics as follows:

- Working Group 1: Storm Hardening Design Standards and 2014 Projects;
- Working Group 2: Alternative Resiliency Strategies (strategies for optimizing load for system efficiency and management of emergency conditions, including microgrid projects, strategically sited distributed generation, energy efficiency, demand response, and interactive meters);
- Working Group 3: Natural Gas System Resiliency; and
- Working Group 4: Risk Assessment and Cost/Benefit Analysis.

The Collaborative Parties joined one or more of the working groups, and each working group conducted a brief initial meeting at the conclusion of the August 8 meeting.[7]

Judge Stein stated her expectation that Con Edison's report would be substantially informed by Working Group 1's examination of storm hardening design standards and 2014 resiliency projects. Recognizing that the other working groups may require more time to examine their topics, Judge Stein encouraged the other working groups to contribute to the report and particularly to propose for the Commission's consideration a scope of work to be conducted during a second phase of the Collaborative.

B. Meetings

Each working group has met a number of times to exchange and discuss information regarding their topic areas. The following provides an overview of the meetings of each work group:

<u>Working Group I: Storm Hardening Design Standards and 2014 Projects</u>

- August 15 Collaborative Meeting
    - Presentation on coastal flooding storm hardening projects
        - Substation projects and generating station projects
        - Reconfigure Fulton and Bowling Green networks
        - Isolation switches for 460 volt (V) customers (Brighton Beach)
        - Submersible 265/460V network protector housing and submersible 120/208V transformer/network protector
        - Switches to isolate high tension customer equipment in nine Manhattan networks

- August 22 Collaborative Meeting
    - Presentation on overhead distribution system storm hardening projects

[7] Con Edison and Staff are members of each working group.

      - Reduce feeder segment size
      - Isolate open wire spurs
      - Improve auto-loop circuit reliability
      - Selective undergrounding
  - Presentation on impact of increased air temperature on system reliability
      - Network Reliability Index as tool to model impacts of hotter and longer heat waves
  - Presentation on gas system storm hardening initiatives
      - Vent line protectors
      - Tunnel hardening
      - Gas main replacement in flood zones
      - Liquefied natural gas (LNG) plant programs
  - NYC presentation on flood maps
      - Coastal storm modeling and mapping
      - FEMA flood zone designations
      - Evolution of New York City coastal flooding vulnerability from FEMA's 1983 flood maps to FEMA's June 2013 Preliminary Work Maps

- September 10 Collaborative Meeting
  - Discussion of storm hardening project cost estimates
  - Discussion of Con Edison's responses to Staff's information requests
  - Discussion of NGO proposal for 2014 long-term climate change adaptation study

- September 26 Collaborative Meeting
  - Outline of Con Edison's report on the Collaborative and storm hardening projects
  - Project cost information

<u>Working Group II: Alternative Resiliency Strategies</u>

- September 17 Meeting
  - Presentations on current status of distributed generation, energy efficiency and micro grids

- October 3 Meeting
  - Presentation on City/Pace DG Collaborative

- October 7 Meeting
  - Presentations on dynamic rates

<u>Working Group III: Natural Gas System Resiliency</u>

- September 3 Meeting
  - Presentation of current methane detection and measurement technologies
  - Presentation of Con Edison's emission reduction programs

- September 26 Meeting
  - Discuss Environmental Defense Fund (EDF) proposal
      - Identify technology and devise pilot to map and quantify leaks

        - Develop cost-effective main replacement program for reducing methane emissions

- October 11 Meeting
    - Discuss Con Edison proposal
        - Develop program to quantify and reduce methane emissions associated with the Type 3 leak backlog

Working Group IV - Risk Assessment and Cost/Benefit Analysis

- Conference call meetings on August 16, September 5, and October 1 to discuss data and inputs into the Risk Assessment and Prioritization model
    - Discussion of approach(s) to quantifying risk and the financial benefits resulting from risk reduction
    - Description of the current Con Edison Risk Assessment and Prioritization Model including the population and infrastructure data contained within the risk worksheet and derivation of probabilities associated with each asset risk
    - Development of a cost/value analysis for all of the assets currently targeted within Con Edison's storm hardening plans
    - Identification of salient elements in the quantification of risk and financial benefits (9/5)

- Meetings with NYC Mayor's Office of Long-Term Planning and Sustainability
    - Incorporate data from City storm surge risk model, e.g., surge probabilities; network demographics by critical customers, economic activity, high-rise housing units with vulnerable residents

- Working Risk Prioritization model by mid-October
    - Apply the Risk Assessment and Prioritization Model in the assessment of 2014 projects

C. Discovery/Evaluation/Analysis

Issues

Working Group 1's evaluation of Con Edison's storm hardening projects began with detailed presentations of those projects provided by representatives of the Company's electric, gas, and civil engineering organizations. These presentations addressed project design, scope, benefits, cost, and alternatives. During each presentation, the parties engaged the presenters in discussions to better understand the projects. The presentations were provided to the parties for follow-up review. The Company made five major presentations to the working group on the following topics. The presentations can be found in Appendix G: Collaborative Presentation Materials.

- Substation Flood Hardening Design Concepts
- Substations and Generation Stations Flood Hardening Projects
- Coastal Network Flood Hardening Projects
- Overhead Distribution System Storm Hardening Projects
- Gas System and Tunnels Flood Hardening Projects

Follow-up Questions and Responses

Working Group 1's assessment of storm hardening projects included requests to Con Edison for information supporting the scope, benefits, and cost of the Company's electric, gas, and electric and steam generation projects. Staff's information requests to the Company are provided in Appendix G: Collaborative Presentation Materials.

Con Edison furnished data in response to Staff's information requests on the following topics:

- Project appropriation funding;
- June 2013 FEMA flood maps that were used to determine the surge and inundation levels for each of the substations, steam generating stations, and coastal network projects;
- Basis for flood surge levels established for projects;
- Flood barrier-wall construction data;
- Project alternatives with supporting cost data;
- Use of contingency funding in project cost estimates;
- Revised project scopes and incremental project costs resulting from use of June 2013 FEMA flood maps plus three feet design standard;
- Incremental cost to design to June 2013 FEMA flood maps plus five feet;
- Revenue requirement impact of 2014 project costs as updated for June 2013 FEMA flood maps plus three feet design standard;
- Impact of June 2013 FEMA flood maps plus three feet design standard on projects to harden underground coastal distribution networks;
- Status of project to underground selected overhead distribution circuits;
- Data supporting river-barrier sluice gate installations at generation stations; and
- Cast iron and bare steel inventory and replacement cost by division within the 2013 FEMA plus three feet floodplain.

Field visits

Staff also conducted two field visits of substation and generation station sites to examine the storm hardening measures that the Con Edison established by June 2013 in advance of the 2013 hurricane season and to assess the additional measures planned for implementation in 2014.

The first field visit took place on September 19, 2013 at Con Edison East 13th Street Substation Complex. During the tour, Company engineers presented and discussed with Staff the various measures that the Company has designed and has constructed or plans to construct to protect various components of substations located in coastal flood zones including:

- Substation perimeter;
- Doorways, hatches and entrance gates;
- Relay houses;
- Conduits for power and control cables;
- Cable trenches; and
- Sewer connections.

Staff inspected the following measures installed by June 2013:

- New walls/barriers around critical equipment;
- New sump pumps;
- Sealed conduit penetration points;
- Shrink wrap of control boxes;
- Backup nitrogen pumps;
- Raised equipment; and
- Valve-off sewer drains.

Con Edison also identified and discussed the locations and equipment receiving the following additional protective measures in 2014:

- Increased wall height;
- Distributed and elevation adjustable relay panels;
- Elevation of control house;
- Elevation of static terminal boxes; and
- Change controls to fiber optic

The second field visit took place on September 23, 2013 at the East River and 59th Street Generating Stations. Company engineers presented and discussed with Staff the various measures that the Company has designed and has constructed or plans to construct to protect various components of the East River and 59th Street Generation Stations including:

- Station perimeter;
- Intake and Discharge Tunnels;
- Doorways, hatches and entrance gates;
- Conduits for power and control cables;
- Cable trenches;
- Sewer connections; and

Staff inspected the following measures installed by June 2013:

<u>East River Generation Station</u>

- 17 moated areas with 4' high concrete walls;
- 32 flood gates on exterior walls of building;
- 6 -1000 gpm pumps; and
- Sealing of 10 major water infiltration locations and many smaller ones

<u>59th Street Generation Station</u>

- 19 flood gates;
- 5 - 1000 gpm pumps; and
- Flood barriers

Company also identified and discussed the locations and equipment receiving the following additional protective measures in 2014:

East River Generation Station

- New sluice gates and doors to seal tunnels;
- New diesel generator above flood elevation;
- Reinforce exterior perimeter wall;
- New moats around critical equipment to new design criteria; and
- Install additional height on flood gates and accommodating foundations to increase elevation of existing walls

59th Street Generation Station

- Relocate equipment to higher elevations Including switchgear, electrical panels, compressors, etc.;
- Relocate fire pump room to higher elevation;
- Make mobile diesel driven pumps permanent;
- Additional permanent high capacity pumps;
- Install sump pumps in new moated areas;
- New diesel generator above flood elevation;
- New sluice gate and walls to seal tunnels;
- Install additional height on accommodating foundations to increase elevation of existing walls; and
- New concrete slab under service water pump platform

During the September 23rd meeting, the Company made a detailed presentation to Staff on the various planned storm hardening projects at the East River and 59th Street Generation Stations, particularly the need for sluice gate installations. The presentation, titled "Presentation - PSC Site Visit 9-23-13," is provided in Appendix G: Collaborative Presentation Materials.

IV. Collaborative Discussion and Outcome

A. Overview

The Collaborative process offered Con Edison, Staff, and interested parties an opportunity to discuss Con Edison's storm resiliency plans in parallel with consideration of the Company's plans in the rate cases. Con Edison, Staff, and the interested parties held meetings from July 2013 through October 2013.

Through the Collaborative process, the parties discussed topics and impacts that broadened the scope of the collaborative beyond storm hardening, into the wider scope of resilience in the face of changing conditions and the exploration of the Company's plans to address climate change impacts. These included:

- **Review of Design Standards and Projects** - Con Edison and the parties reviewed Con Edison's resiliency plans and alternative options and discussed the design standard basis for the projects that comprise the resiliency plans
- **Discussion of Climate Change Impacts** - The parties, led by the City of New York (the City), Columbia Center for Climate Change, and NGOs, raised concerns regarding potential climate change impacts to the resiliency plans, with Con Edison providing current views on its approach and how the current approach could evolve.

In addition, Staff and other parties toured Con Edison's facilities to further their understanding of facilities and equipment affected by Sandy and the Company's resiliency plans. Other parties proposed alternatives to traditional storm hardening planning. Many parties examined measures to assess the costs and benefits of the Company's resiliency plans.

Con Edison received feedback and insights that it believes will strengthen its resiliency plans and improve its service to the communities the Company serves in the following key areas:

- **Design standard for protection of equipment and locations affected by flood** – Con Edison will design flood protection projects based on the 1% annual flood hazard elevation (100 year floodplain) established by Federal Emergency Management Administration's (FEMA) June 2013 Preliminary Work Maps 100-year floodplain plus three feet of freeboard (FEMA plus three).
- **Modification of Con Edison risk assessment model for storm hardening projects** – Con Edison has amended its risk assessment model to incorporate a storm surge inundation prediction model developed by the New York City Mayor 's Office of Long Term Planning and Sustainability.
- **Consideration of the impact of climate change on storm resiliency plans** – Con Edison will conduct a Climate Change Vulnerability Study. The study seeks to synthesize current views on climate change, identify the design basis/infrastructure that might be affected, and develop a shared understanding among Collaborative participants.
- **Design resiliency into capital investments and operating practices** – Con Edison will continue to consider resiliency in its design, installation, operation, and maintenance of facilities and equipment.

B. Establishment of Phase II Working Group Collaborative

The Collaborative parties recognize the need to continue the discussion on several topics in a second phase of the Collaborative following the preparation of this Report on the Collaborative's activities up to November, 2013. The Collaborative has developed a future agenda including:

1. **Working Group 1: Storm Hardening Design Standards and 2014 Projects** proposes in Phase 2 to sponsor Con Edison's 2014 Climate Change Vulnerability Study as outlined in this Report and examine Con Edison's storm hardening project plans under development for initiation in 2015, including undergrounding of electric overhead distribution facilities, tunnel hardening, gas main replacement in flood zones and steam distribution projects[8].
2. **Working Group 2: Alternative Resiliency Strategies** proposes in Phase 2 to (1) examine potential alternative strategies to achieve resiliency or mitigation of the impact of future extreme weather, including heat and storms, on Con Edison's customers. WG2 has identified the following potential approaches to resiliency: distributed energy resources, which includes distributed generation (DG) (such as combined heat and power generation (CHP) and renewable generation), microgrids, energy efficiency (EE), demand response (DR), electric vehicles (EVs), energy storage, and time-differentiated pricing (such as time-of-use (TOU) rates); (2) develop a ranking of strategies based on cost-effectiveness in coordination with related work underway in Working Group 4 and (3) develop a proposal to Commission regarding alternative resiliency solutions.
3. **Working Group 3: Natural Gas System Resiliency** proposes in Phase 2 (1) to study and quantify the leakage rate of known Type 3 leaks and (2) to develop and propose to the Commission a program for reducing the backlog of those leaks.
4. **Working Group 4: Risk Assessment / Cost Benefit Analysis** proposes in Phase 2 to develop a formal economic cost/value model that can be applied to the storm hardening projects that were examined in the working group's risk assessment and prioritization model developed during Phase 1. [9]

---

[8] Among the projects under development to improve steam distribution system resiliency are:

- Installation of additional manually operated isolation valves to maintain customers in service as portions of the distribution system are preemptively shut down; and
- Installation of remotely operated isolation valves to maintain areas in service until flooding is imminent

The Company is also evaluating the circulation of hot air to keep the steam mains hot while off line during a flood event.

[9] UWUA Local 1-2 contends that staffing levels are an appropriate resiliency topic for consideration in Phase II discussions by Working Group 2 (Alternative Resiliency Strategies) and Working Group 4 (Risk assessment / Cost Benefit Analysis). Discussion of staffing issues in this Collaborative is inappropriate for several reasons. Staffing levels raise wide-ranging considerations that are not within the expertise of the Collaborative and would result in a debilitating dilution of the Collaborative's focus on core resiliency issues. Local 1-2 proposals supporting its staffing contentions were thoroughly examined and refuted by the Company during the litigated phase of the rate cases where Con Edison demonstrated that the Company's operations are adequately and effectively staffed by a combination of Local 1-2 members and contract workers. The Collaborative should not be encumbered with examining that work force balance. In addition, as discussed in Con Edison's rate case testimony, the Company and Local 1-2 during the collective bargaining process agreed upon a process for Local 1-2 and the Company to examine Local 1-2 concerns regarding staffing issues. That process remains active, and examination of Local 1-2

Con Edison remains committed to improving resiliency of its infrastructure and looks forward to the Collaborative process in gaining additional insights and perspectives outside the Company.

C. Summary of Working Group 1 Discussion and Outcome

Working Group 1 focused on Storm Hardening Design Standards and 2014 Projects. This section summarizes the outcomes of each major discussion area. Subsequent sections describe these discussion areas and outcomes in detail.

Design Standards

Con Edison infrastructure standards are based on New York City Department of Buildings Code (NYC Building Code), FEMA predictions of floodplains, and American Society of Civil Engineers (ASCE), National Electric Safety Code, and Con Edison's specific standards.

Con Edison has established a design standard for flood protection that consists of the 1% annual flood hazard elevation (100 year floodplain) as established by the June 2013 FEMA Preliminary Work Maps plus three feet of freeboard (FEMA plus three). This design standard meets and exceeds the minimum requirements set by the NYC Building Code, while incorporating current projections for sea level rise due to climate change. The NYC Building Code's requirements for flood protection cite the Base Flood Elevation (BFE) and floodplain extents from FEMA Flood Insurance Rate Maps (FIRMs). The NYC Building Code requires additional freeboard of up to 2 feet above the BFE, depending on structural occupancy category. A freeboard standard of 1 foot would meet the NYC Building Code requirement for facilities within Structural Occupancy Category Class III that is applicable to Con Edison's structures. By adopting a freeboard standard of 3 feet (36 inches), Con Edison's design standard exceeds the NYC Building Code's minimum standard and simultaneously accounts for impacts from sea level rise of up to 31 inches projected by the NPCC at the High Range (90th percentile) for the 2050s.

Design Standard Stipulation

Con Edison's flood protection design standard for storm hardening and resiliency projects commencing during the period of 2014 through 2016 will be based on the June 2013 FEMA Preliminary Work Maps. Con Edison will design projects located within the 100-year floodplain to withstand the level of a 100-year flood plus three feet to address, among other things, considerations of the impact of future climate change.

The FEMA plus three design standard will be utilized as the *minimum* protection level for projects to protect critical components of the Company's systems. During the design phase, all projects will be evaluated to determine whether a higher protection level should be achieved. Con Edison will determine whether to exceed the design standard level based on a variety of factors, including employee safety, impact to operations and/or maintenance, added cost, etc. If it is deemed feasible to

---

staffing issues in a parallel setting within the Collaborative intrudes upon and is inconsistent with this collective bargaining process. In addition, the Company understands that Staff will propose that the Commission initiate a statewide audit of utility staffing issues in response inter alia to the Moreland Commission and 2100 Commission Reports. Staff is presently seeking staffing information from Con Edison and other utilities in preparation for this audit. The Company's staffing levels will be examined in that audit and should not be additionally examined in the Collaborative.

achieve a higher flood protection level within the constraints of the particular project, the Company will do so.

Storm Hardening Projects from 2013 through 2016

From 2013 through 2016, Con Edison is proposing to invest approximately $1 billion to improve the resiliency of the electric and gas delivery systems and the electric and steam generating stations. An overview of these expenditures is provided in Table 2: CECONY Capital Expenditures:[10]

Table 2: CECONY Capital Expenditures

($ Millions)	2013	2014	2015	2016	Total
Electric Substations	30.0	60.0	70.0	80.0	240.0
Electric Network Distribution	21.0	72.5	60.5	52.0	206.0
Electric Overhead Distribution	19.6	15.0	115.0	112.0	261.6
Transformers	10.0	12.5	11.3	11.4	45.2
Electric Transmission	3.9	4.9	2.0	2.0	12.8
Electric and Steam Generation	18.4	42.8	51.5	52.3	165.0
Gas and Tunnels	2.1	6.8	41.6	51.7	102.2
Telecommunications	0.0	1.3	2.7	2.6	6.6
Facilities	0.0	0.0	5.0	5.0	10.0
Total	**105.0**	**215.8**	**359.6**	**369.0**	**1,049.4**

Substations

Five transmission substations were shut down due to Sandy. In total, 14 Manhattan networks, one Brooklyn network, and three Staten Island load areas were shut down by the storm. Many of these outages were the result of flooding at substations. The storm surge from Sandy substantially exceeded historical storm data and storm surge predictions. Con Edison installed temporary flood protection; however, these measures were insufficient largely because the actual surge far exceeded predictions. As a result, critical stations were forced offline, leading to a large number of customer outages followed by a restoration period of up to four days. By protecting our substations, we will minimize the potential for large-scale outages across multiple networks. The substations that were operationally impacted by the storm include East 13th Street, East River, East 15th Street PURS, East 36th Street, Seaport, and Trade Center in Manhattan; Gowanus in Brooklyn; and Goethals and Fresh Kills in Staten Island. These stations have been fortified already with immediate hardening measures in preparation of the 2013 hurricane season.

[10] Con Edison will follow established capital expenditure review practices in updating Staff regarding the Company's progress and expenditures in implementing storm hardening projects that are reflected in the revenue requirement to be approved in the Company's rate cases.

Our 2014 to 2016 storm hardening plans include 16 substations. These substations are Avenue A, East 13th Street, East River, East 15th Street PURS, East 36th Street, Leonard Street, Seaport, Sherman Creek, and Trade Center in Manhattan; Farragut and Gowanus in Brooklyn; Rainey and Vernon in Queens; Hellgate and Bruckner in the Bronx; and Goethals and Fresh Kills in Staten Island.

To harden our substations in the 2014-2016 timeframe, we are:

- Installing new relay cabinets at the location of the equipment that they protect;
- Installing additional fiber-optic-based communications equipment which is more resistant to flood damage than copper cable;
- Defining purchase specifications to ensure new equipment includes raised critical flood-protection controls and cabinets;
- Raising critical control cabinets in pressurization and cooling plants;
- Installing new emergency diesel generators elevated above the flood-control level;
- Installing new high-capacity flood control pumps;
- Relocating other critical station equipment above the flood-control elevation;
- Making submersible or protecting critical equipment that remains in the flood zone;
- Installing additional height on accommodating foundations and other immediate installations to meet new flood control levels;
- Installing moat walls and raising existing walls to meet new flood-control elevations; and
- Installing new sheet-pile surge walls.

Capital expenditures for these substation initiatives are projected to total $240 million, which includes $30.0 million in 2013, $60.0 million in 2014, $70.0 million in 2015, and $80.0 million in 2016. These substation storm hardening projects are currently being designed to meet the FEMA plus three feet design standard. The specific work required to implement storm hardening measures at each substation is currently being refined and designed, and project scopes are becoming more detailed. Accordingly, project specific expenditures may be adjusted from original projections, but rate case funding requests for 2014 remain constant as filed in the Company's rate case update.

Electric Network Distribution

In the event of a major storm, flooding caused by rain and coastal storm surges could cause major damage to our network electric infrastructure as was experienced in Sandy. Con Edison began addressing this risk in 2005 based on lessons learned by electric utilities from Hurricane Katrina. The Company proactively began to require customers interconnecting with network distribution facilities in flood-prone areas to either install submersible electrical equipment or raise critical equipment above the ground floor. Additionally, Con Edison began installing submersible transformers and network protectors as equipment in flood-prone areas was replaced or upgraded. These upgrades have improved the resiliency of network system by enabling a more rapid recovery and have improved the safety of our community.

To harden our electric network distribution system in the near term, we are:

- Proactively replacing non-submersible equipment, including installing 265/460 Volt submersible network protectors and 120/208 Volt submersible transformer/network protectors, rather than requiring such designs for only new installations and upgrades;
- Reconfiguring the Bowling Green and Fulton networks using smart-grid switches in order to limit the impact of flooding to isolated parts of the networks; and
- Protecting the networks in flood zones by installing smart switches to isolate high tension customers whose equipment is subject to flooding.

Capital expenditures for these electric network distribution initiatives are projected to total $206 million, which includes $21.0 million in 2013, $72.5 million in 2014, $60.5 million in 2015, and $52.0 million in 2016.

Electric Overhead Distribution

As a result of Sandy, the Company's overhead distribution system was impacted by wind and tree damage that interrupted service to 604,603 (about 70%) of the 868,347 non-network customers supplied from the overhead distribution systems in the Bronx, Brooklyn, Queens, Staten Island, and Westchester County operating areas. Our post-storm assessments identified damage to more than 900 transformers, 950 poles, and 140 miles of cable. The most critical threat to the overhead electric distribution system is the impact of falling trees on Company infrastructure. By protecting our overhead electric distribution system, we will significantly reduce the number of customer outages and improve restoration times to those customers.

To harden our electric overhead distribution system in the near term, we are:

- Installing additional reclosers and sectionalizing switches that are designed to reduce the number of customers per auto-loop circuit segment to minimize the customers impacted by damage;
- Installing isolation switching to minimize upstream outages on main feeders from damage on open wire spurs;
- Improving auto-loop circuit reliability by upgrading poles and cables, and installing breakaway devices;
- Selectively undergrounding overhead components to protect critical and/or susceptible circuits; and
- Enhancing the vegetation management program.

Prior to the initiation of the storm hardening program, the Company undertook an extensive program to expand the use of smart switches and smart grid technologies on its overhead distribution system and expand the communication infrastructure to support additional devices. The Company has developed and installed recloser technology that automatically controls every recloser on an auto-loop circuit preventing additional faults. The Company's overhead system storm hardening program exploits this technology.

Capital expenditures for these electric overhead distribution initiatives are projected to total $261.6 million, which includes $19.6 million in 2013, $15.0 million in 2014, $115.0 million in 2015, and $112.0 million in 2016.[11]

Generating Stations

Our post-Sandy assessments of damage at Con Edison's generating stations, like our assessments of damage at substations, led us to conclude that we need to take additional steps to protect our generating stations. Our hardening projects at the generating stations follow the same design guidelines that we applied to substation-hardening projects. Immediate storm hardening efforts were completed to prepare infrastructure for the 2013 hurricane season.

In addition to the immediate measures, we have developed a longer-term storm-hardening plan for the three steam-generating stations that were operationally impacted by Sandy – East River, 59th Street, and 74th Street stations, as well as for the 60th Street and Ravenswood A House Steam Stations which were also flooded during Sandy, but their operations were not severely impacted.

Our 2014 to 2016 initiatives for storm-hardening our generating stations include plans to:

- Install sluice gates in the intake and discharge tunnels to control the inundation of floodwaters (this will require de-silting of the tunnels);
- Relocate critical mechanical and electrical equipment above the defined flood-control elevation;
- Install submersible equipment within the flood-control elevation;
- Reinforce station perimeter walls to withstand higher flood levels;
- Install pressure resistant/submarine type doors to protect deep basements or structures;
- Install permanent, high-capacity flood-control pumps in additional areas of the stations;
- Install new emergency generators to power flood pumps and to provide additional support to the stations during an emergency; and
- Raise existing moats and walls where possible to meet the flood-control elevation.

Capital expenditures for these generating station initiatives are projected to total $165 million, including $18.4 million in 2013, $42.8 million in 2014, $51.5 million in 2015, and $52.3 million in 2016. These generating station storm hardening projects are being designed to meet the 2013 FEMA plus three design standard.

Gas

As a result of Sandy, nearly 400 service outages affected more than 4,200 customers in the Bronx, Manhattan, Queens, and Westchester. Our post-storm assessments have identified the potential for significant damage if our region were to experience a significant coastal storm in the future. The most critical threat to the gas system is the introduction of water into gas-distribution equipment, which can damage pipes, lead to over-pressurization, or result in service interruptions. By protecting our gas system from water infiltration, we will spare our customers the long process of restoring gas services, which must be done one customer at a time.

---

[11] These projected costs include $100 million per year for selective undergrounding in 2015 and in 2016.

To harden our gas system in the near term, we are:

- Accelerating plans to install vent line protectors, also known as float check valves, to prevent water from entering high-pressure service lines through the venting system;
- Establishing plans to replace cast iron and bare steel pipe in flood-prone areas; and
- Elevating critical equipment at liquefied natural gas facilities to FEMA plus three feet.

Capital expenditures for these gas distribution system initiatives are projected to total $42.2 million, which includes $2.1 million in 2013, $6.8 million in 2014, $16.6 million in 2015, and $16.7 million in 2016.

Tunnels

During Sandy, water entered several tunnels, including the First Avenue, Ravenswood, Astoria, Hudson Avenue, Flushing, and 11th Street tunnels. These tunnels contain steam mains, gas mains, and/or high voltage electric feeders that may need to be de-energized for safety if the tunnels are significantly flooded. Most of our tunnels have "head-house" entrances that are in close proximity to bodies of water but not designed to withstand coastal flooding.

To harden our tunnels during 2015 to 2016, we are:

- Constructing hardened and reinforced concrete structures to replace certain head-houses and hardening other with flood doors and floodgates;
- Constructing barrier walls and sealing cracks and other penetrations in the interior tunnel walls to prevent water infiltration;
- Improving pumping operations to pump out water that infiltrates; and
- Installing remote cameras and lighting for remote monitoring.

Capital expenditures for these tunnel initiatives are projected to total $60 million, which includes $25 million in 2015 and $35 million in 2016. During 2013, we are investing about $0.5 million to storm harden the First Avenue Tunnel.

D. Design Standards

Rate Case Stipulation Establishing Storm Hardening Design

In the rate cases, Con Edison proposed storm hardening measures for energy infrastructure that experienced significant flooding during Sandy.[12] Con Edison's proposed measures would harden each substation and generation station (collectively "stations") that flooded during Sandy to a new flood-level design. The new design was based upon the highest of the following elevations, explained below:

1. Base Flood Elevation (BFE) plus two feet. The BFE is the flood elevation, including wave height that has a 1% chance of being equaled or exceeded in any given year. The BFE values reflect

[12] The company also proposed storm hardening measures for the overhead electric system, for the gas system, and for tunnels.

the 2007 FEMA Flood Insurance Rate Maps for facility locations that fall within a special flood hazard area (typically zone AE for NYC).

2. Category 1 Hurricane flood inundation elevation. This value is based on the latest (2010) National Oceanic and Atmospheric Administration (NOAA) Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model for the NYC area, as implemented by the NYC Office of Emergency Management.

3. The maximum elevation of water observed by Con Edison at the facility during Sandy on October 29, 2012.

The highest elevation among these three sources was the minimum flood-water height to which critical equipment and structures at the stations would be protected. Con Edison proposed projects to achieve this protection to be implemented during the period of 2013 through 2016.

A number of rate case parties supported the need for initiatives to storm harden the Company's stations that experienced flooding during Sandy, but also urged the Company to address the other stations located in flood zones. Several parties pointed out that Con Edison's storm hardening designs did not reflect the most recent FEMA flood maps i.e., those issued contemporaneous with and/or after the rate filings were made, and the potential flooding impacts of current projections for climate change, such as those of NPCC. The parties' rate case testimony generally recommended that Con Edison adopt a storm hardening design standard that both reflects ABFE maps issued by FEMA in late January and in February 2013 and addresses modeled climate change impacts.[13] In the interim, in June 2013, FEMA issued updated flood maps titled Preliminary Work Maps.

Upon conferring with the parties in the rate case on the appropriate flood protection design standard for resiliency plans, Con Edison agreed to modify its proposed resiliency plans for infrastructure in New York City to reflect both the FEMA June 2013 Preliminary Work Maps and potential sea level rise due to climate change. To memorialize Con Edison's agreement, Con Edison, the City of New York, and several non-governmental organizations, entered into an agreement dated July 19, 2013. In the agreement, the Company committed that its flood protection design standard for storm-hardening related capital projects initiated during 2014 for the portion of its service territory located in the City of New York will reflect the FEMA Preliminary Work Maps issued in June 2013 and would take into consideration the location of the floodplains and the extent of potential flooding set forth on those maps. The agreement states that Con Edison will design projects located within the 100 year floodplains with the objective of withstanding the level of a 100-year flood, plus three feet to address, among other things, considerations of the impact of future climate change. The agreement is in the form of a stipulation and was entered into the record of the rate cases as Exhibit 846.[14]

During the meetings of Working Group 1, a representative of the City of New York made a presentation providing information regarding FEMA flood maps for New York City, including concepts of coastal storm

[13] The ABFE maps for New York City areas were issued in late January and in February 2013 after the Company filed its rate cases.
[14] In this report, this design standard will be referred to as "2013 FEMA plus three."

modeling and mapping, information regarding FEMA flood zone designations, and the evolution of New York City coastal flooding vulnerability from FEMA's 1983 flood maps to FEMA's June 2013 Preliminary Work maps.

Con Edison is using 2013 FEMA Preliminary Work Maps 100-year floodplain plus three feet as the design standard applicable to the Company's electric, gas, and steam and electric generation storm hardening and resiliency projects that are being designed to address storm surge flooding and will be commenced during the period of 2014 through 2016.

During the meetings of Working Group 1 and in response to information requests issued by Staff, Con Edison presented the electric, gas, and steam and electric generation storm hardening and resiliency projects that are being designed to address storm surge flooding and will be commenced during the period of 2014 through 2016. These presentations and responses updated the projects proposed in the rate cases to identify incremental measures resulting from the use of 2013 FEMA plus three and to identify the revised costs of these projects. Con Edison has presented these impacts in detail in this report.

Flood Protection Design Standard

Con Edison's current design standard for flood protection consists of the 1% annual flood hazard elevation (100 year) established by FEMA June 2013 Preliminary Work Maps plus an additional three feet.[15] The additional three feet of freeboard over the FEMA level is a combination of two feet freeboard prescribed by the New York City Building Code to account for potential uncertainties related to storm surge elevations and an additional one foot such that the total of three feet (36 inches) freeboard accounts for potential sea level rise up to 31 inches projected in the June 2013 NPCC report (90th percentile, high-end projection).

Appendix G of the New York City Building Code requires that buildings located in areas of special flood hazard defined as the 100 year flood plain established in the FEMA Flood Insurance Rate Maps (FIRMs), must build to the base flood elevation specified in the FIRMs or higher depending on the structural occupancy category (SOC)[16] of the structure. Appendix G, Table 2-1 requires one foot of freeboard for SOC Class III structures and two feet of freeboard for SOC Class IV structures. While Con Edison

---

[15] Con Edison's resiliency plans for electric infrastructure in Westchester County consists of a variety of measures to strengthen the overhead distribution system against the impacts of high wind. These measures are discussed in detail in this Report. The Company does not have critical distribution structures in Westchester County coastal flood zones, and in the event of impending coastal flooding, the structures that are located in flood zones are protected by temporary measures and, if necessary, can be switched out of service without interrupting service to customers. Accordingly, the Company is focusing its resources on measures to protect the overhead system from wind storm damage and has not proposed coastal flood protection measures in Westchester County.

[16] The New York City Building Code, Appendix G, references the most current FIRMs. The most current FIRMs for New York City were issued in 1983. FEMA is presently revising the flood maps for New York City based upon Hurricane Sandy experience. Upon FEMA's issuance of ABFE maps for New York City in January 2013, the Mayor of the City of New York issued an emergency decree in January 2013 making changes to both the Building Code and the Zoning ordinances to require use of the ABFE map base flood elevations in rebuilding structures in flood hazard areas. The ABFE maps have been replaced by the Preliminary Work Maps issued in June 2013. New FIRMs are in the process of being developed based on the Preliminary Work Maps.

considers its structures to be SOC Class III structures, the incorporation of two feet of freeboard brings the Company in line with the most stringent requirement for flood protection (two feet freeboard) that is provided by the NYC Building Code.

The 2013 NPCC report projects several scenarios for sea level rise over the next several decades. The high end (90th percentile) projection for the next decade and a half (the 2020s) is 11 inches and through the 2050s is 31 inches. The addition of one foot, in combination with the two feet above the FEMA 100-year floodplain established in the NYC Building Code (total of three feet or 36 inches), provides freeboard meeting NPCC's current high-end projections (90th percentile) for 31 inches sea level rise through the 2050s

Short-Term Flood Protection Design Standard

Con Edison's flood protection design standard reflects FEMA's Preliminary Work Maps for New York City issued on June 10, 2013. Con Edison's projects commencing during the period of 2014 through 2016 for the protection of electric, gas, and electric and steam generation facilities will be built to flood zone boundaries and elevations derived from the June 10, 2013 Preliminary Work Maps for New York City plus three feet freeboard at a minimum. The FEMA plus three design standard will be utilized as the *minimum* protection level for projects to protect critical components of the Company's systems. During the design phase, all projects will be evaluated to determine whether a higher protection level should be achieved. Con Edison will determine whether to exceed the design standard level based on a variety of factors, including employee safety, impact to operations and/or maintenance, added cost, etc. If it is deemed feasible to achieve a higher flood protection level within the constraints of the particular project, the Company will do so.

Long-Term

Con Edison plans to design flood protection projects commencing after 2016 to flood zone boundaries and elevations derived from then-current FEMA maps plus three feet freeboard. The Company will monitor for changes in base flood elevations and for updates in climate change forecasts and sea level rise projections made by organizations such as the NPCC or IPCC. Every five years, or sooner if warranted, the Company will consider revision of the flood protection design standard to reflect such changes as well as current FEMA flood maps and NYC Building Code requirements.

Overhead Distribution System Design Standard

The Company's design basis for the overhead distribution system is consistent with the National Electric Safety Code (NESC). The NESC Section 25 requires power facility structures to be designed to withstand specific combinations of ice and wind depending on loading class. There are three district loading classes as shown in Figure 250-1 of the NESC:

- Heavy – North Central & Eastern US
- Medium – Northwestern, Mid Central & Eastern portions of U.S.
- Light – Southwest, S. Central & S. Eastern U.S.

Con Edison's service territory lies entirely within the heavy loading district. Additionally there are three grades of construction within the NESC Section 24: B, C and N with Grade B being the highest. Con

Edison follows the design basis of NESC Section 250B, Grade B, Heavy. This is the most stringent design specification for pole loading within the NESC.

During a typical storm event, the overhead distribution system's main vulnerability is from falling trees and limbs. The predominant failure mode for the Con Edison system is not due to the force of wind or ice conditions on overhead infrastructure, but rather damage to equipment (poles, wires, transformers, etc.) that breaks due to impact by trees and limbs which fall under wind and storm conditions.

The Company will continue to use open wire as its standard. Open wire is used industry wide for normal applications on the overhead system. Open wire compared to similar aerial cable has increased BIL levels, which offer protection from surges such as lightning or switching transients. Open wire construction is less expensive than comparable alternatives. Storm damage to open wire is often easier and faster to repair, and because it is an industry standard, mutual aid crews are generally familiar with repair methods. The typical application of open wire with the tree wire covering will continue in most areas to provide protection against limb contacts.

Beyond the open wire standard, the Company is deploying aerial cable systems and express underground style aerial cable systems for added protection. This is done in areas where an open wire system with tree covering will remain vulnerable to uprooted trees and large tree limbs, based on engineering evaluation of the conditions and predicted performance. These two types of systems offer added protection due to the strength of their steel messenger and thick cable jackets.

In the aftermath of Sandy, the Company issued Bulletin B-212 which provides a guideline for regional engineering and overhead construction on selecting adequate class poles for storm hardening. The specification is applicable for all new construction or pole replacement work on feeder main runs, non-fused spurs, laterals that supply large customer counts, or laterals that connect to emergency back-up tie points. This Bulletin requires consideration of the use of stronger poles in critical locations and provides guidance on employing them for storm hardening purposes in vulnerable areas.

In order to further mitigate the risk from falling trees and limbs, the Company is making enhancements to improve overhead system storm performance. These improvements are discussed in following section.

2014 Climate Change Vulnerability Study

A key element of Con Edison's storm hardening approach is to understand how weather and climate are changing and what potential risk and impact are to our infrastructure. As discussed previously, Con Edison has established a flood protection design standard for projects to be commenced during 2014 to 2016. The impact of future changes in FEMA base flood elevations and projections for sea level rise need to be considered in the flood protection design of future projects. In addition to flood, other aspects of weather and climate need to be considered in Con Edison's planning to harden its energy systems in the future. These may include temperature, humidity, duration and frequency of heat waves, wind, ice, and snow. The Collaborative recognizes the importance of studying these weather and climate factors and recommends a 2014 Climate Change Vulnerability Study (Appendix C: 2014 Climate Change Vulnerability Study Outline). The objective of the 2014 Climate Change Vulnerability Study is to synthesize current views on climate change, identify the design basis/infrastructure that might be affected, and develop a shared understanding among Collaborative Parties.

E. Integration of Resilience Considerations into Con Edison's Processes

Network Distribution System

All equipment installed by new customers in the flood zones must be submersible or elevated out of the flood area. The Company's Regional Engineering and Customer Engineering Departments will design all new installations in the underground distribution system to be of submersible design, whether or not located in flood zones, with the possible exception of switchgear in high elevations of buildings.

Overhead Distribution System

The Company has revised EO-10353 "Tree Trimming Requirements for Overhead Electric Distribution Lines" to provide enhanced vegetation management. Enhanced vegetation control measures are designed to achieve maximum resiliency from extreme weather conditions that have the potential to damage the overhead electric distribution facilities within New York City and Westchester County. Enhanced vegetation control measures provide for enhanced vegetation clearances, large tree removal, and limited tree growth as follows:

- Extended Vegetation Clearances – The trimming and clearance of vegetation surrounding overhead electric distribution pole lines and open primary wires to distances beyond the preferred clearances established under the Company's standard tree-trimming program.
- Large Tree Removal – A tree of a defined height, both "On-ROW" or "Off-ROW" that if uprooted in the event of extreme weather has the potential of causing extensive damage to an overhead electric distribution pole line. The identified tree will be considered for removal. For replacement, a tree of limited growth or "ornamental tree" can be planted (under the responsibility of the local municipal authorities or property owners).
- Limited Tree Growth – A tree species that does not grow beyond a defined height at maturity i.e., an adult ornamental tree that does not grow beyond 20 feet.

From a system reliability and resiliency stand point, the quickest and most cost effective option to protect the system is to add additional isolation devices, such as fuses and switches. These devices provide a number of benefits. A typical Con Edison circuit runs for several miles. A failure at a certain point of the circuit will impact other customers on the same circuit depending on the location of the closest upstream protective device. By increasing the number of automatic protective devices per circuit we limit the impact of a single event such as a falling tree without requiring operator intervention. Examples of these isolation devices are fuses, reclosers and Kyle switches. In addition to the benefit of the automatic operation, having additional devices also allows greater flexibility in isolation and restoration when a failure does occur.

The Company is installing additional reclosers and sectionalizing switches (both SCADA-ready and manual) that are designed to reduce the number of customers between cable segments. In case of permanent faults occurring on the overhead system, the additional reclosers and sectionalizing switches are designed to reduce the number of customers impacted by a faulted cable section to a target of 500 or less. The Company's goal of approaching 500 customers per segment offers the best balance between reliability and expenditure given the current system configuration.

For those locations without automatic protective devices, remotely operated SCADA gang switches can be operated from the control room, without having to dispatch a crew to the location, once operators have received field damage assessment reports and other information. These switches will be deployed in locations where additional automatic switches cannot be added.

Additionally, the Company is installing spur fuses which are designed to isolate faulted sections from the feeder main run. The Company is also installing break-away devices on overhead service cables (cable supplying individual customer premises) which if struck by falling trees or heavy branches are designed to break away rather than pull down and damage the customer's equipment. The break-away device is designed to fully de-energize the service conductors and maintain public safety and can be quickly reconnected to restore service to a customer.

Substations

Since 2009, Con Edison has by specification designed all critical equipment at new substations to be sited above the Category 2 Hurricane flood elevations or the 100-year FEMA flood elevations, whichever is higher.[17] All new or replacement critical equipment at existing substations is evaluated for design and installation above the Category 2 Hurricane flood elevations or the 100-year FEMA flood elevations, whichever is higher.

The Company has revised its specification for the purchase of transformers for substations. Any new transformer that is purchased, whether it is to replace a failed unit, to increase reliability, or specifically for storm hardening, will be manufactured to incorporate storm hardening philosophy so that any mechanism or controls that are normally installed on the housing of the transformer will be installed at a higher elevation to be above the flood control level. Examples include the tap changer control mechanism and current transformer (CT) circuits.

Con Edison seeks to merge equipment replacement / upgrade work with storm hardening related to the same equipment when cost effective and operationally practical. For example, the East 13th Street Substation storm hardening project has considered and merged other equipment replacement and upgrade work into the storm hardening scope. A specific example is the upgrade of category alarms, which is a standard capital program. At East 13th Street, a planned alarm system replacement project was cancelled and the upgrade of the alarm panel was merged into the storm hardening project

[17] The 100 yr. flood elevation is established by the Federal Emergency Management Agency (FEMA) as shown on its Flood Insurance Rate Maps (FIRM). The New York City area flood maps are currently being revised and the proposed elevations are shown on FEMA's Preliminary Working Maps which can be found online at the FEMA.gov web site. The Category 2 elevation is established by the National Oceanic and Atmospheric Agency (NOAA) using its SLOSH (Sea, Lake and Overland Surge from Hurricanes) model to predict the water inundation levels under the influence of four categories of hurricanes (Category 1 to 4 based on wind speed). To determine the elevations, Con Edison has until recently used the 1990 maps prepared by the Army Corps of Engineers as part of the NY State Hurricane Evacuation Study. The Company currently uses the SLOSH model directly, as provided by the Army Corps of Engineers, in the ArcGIS software.

establishing a new control room. The new alarm panel is being incorporated into the new Human Machine Interface (HMI) system that is being installed for the new control room. The original alarm panel replacement project planned to incorporate a new microprocessor based system and a fiber optic network. Because this is the type of work planned for the East 13th Street storm hardening project, the two were merged.

Gas System

The current gas main replacement program or any targeted replacement that occurs within flood zones, will upgrade facilities to high pressure where possible in order to reduce the potential for water intrusion into the gas system during flooding. Where not feasible, the new pipe will be tested and installed to allow for future upgrading.

All gas main replacements or relocations within flood zones will include valve installations to allow for isolation that will minimize water migration and allow for quicker restoration.

Where the installation of vent line protectors (VLPs) is impractical for new high pressure services installations within flood zones, the service vent line will be raised to a minimum of three feet above the BFE provided on the June 2013 FEMA maps and at a freeboard elevation above future FEMA maps adequate to address projections for sea level rise.

Any new regulator installation within flood zones will incorporate design measures that minimize the impact of flooding on communication and control equipment.

Generating Stations

For the generating stations, Steam Operations and Engineering maintain a list of critical equipment for each station that falls within the projected flood plain. This list is currently being updated for each station to reflect the new flood design standard. In addition, all system descriptions are being updated to reflect the new standard as well as all of the associated equipment that would be affected. This will ensure that all station projects in the future will incorporate storm hardening and flood protection philosophies in their solutions.

V. Storm Hardening Projects

A. Approach to Addressing Resiliency Projects

Our approach is to identify the vulnerabilities in our stations and distribution systems, consider the probability of an event, and find cost-effective solutions to mitigate the vulnerabilities. In practice this becomes rather complex, with each station and system requiring varying solutions and therefore different investments.

This section of the Report describes the types of resiliency measures that Con Edison proposes to implement during 2014 through 2016 to mitigate potential impacts of flooding/surge damage and high-speed wind on the Company's stations and distribution systems. This section will also present in detail Con Edison's proposed resiliency programs and projects and associated costs for its electric substations, electric and steam generation stations, network and overhead electric distribution systems, gas distribution system, and tunnels.

Most of the resiliency programs and projects are scheduled to commence in 2014 or in 2015. As described below, the projects at some facilities, particularly at generating stations and several substations, are projected to require more than one year to complete. Once such projects are initiated, capital investments will be required over two or more years in order to complete the planned work. In addition, as described below, the Company is proposing a number of multi-year resiliency programs to add and / or replace equipment on its electric and gas distribution systems. These programs would continue to require capital investment beyond 2016 to provide cumulative storm mitigation benefits as deployment progresses throughout vulnerable areas of the distribution systems.

B. Resiliency Measures Generally

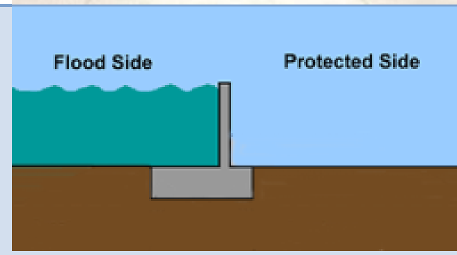
Our resiliency measures are intended to fortify our system against the impact of acute weather events. These impacts can largely be categorized as flooding/surge damage and wind damage. We have developed a set of measures that enable us to fortify our system to prevent, mitigate, and/or facilitate the restoration from such weather characteristics.

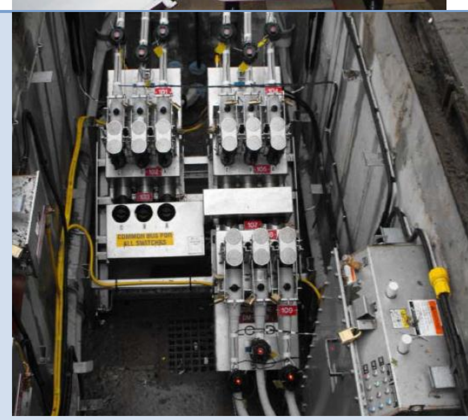
Protecting from Flooding and Storm Surge

Damage due to flooding and storm surge primarily impacted our electric substations, electric and steam generating stations, electric network distribution system, and gas distribution system. We have developed solutions to mitigate this damage and improve service restoration which are explained in the table below.

Table 3: Flood/Surge Damage Measures

Solution	Description	Example
Equipment Relocation	Relocate the equipment to a higher elevation or a different location outside the flood zone.	

Waterproof Barriers for Building Openings	Provide a complete barrier to water during a flood event. Examples include rolling barriers at doors and prefabricated post and panel barriers assembled just prior to a storm event.	
Flood Walls and Barriers	A **flood barrier** is a barrier designed to prevent a storm surge or spring tide from flooding the protected area behind the barrier. Flood barriers include flood walls as well as other barrier structures such as levees and dykes A **flood wall** is a vertical artificial barrier designed to temporarily contain the waters of a river or other waterway which may rise to unusual levels during seasonal or extreme weather events. Flood walls are mainly used on locations where space is scarce, such as cities or where building levees or dikes would interfere with other interests, such as existing buildings, historical architecture or commercial use of embankments. Flood walls are mainly constructed from prefabricated concrete elements and often have floodgates which are large openings to provide passage except during periods of flooding, when they are closed.	
Sluice Gates	A sluice (from the Dutch "sluis") is a water channel controlled at its head by a gate. A sluice gate is traditionally a wood or metal barrier sliding in grooves that are set in the sides of the waterway. Sluice gates commonly control water levels and flow rates in rivers and canals. The sluice gate is a movable gate allowing water to flow under it. When a sluice is lowered, water flow is stopped. Usually, a mechanism drives the sluice up or down. This may be a simple, hand-operated, chain pulled/lowered, worm drive or rack-and-pinion drive, or it may be electrically or hydraulically powered.	

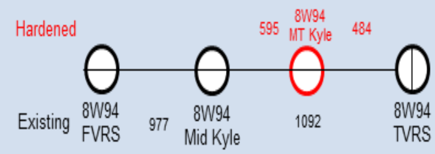
Pumps	Another form of protection, high volume pumps have been installed to remove any water that gets through the wall protection	
Submersible Equipment	Waterproof equipment which can operate while immersed and resist the corrosive effects of exposure to salt water and re-energize immediately after pre-emptive shutdown.	
Isolation Switches	Isolation switches on network feeders allow the isolation of vulnerable flood zones and maintain service to customers in non-flood zones during storms. Opening the switches in advance of a flood event will divide a network into an area that will remain energized and an area that will be de-energized. Switches on high tension (13,800 volt) customer equipment will de-energize and isolate customer switchgear that could fail due to flooding and de-energize the network feeders supplying these installations thereby jeopardizing the sustainability of the entire network.	

Equipment Wraps and Covers	Generally, two techniques used for water-tight enclosures are wrapping the equipment in a waterproof material to provide temporary protection or to cover the equipment to provide permanent protection.	

Protecting from Wind

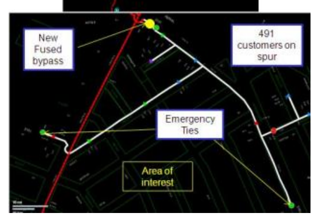
Damage due to wind primarily impacted our overhead electric distribution system. Wind damage is caused by downed vegetation due to high speed winds. We have developed solutions to mitigate this damage and improve restoration.

Table 4: Wind Damage Measures

Solution	Description	Example
Reduce Circuit Segment Size	Our Overhead System Upgrade plan will reduce storm impact to customers by reducing the number of customers served by a single circuit to fewer than 500 customers (from current average of 630), where practical. By doing this, we will be able to reduce the number of customers that are out of service as a result of a single point of damage on the system. The example one line schematic to the right shows a real world example of how the addition of a single automatic device reduces a circuit segment from 1,092 customers shown in black text on the bottom for the existing system to 2 segments with 595 and 484 customers respectively shown on top in red text. The switch shown added (labeled MT Kyle) is a smart switch with automatic operation that sends back telemetry data to our control center and has remote control capability.	 

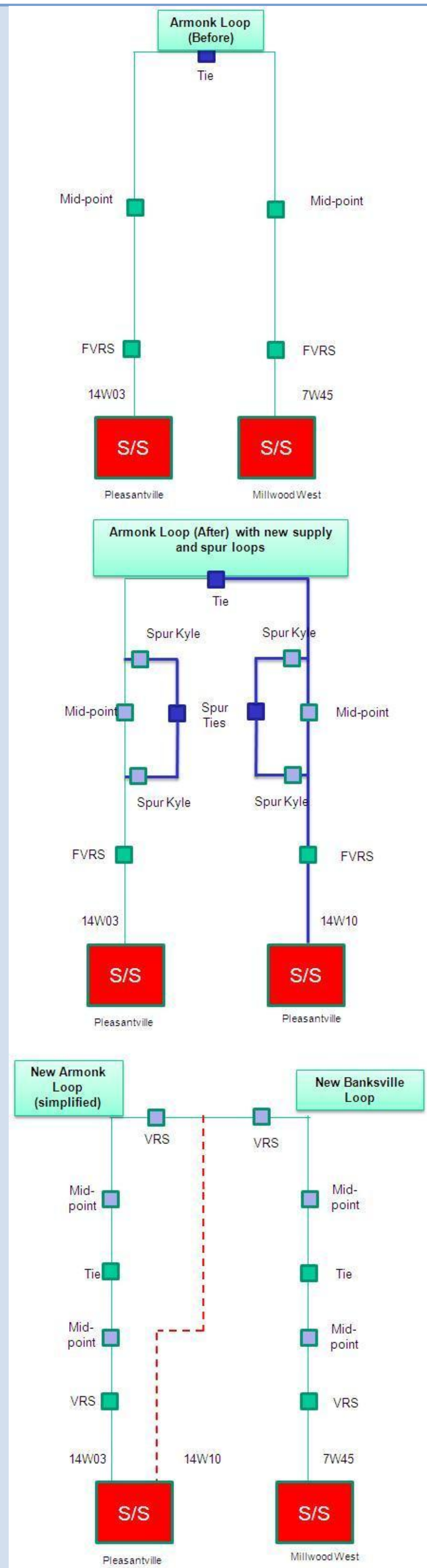
Isolation of Open Wire Spurs from Feeder Main Runs

Our overhead distribution system relies on a combination of main feeder lines and smaller spurs off of the main line to distribute power throughout a neighborhood. To reduce the risk that damage on spurs will affect main feeder lines, fuses, fuse bypass switches and automatic sectionalizing switches will be added to spurs and sub-spurs with open wire that are more than 2 spans in length (i.e., the distance between three utility poles) in order to prevent damage to vulnerable open wire segments from affecting main feeder run so that circuit damage will affect fewer customers. In the example shown to the right, installation of a fused bypass switch (see photo) will create a fused spur with 491 customers such that a fault on this spur would interrupt service only to these customers and protect 1,154 customers that otherwise would also have lost service. In addition, the fused spur provides emergency tie points for use as operational needs arise.



<table>
<tr>
<td>Improvement of Auto-loop Reliability</td>
<td>Auto-loops are looped circuits that are fed power from both ends (redundant supply). The following measures will be implemented to improve auto-loop design:

Add supply feeders, or utilize customer-side generation, to allow power to be fed not only from both ends, but also from other points along the feeder circuit to support continued service during feeder outages
Divide large auto-loops into several smaller loops
Upgrade wire and pole sizes to be 15 percent stronger and able to withstand gusts up to 110 miles per hour
Use Aerial Cable, which is more resilient than traditional open wire design
Implement “sacrificial components,” such as breakaway hardware and detachable service cable and equipment, to prevent pole and customer equipment damage

The example shown to the right employs most of the above design elements and is the first phase of future hardening work in the area.</td>
<td>
</td>
</tr>
</table>

Selective Undergrounding of Overhead Infrastructure	Our plan to fortify our overhead distribution system also includes careful consideration of the option of replacing portions of that system with underground equipment. Several years ago, Con Edison conducted a study on the costs and feasibility of undergrounding our overhead facilities, including estimating costs of undergrounding overhead feeders. The study recommended an underground loop system, similar to our overhead auto-loop design, consisting of cable installed in a conduit and manhole system with underground vault transformers. Switching would be enabled by a combination of vault-type automatic sectionalizing switches, manual single-phase vacuum switches and disconnectable splices. A typical conduit trench is shown to the right. We will select circuits for undergrounding using a prioritized list of critical municipal facility locations and a ranking of feeders within each municipality based on past performance, condition of infrastructure, and the potential for future problems. We will then evaluate designs and develop costs for each project. During the first quarter of 2014, we anticipate establishing the work to be done in 2015.	

C. Electric Substation Storm Hardening

Substation Storm Hardening Objectives

Flooding during Sandy shut down five transmission substations and one area substation.[18] In total, 11 Manhattan networks and three Staten Island load areas were shut down as the result of flooding at these substations. Before Sandy, flood protection of substations was based on historical storm data. As

[18] The transmission substations are East 13th Street and East River in Manhattan, Gowanus in Brooklyn, and Goethals and Fresh Kills in Staten Island. The area substation is Seaport in lower Manhattan.

Sandy approached, predictions for the storm surge were very close to the Company's existing flood protection level. To prepare for this unprecedented flooding, we installed additional temporary protection measures, including water barriers and sand bags to protect critical equipment as high as three feet above the predicted surge level. Despite our preparations, these additional measures were insufficient to prevent flooding in our substations, mainly because the storm surge far exceeded predictions — in fact, Sandy's surge far exceeded any storm surge in the history of New York City, dating back to a record previously set in 1821. As a result, critical stations were forced offline, leading to a large number of customer outages followed by a restoration period of up to four days.

These substations suffered a tremendous amount of salt-water flooding that damaged an extensive amount of equipment that is critical to feeder operation including the various components of the protective relaying and dielectric systems.[19] Salt water submergence caused extensive corrosion of controls and operating mechanisms. Transmission feeders and equipment could not be restored to service until minimal amounts of these auxiliary systems were in service. Restoration of these systems entailed a laborious and time-consuming process to clean, dry, or replace relay protection and station auxiliary equipment.

In each of the operationally affected stations, Con Edison installed by June 1, 2013, the onset of the 2013 hurricane season, many of the following flood control measures to mitigate the effects of a storm similar to Sandy:

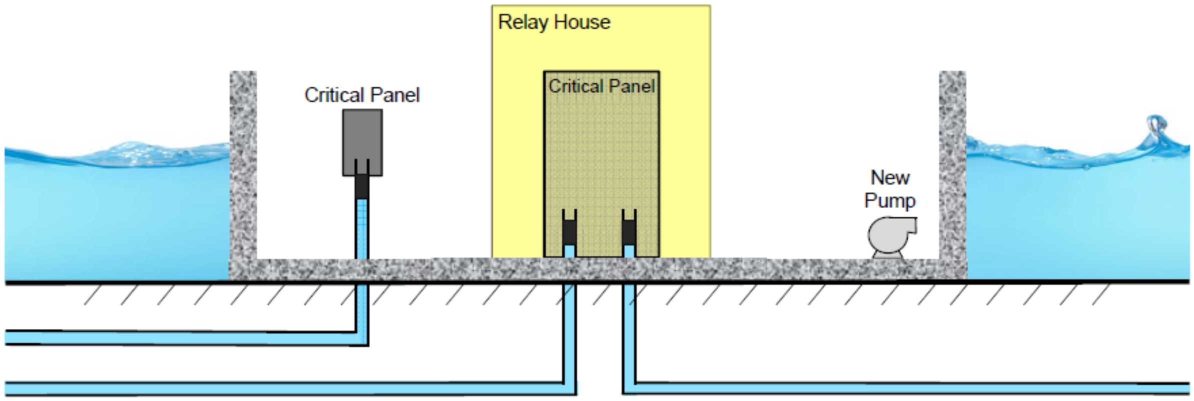
- Reinforced-concrete protective moats around critical equipment and secondary flood pumps that provide additional protection against seepage into the moats;
- Seal all electrical conduits and cable troughs that could provide a water path between the outside environment and the protected interior;
- New flood doors at egress points to protect against floodwaters;
- New gaskets on all cabinets to protect against water infiltration;
- Expansive polymer foam in the conduits that enter each panel to ensure no floodwater is able to enter and damage equipment;
- Nitrogen-driven pumps that maintain pressure on critical feeders in the event of a loss of normal power to the pumping plants;
- Secured industrial shrinkable fabric material to protect non-operating equipment for deployment as part of coastal storm preparations (as outlined in the Corporate Costal Storm Plan) to enhance protection against moisture intrusion;

[19] All major components of these transmission stations (feeders, power transformers, phase angle regulators and breakers) require protective relaying systems. These relay systems detect electrical faults and remove current carrying equipment from service to minimize damage and prevent cascading trip-outs from occurring. These relay systems, which require power to operate, are comprised of low voltage wires, control cabinets, relays, and telephone lines. Many of the feeders (transmission and sub-transmission) are comprised of current carrying conductors contained within a pipe. The conductors are surrounded by pressurized oil (pressurized to approximately 200 pounds per square inch), which is the insulating medium for the conductor. The dielectric system maintains this pressurized oil. It is comprised of Public Utility Regulating Stations (PURS), pumping plants and pressurization plants which contain many components such as pumps, valves, piping, etc. These plants require power to operate.

- Remove existing fencing and raise the concrete threshold level around the perimeter of the station;
- New flood panels and new, higher, reinforced baffle plates behind louvers to protect against additional surge of floodwaters;
- New reinforced-concrete wall along the property line of certain stations to protect against floodwaters; and
- New watertight joint material to replace all existing caulking on the joints of precast panels at certain stations.

During 2014 to 2016, Con Edison plans to install the following additional measures that will allow the stations to maintain their normal electrical configuration, while minimizing saltwater damage to critical electrical equipment and preventing widespread customer outages due to a substation shutdown:

- Install new relay cabinets distributed throughout the substations at the location of the equipment that they protect. The new cabinets will be able to be moved above the flood zone when a storm is expected. In addition, fiber-optic equipment, which is more resistant to flood damage, will be utilized for communications throughout substations;
- Install additional fiber-optic-based communications equipment to eliminate or significantly reduce copper cable, which is more vulnerable to salt-water infiltration;
- For future equipment purchases, such as transformers and phase-angle regulators, define the purchase specification to ensure that new equipment comes with critical flood-protection controls, including a tap-changer mechanism;
- Raise critical control cabinets in pressurization and cooling plants;
- Install new emergency diesel generators elevated above the flood-control level. Include design provisions to easily remove and reinstall the generator in case it has to be relocated during an emergency. Also, install quick-type emergency connection points that are accessible at the station;
- Relocate substation control rooms to higher elevations; for example, using the available second floor space at East 13th Street. This shift will include the installation of new Human Machine Interface (HMI) equipment and the relocation of L&P transformers as well as AC load boards;
- Install new high-capacity flood control pumps at certain stations;
- Relocate other critical station equipment above the flood-control elevation;
- Make submersible or protect critical equipment that remains in the flood zone;
- Install additional moat walls (diagram below) at other substations and raise existing walls to meet new flood-control elevations; and
- Install new sheet-pile surge walls around the perimeter of Goethals substation, and along sections of the perimeter at Fresh Kills and Gowanus stations. At Goethals, the wall will extend approximately 25 feet below grade and up to the flood control elevation above grade. This wall will protect the station from flooding as well as potential infiltration of ground water.



Substation Projects and Cost Estimates

Substation storm hardening projects during 2014 to 2016 will protect 16 electric substations against future flood conditions and storm surge. The storm hardening program is focused on the following primary objectives:

- Prevent de-energization of power supply equipment due to flood water intrusion;
- Maintain relay protection integrity;
- Minimize equipment damage from salt water; and
- Allow for rapid recovery.

The projects will protect the following Con Edison facilities:

1. East 13th Street
2. East River
3. East 15th Street PURS
4. East 36th Street
5. Seaport
6. Trade Center
7. Gowanus
8. Goethals
9. Fresh Kills
10. Hellgate/Bruckner
11. Sherman Creek
12. Farragut
13. Rainey
14. Vernon
15. Leonard Street
16. Avenue A

The installation of storm hardening measures is critical to maintaining the operational integrity of the facilities during extreme storm events. The storm hardening program will ensure that each station is protected and that the infiltration of flood waters will not interfere with the operation of the station. This will allow the stations to maintain their configuration while minimizing salt water damage to critical electrical equipment and will prevent widespread customer outages due to a complete loss of a substation.

In the rate case, Con Edison presented plans to install storm hardening measures at 14 substations from 2014 through 2016 at a total estimated cost of $210.0 million, including $60.0 million in 2014, as follows:[20]

Table 5: Substation Cost Estimates ($millions)

Station[21]	2014	2015	2016	Total
E 13th Street	32.0	34.0	39.1	105.1
East River Substation	1.35	2.8	3.15	7.3
Gowanus	2.5	6.25	4.25	13.0
Goethals	9.65	7.2	8.75	25.6
Fresh Kills	7.0	6.25	4.75	18.0
E 36th Street	1.0	1.5	1.0	3.5
E 15th Street	2.75	3.25	3.0	9.0
World Trade Center	1.2	0.7	1.0	2.9
Seaport	1.05	1.3	2.25	4.6
59th Pier	1.5	1.5	2.45	5.45
W 49th Street	0.0	1.15	1.0	2.15
Hellgate/Bruckner	0.0	1.9	4.45	6.35
Sherman Creek	0.0	1.7	4.35	6.05
Academy	0.0	0.5	0.5	1.0
All Substations	**60.0**	**70.0**	**80.0**	**210.0**

As a result of ongoing project development work, including incorporation of the new flood protection design standard, FEMA plus three feet, in late July 2013, Con Edison is refining the estimated costs of the substation storm hardening projects. Con Edison presented to Collaborative Working Group 1 updated costs for storm hardening work at nine of these substations as follows:

[20] As discussed below, storm hardening work at three of these substations has been postponed beyond 2016, and storm hardening work is planned five additional substations during 2014 to 2016.

[21] Scopes of work and further refined estimates for Farragut, Rainey, Leonard Street, Avenue A, and Vernon stations are currently in development.

Table 6: Updated Substation Project Costs ($ millions)

Station	Storm Hardening Project Cost (2014-2016) @ 60% Contingency (March 2013 Update[22])	Total Storm Hardening Project Cost @ 30% Contingency (June 2013 FEMA + 3')
East 13th Street	105.1	120.7
East River Substation	7.3	9.8
Gowanus	13.0	14.7
Goethals	25.6	25.7
Fresh Kills	18.0	17.5
East 36th Street	3.5	3.0
East 15th Street	9.0	9.2
Trade Center	2.9	1.5
Seaport	4.6	2.6

The total estimated cost of these nine projects has increased by $15.7 million from $189 million to $204.7 million. These updated cost estimates reflect the current level of development of project designs and information, which is not yet final.

Also as a result of adopting a new flood protection design standard in late July 2013, Con Edison identified five additional substations where flood protection measures would be installed from 2014 to 2016 and three substations where work originally planned for 2014 to 2016 would no longer required. The five additional substations are:

1. Farragut
2. Rainey
3. Vernon
4. Leonard Street
5. Avenue A

The preliminary costs for Farragut, Rainey, and Vernon total $2.9 million. Preliminary costs for Leonard Street and Avenue A have not yet been developed.

The three substations that have been removed from the 2014-2016 program are:

1. 59th Pier
2. W 49th Street
3. Academy

[22] The March 2013 Update refers to the additional detail that was provided in the Company's rate cases update filing on March 25, 2013 to support the projected storm hardening project costs.

The funding of $8.6 million projected for these three substations will support the flood protection measures to be installed at the five added substations and increased costs for other substations.

As Con Edison prepares detailed designs for each project and refines the costs for each project, estimated project costs will be adjusted and provided to Staff and the Collaborative Parties for review within Working Group 1's Phase II agenda. The Company's preliminary 2014 budget continues to project expenditures of $60 million for substation storm hardening projects consistent with the Company's rate case projection.

Substation Projects Work Scope

Con Edison plans to install flood control measures at 14 substations during 2014 to 2016. A description of the project scope and cost can be found in Appendix H: Project Details.[23]

Substations Project Issues

The primary issue associated with substation storm hardening is the potential for adjustment of the flood protection design basis in the future. The current flood control level, adopted in July 2013 after discussions with the City of New York and other stakeholders, is the June 2013 FEMA 100 year floodplain plus three feet. Con Edison has modified its flood protections measures at the substations to incorporate this design level with overall costs expected to remain fairly consistent with the Company's rate case estimate of $210 million from 2014 to 2016. The current design standard is intended to accommodate current flood zone maps and current projections of climate change and sea level rise by the 2050s. To the extent that the design level is increased in the future to accommodate revised flood maps or even more acute climate change effects, the impact on the substations would focus on large, established equipment, such as transformers, and would require significantly more funding to move out of the flood risk area or protect with other measures. This issue is expected to be examined in the study of system vulnerability to long-term climate change that is proposed in this Report.

D. Electric Network Distribution System Storm Hardening

Network Distribution System Storm Hardening Objectives

In the event of a Category 1 or 2 hurricane, flooding caused by rain and coastal storm surges could cause major damage to our underground electric infrastructure, particularly in low-lying areas, as was experienced in Sandy. Our coastal networks in Brooklyn, Manhattan, and Queens could be submerged in several feet or more of salt-water. Severe flooding in our underground networks and at our substations causes customer outages. Outages also occur when we preemptively de-energize specific flood-prone

[23] The tables in Appendix H: Project Details general provide the following information:

- The need for and the benefits provided by the projects;
- Measures, and associated cost, installed during 2013;
- Additional measures to be installed during 2014 to 2016 to meet the design standard based on the June 2013 FEMA flood maps plus three feet;
- Construction start and end dates;
- Estimated project cost from 2014 to 2016; and
- Alternative mitigation measures that Con Edison considered but did not select and reasons.

networks when severe flooding is predicted, as was the case during Sandy, in order to prevent damage to our equipment and customer equipment, and to protect the public. This action reduces the risk that energized switchgear would come into contact with floodwaters in basements, which would result in even more extensive damage and potentially an even longer restoration process.

The underground network cable system is submersible; all primary and secondary network cables are fully insulated, and waterproof splices are used to connect them in every manhole and service box on the system. Network switches, called a Network Protector (NWP), are not submersible; a NWP is used to take a 120/208 volt or 265/460 volt distribution transformer out of service for routine work or during an emergency (a fault on the distribution feeder that supplies the associated transformer). The customers' switchgear is also typically not submersible.

There are three types of services, 120 volt, 460 volt, and High Tension Vault (HTV), typically 13 kV. The latter is used for large facilities that have their own transformers; they do not have NWPs and cannot be removed from service directly by the company. Extensive flooding of the networks, as experienced during Sandy, poses three threats: a safety concern (shock or electrocution) from submerged customer equipment at the 120V level; a fire concern due to cross phase arcing of submerged 460V equipment in the NWP vault room; and system sustainability issues from faulted HTV equipment causing network feeders to de-energize.

Con Edison began addressing this risk in 2005 based on lessons learned by electric utilities during Hurricane Katrina. The Company proactively began to require that interconnecting customers in flood-prone areas either install submersible electrical equipment, or raise critical equipment above the ground floor. By taking these steps, we not only mitigated the potential impact of a major flooding event on those customers' equipment, but also reduced the probability that our system would be impacted by a fault current on the customers' side of the meter. Additionally, Con Edison began installing submersible transformers and network protectors as equipment in flood-prone areas was replaced or upgraded.

During Sandy, three networks were taken out of service preemptively and 24 additional feeders in eight other networks were shut down to de-energize 460V services. The three networks shut down (Bowling Green, Fulton, and Brighton Beach) have too many 460V services in the flood zones to simply remove the associated feeders from service; there would not be enough feeders remaining in service to supply the remaining network load. In addition, multiple network feeders de-energized due to faults on HTV equipment. It took five days to restore service, and 11 days to return to full contingency design (N-2), primarily because many NWP replacements were required. Our goal is to reduce these periods to 24 and 48 hours respectively. To accomplish this, we must install submersible units to eliminate the need for replacing these NWPs.

In the aftermath of Sandy, we further assessed the design basis for each underground electric network and developed strategies to further reduce the impact of flooding on underground equipment, including a plan to replace non-submersible equipment more proactively, rather than requiring such designs for only new installations and upgrades. Thus, all 120/208 Volt transformers in New York City flood zones will be replaced with off-the-shelf submersible equivalents, and a newly designed submersible network protector for the 460 Volt services (which generally are used to supply larger buildings) will be installed to protect installations in flood zones from saltwater damage.

Smart-grid technologies give us tools that make the grid more flexible and responsive during extreme weather, which allows us to minimize power outages. Smart-grid measures such as sectionalizing switches allow system operators to identify and isolate problem areas and rapidly bring power back to the surrounding areas, keeping more customers in service. We will continue to advance the installation of smart-grid technologies, including sectionalizing switches in our underground and overhead electric systems.

To protect underground networks vulnerable to corrosive salt-water flooding, and minimize power outages, we are installing smart switches to reconfigure our most vulnerable underground networks to form separate flood areas. We will re-configure three networks using smart-grid switches in order to limit the impact of flooding to isolated parts of the networks, protecting the rest of the networks. When the region is threatened by floods, we will be able to preemptively isolate areas at risk, while keeping electricity flowing in the surrounding areas. Two of these vulnerable networks — Lower Manhattan's Fulton and Bowling Green networks, which were preemptively shutdown during Sandy — will be permanently divided into smaller networks. Fifty percent of the customers in these networks will be protected from outages in similar storms. Isolation switches will be utilized in other networks to de-energize high-tension customer equipment that poses a risk to the electric grid if flooded. We have already successfully applied this segmentation strategy in our smart-grid demonstration projects in Queens, and with that experience, will now advance that approach.

With the use of underground smart switches and submersible equipment, coastal networks will be restored in 24 hours after they are preemptively de-energized to protect equipment; these measures will provide substantially faster service restoration than occurred following Sandy.

Network Distribution System Projects and Cost Estimates

In the rate case, Con Edison presented plans to conduct four programs to storm harden the electric distribution networks from 2014 through 2016 at a total estimated cost of $165 million, including $65 million in 2014, as follows:

1. Switches to Reconfigure Fulton and Bowling Green Network Boundary: $21.0 million (all expenditures in 2014).
2. Switches to Isolate Customer Equipment in Nine Manhattan Networks: $65.0 million from 2014 to 2016 ($19 million in 2014).
3. Submersible 120/208 Volt Transformers: $40.0 million from 2014 to 2016 ($15.0 million in 2014).
4. Submersible 460 Volt Network Protectors: $39.0 million from 2014 to 2016 ($10.0 million in 2014).

Con Edison presented to Collaborative Working Group 1 updated costs for storm hardening electric distribution networks from 2014 to 2016 in the total amount of $185 million, including $72.5 million in 2014, as follows:

1. Switches to Reconfigure Fulton and Bowling Green Network Boundary: $21.0 million (all expenditures in 2014).
2. Switches to Isolate Customer Equipment in Nine Manhattan Networks: $65.0 million dollars from 2014 to 2016 ($19 million in 2014).
3. Submersible 120/208 Volt Transformers: $60.0 million from 2014 to 2016 ($22.5 million in 2014).
4. Submersible 460 Volt Network Protectors: $39.0 million from 2014 to 2016 ($10.0 million in 2014).

The $20.0 million increased cost from 2014 to 2016, including a $7.5 million increase in 2014, results from an increase in the unit cost for submersible 120/208 volt transformer installations. The Company explained to the working group that after more detailed review and analysis, the unit price was increased from $100,000 to $150,000 due to the higher percentage of the larger capacity 1000 kVA units to be replaced vs. the more typical 500 kVA units. These larger transformers are more common in areas with higher load densities. In many cases, we will avoid the substantial cost of having to construct a new transformer vault for these 1000 kVA units by using the smaller submersible network protector switch that we recently developed for these larger transformers. (Typical new vault costs could be twice the cost of the transformer or more, and locating a vault in the street or sidewalk can be challenging due to the congested infrastructure under the streets in the city.)

Con Edison has accelerated the project to install switches to reconfigure boundaries of the Fulton and Bowling Green networks to begin work in 2013. The Company plans to spend $5 million in 2013 and $16 million to complete the project in 2014. To offset the $5 million expenditure in 2013, the Company has deferred $5 million in work planned in 2013 to install switches to isolate network customer equipment and will increase expenditures for such switch installation in 2014 by $5 million to $24 million. The net result is that 2014 expenditures for electric distribution network storm hardening are projected to remain at $72.5 million.

Network Distribution System Projects Work Scopes

A detailed description of the project scope and cost for each of the four electric network distribution projects discussed above can be found in Appendix H: Project Details.

E. Electric Overhead Distribution System Storm Hardening

Overhead Distribution System Storm Hardening Objectives

The Company's design basis for the overhead system is consistent with the National Electric Safety Code (NESC). The NESC section 250B requires power facility structures to be designed to withstand specific combinations of ice and wind depending on loading class. Con Edison follows the Grade B design basis, which is the highest design grade in the NESC. Nonetheless, the overhead system remains vulnerable to failure due to the impact of high winds on vegetation. During a typical storm event, the overhead distribution system's main vulnerability is to falling trees and tree limbs.

The Con Edison electric overhead distribution system has provided industry leading reliability on blue sky days due to the redundancy of its automatic loop and 4kV primary grid power delivery design. This redundancy and the ability for the system to automatically isolate faults and heal itself works extremely well to provide uninterrupted service to customers during events with one failure location. In storm events when widespread damage occurs, our system will automatically isolate damage, however, there are outage mitigation limitations such as when main supply feeds are unable to supply customers until field work and further isolation can be done.

In the past two years our overhead system experienced severe damage from Irene and Sandy. Several additional storms, though smaller in scale, were also destructive, including the February 2010 snowstorm, the March 2010 nor'easter and the October 2011 snowstorm. Prior to 2010, the last year with more than one major, destructive storm was 2006. While a majority of customers were usually be restored over several days, complete restoration of the overhead electric system took a week or more for each of these storms, primarily due to extensive damage caused by downed trees and tree limbs, and the multiple impacts of those trees on single electric feeder routes.

To avoid lengthy outages after any future major weather event, we plan to further harden the existing overhead system — both to reduce damage and to minimize the impact of any outages that do occur. The goal of Con Edison's overhead system storm hardening strategy is to make the grid stronger and also more flexible and responsive by mitigating each specific risk associated with the impact of high winds on vegetation. Our planned investments will reduce customer outage impacts on the overhead system by an estimated 15 to 20 percent. We will also reduce damage assessment time to improve recovery and response operations and thereby reduce outage duration by at least a similar amount. In addition to mitigating the impact of storm damage on customers, this work is expected to lower future restoration costs and increase the system's reliability on good weather days.

Con Edison's program to harden overhead circuits involves three main projects: reducing the number of customers served from each feeder segment, installing isolation switches on small open wire spurs off the main circuit line, and improving reliability by providing additional supply connections to existing distribution system routes. In addition, the Company plans to continue its ongoing investment in projects, such as sectionalizing switches that strengthen our overhead system's resistance to extreme heat.

We are also examining the costs and benefits of undergrounding certain sections of the overhead system. Undergrounding would reduce the overall frequency of outages. During Phase II of Working Group 1, the Company plans to provide a more detailed plan for undergrounding sections of the overhead system in 2015 and 2016.

From a system reliability and resiliency stand point, the quickest and most cost effective option to protect the system is to add additional automatic isolation devices, such as fuses, reclosers, and Kyle switches. These devices operate automatically to isolate the extent of an outage and rapidly restore service to customers on the upstream side of the isolation device without the need for operator intervention. A typical Con Edison circuit runs for several miles total. A failure at a certain point of the circuit will impact other customers on the same circuit depending on the location of the closest upstream protective device. Increasing the number of automatic protective devices per circuit limits the number of customers affected by a single event, such as a falling tree. In addition to the benefit of the automatic operation, having additional devices also allows greater flexibility in isolation and restoration when a failure does occur.

The Company is installing additional reclosers and sectionalizing switches (both SCADA-ready and manual) that are designed to reduce the number of customers between cable segments. In case of permanent faults occurring on the overhead system, the additional reclosers and sectionalizing switches are designed to reduce the number of customers impacted by a faulted cable section to a target of 500 or less. The Company's goal of approaching 500 customers per segment offers the best balance between reliability and expenditure given the current system configuration.

For those locations without automatic protective devices, SCADA gang switches can be remotely operated from the control room, without having to dispatch a crew to the location, once operators have received field damage assessment reports and other information. These switches will be deployed in locations where additional automatic switches cannot be added.

Additionally, the Company is installing spur fuses that are designed to isolate faulted sections from the feeder main run. The Company is also installing break-away devices on overhead service cables (cable supplying individual customer premises) which if struck by falling trees or heavy branches will break away rather than pull down and damage the customer's equipment. The break-away device is designed to fully de-energize the service conductors to maintain public safety and can be quickly reconnected to restore service to a customer.

Overhead Distribution System Projects and Cost Estimates

In the rate case, Con Edison presented plans to conduct four programs to storm harden the electric distribution overhead system from 2014 through 2016 at a total estimated cost of $235.35 million ($35.35 million without undergrounding projects), including $14.95 million in 2014, as follows:

1. Reduce Circuit Segment Size: $19.15 million from 2014 to 2016 ($5.35 million in 2014).
2. Isolation of Open Wire Spurs from Feeder Main Runs: $3 million from 2014 to 2016 (all $3 million in 2014).
3. Improvement of Auto-loop Reliability: $20.0 million from 2014 to 2016 ($6.6 million in 2014).
4. Selective Undergrounding of Overhead Infrastructure: $200.0 million from 2015 to 2016.

The estimated costs of these four programs to storm harden the electric distribution overhead system have remained the same in Con Edison's presentation of program costs to Collaborative Working Group 1.

Overhead Distribution System Projects Work Scopes

A description of the 2014 to 2016 project scope and cost for each of the four overhead distribution projects discussed above can be found in Appendix H: Project Details.

F. Electric and Steam Generating Stations Storm Hardening

Electric and Steam Generating Stations Storm Hardening Objectives

Prior to Sandy, electric and steam generating station storm-hardening objectives were based on the impact of previous storms. The Company's generating stations were designed to withstand a storm surge corresponding to a peak tidal water level of 12.1' at the Battery. The flooding from the unprecedented tide levels during Sandy overcame restraint barriers protecting critical station equipment. The storm surge levels resulted in shut-downs and steam service impacts as follows:

- Preemptive shutdown of the East River Generating Station to protect the station's steam distribution outlet mains from contact with flood water;
- Shut down of 59th and 74th Street Steam Generating Stations (nearly 90% of total steam generating capacity being unavailable);
- Shut down of the First Avenue Tunnel;
- Operation of the steam system at pressures lower than normal due to shut-down of steam generating stations; and
- Isolation of steam service to 53 large commercial customers due to forecasted loads in excess of available steam generation capacity.

The East River, 59th Street, and 74th Street Complex steam generating facilities incurred significant damage during the storm.

Our post-Sandy assessments of damage at Con Edison's generating stations, like our assessments of damage at substations, led us to conclude that we need to take additional steps to protect our generating stations from storms, including reinforcing station perimeter walls, installing gates and floodwalls, and raising critical equipment.

The Company plans to protect five steam generating stations against future flood conditions and storm surge. Overall, the storm hardening program is focused on of the following primary objectives:

- Prevent de-energization of steam and 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; and
- Allow for rapid recovery

Con Edison plans to implement storm hardening projects at the following facilities:

1. East River Generating Station and South Steam Station
2. 59th Street
3. 74th Street
4. 60th Street
5. Ravenswood A House

The 60th Street and Ravenswood A House Steam Stations were also flooded during Sandy, but their operations were not as severely impacted as the East River, 59th Street, and 74th Street steam generating facilities. It is important that they be protected in the longer term, however, because a difference in the storm intensity or path and/or changes in the resulting flood level could cause severe impact at these locations in another storm.

The first-phase, immediate storm-hardening projects listed below have been completed as of June 2013 in advance of the hurricane season. The objective of the following measures has been to mitigate the infiltration of water in our generating stations from three primary sources: tunnels, the station perimeter (including doorways and roll-up doors), and pipes and conduits entering the station from the exterior:

- Install new reinforced concrete flood walls to isolate tunnel openings from other areas of the station;
- Install new reinforced concrete flood walls and moats around critical station equipment to protect the equipment against floodwaters that enter the station;
- Install new floodgates and doors in new walls and moats to access isolation zones;
- Install new flood pumps on mobile skids to remove any excess water that enters new isolation zones and moats;
- Seal selected tunnel openings in the station with new plates;
- For manhole covers that link the tunnels and the station floor, install new sealed plate covers with gaskets;
- Intercept all known open drain-piping connections entering the station from the exterior by installing new isolation valves inside the station boundary;
- Install new expansive RTV foam seals at any trench and conduit penetrations into the critical areas of the station to minimize the infiltration of water. These new seals will be installed at all conduits and trenches to ensure that the enclosed critical areas of the station are watertight;
- Install new expansive RTV foam seals in conduits entering all critical panels and cabinets. The expansive foam seals will be installed in all conduits entering the piece of equipment in order to ensure the cabinet or panel is watertight and protected against floodwaters;
- Secure industrial shrinkable fabric material to protect selected non-operating equipment within the postulated flood plain. This protective fabric will be deployed during the Company's 120-hour Corporate Costal Storm Plan to enhance protection from water damage;
- Install new sliding or hinged steel flood control gates, doors and barriers at all station openings, including doorways and roll-up doors; and
- Construct new barriers and walls to close all non-required openings, such as doors, roll-up doors, or windows, that are no longer in service.

In addition to the immediate measures described above, we have developed a longer-term storm-hardening plan for these five generating stations. The following summarizes the installation work to be performed at the generating stations under our longer-term hardening plan:

- Install sluice gates or reinforced concrete walls in the intake and discharge tunnels to control the inundation of floodwaters from those routes (this will require de-silting of the tunnels);
- Relocate critical mechanical and electrical equipment above the defined flood-control elevation;
- Install submersible equipment within the flood-control elevation;
- Reinforce station perimeter walls to withstand higher flood levels;
- Install pressure resistant/submarine type doors to protect deep basements or structures;
- Install permanent, high-capacity flood-control pumps in additional areas of the stations;

- Install new emergency generators to power flood pumps and to provide additional support to the stations during an emergency; and
- Raise existing moats and walls to meet the flood-control elevation.

Flood-control measures at the generating plants will ensure that four of our five steam plants remain online throughout a storm surge. These measures will significantly reduce the number of customers for whom steam service is impacted following the storm and will reduce the number of days that service must be restricted while the full system is restored. Our fifth steam plant, the East River Station, will be preemptively shut down ahead of large storms to protect the heated steam distribution pipes exiting the station from contact with cool floodwater, but with the measures listed above it will return to service faster following a storm event

Generating Stations Projects and Cost Estimates

In the rate case and during the collaborative meetings of Working Group 1, Con Edison presented plans to install storm hardening measures at the five generating stations from 2014 through 2016 at a total estimated cost of $146.6 million, including $42.8 million in 2014. The Company estimates $55.5 million for electric generation facilities, with $14.0 million allocated in 2014, and $91.1 million for steam generation facilities, with $28.8 million allocated in 2014. The estimated costs for these projects for the period 2014 – 2016 is summarized in the following table.

Table 7: Generating Station Cost Estimates ($millions)

Station	2014	2015	2016	Total
East River EP	14.0	21.0	20.5	55.5
East River SP	4.8	4.5	7.0	16.3
59th Street	10.0	12.0	11.9	33.9
74th Street	10.0	12.0	12.9	34.9
60th Street	2.0	1.0	0.0	3.0
Ravenswood A House	2.0	1.0	0.0	3.0
All Steam Stations	**42.8**	**51.5**	**52.3**	**146.6**

Generating Stations Project Work Scopes

Con Edison plans to install flood control measures at five generating stations during 2014 to 2016. A description of the scope and cost for each generating station project can be found in Appendix H: Project Details.

Generating Stations Project Issues

Flood Design

The primary issue associated with generating station storm hardening is the potential for adjustment of the flood protection design basis in the future. The current flood control level, adopted in July 2013 after discussions with the City of New York and other stakeholders, is the June 2013 FEMA 100 year floodplain plus three feet. Con Edison has modified its flood protection measures at the generating stations to incorporate this design level with overall costs expected to remain fairly consistent with the Company's rate case estimate of $146.6 million from 2014 to 2016. The current design standard is intended to accommodate current flood zone maps and current projections of climate change and sea level rise by the 2050s. To the extent that the design level is increased in the future to accommodate revised flood maps or even more acute climate change effects, the impact on the generating stations would focus on large, established equipment and would require significantly more funding to move out of the flood risk area or protect with other measures. This issue is expected to be examined in the study of system vulnerability to long-term climate change that is proposed in this Report.

Sluice Gates and Other Measures

The measures installed by June 1, 2013 are designed to prevent damage to critical equipment from a storm similar to Sandy that would otherwise significantly delay the start-up of the station. The June 1, 2013 measures do not inhibit the ingress of river water through the tunnels into the station. The June 1, 2013 measures (moats and pumps) will protect the critical equipment by containing and discharging this water. Additional measures are required to provide protection of critical equipment to the June 2013 FEMA plus three feet standard, which is about four feet above the protection provided by the June 1, 2013 measures. These measures will increase the height of moat walls but will not inhibit the ingress of river water through the tunnels into the station. Due to interferences within the station, some moat walls cannot be raised to the FEMA plus three flood control level, and therefore, unless sluice gates are installed to prevent tunnel water ingress, some equipment will not be protected to the FEMA plus three flood control level.

Independent of the need to install sluice gates to protect such critical equipment to the FEMA plus three flood control level, the installation of sluice gates (1) will provide defense in depth protection for the station that avoids total reliance on any single measure for flood protection and (2) will prevent the ingress of tunnel water at any storm surge height, including FEMA plus thee and above.

The installation of sluice gates will effectively reduce one of the most significant sources of water infiltration into the station but will not address water entering the station from the perimeter via doorways, rollup doors, louvers, etc. Such infiltration is effectively addressed by flood doors and barriers. Thus, the installation of all storm hardening measures in their entirety is required to avoid flood damage to critical station equipment that could otherwise substantially impact operations or delay the startup of a station. Installation of any one measure by itself would not provide the necessary level of protection for the stations.

G. Gas System Storm Hardening

Gas System Storm Hardening Objectives

While Con Edison's gas system performed relatively well throughout Sandy, our post-storm assessments have identified the potential for significant damage if our region were to experience a significant storm in the future. The most critical threat to the gas system is the introduction of water into gas-distribution equipment, which can damage pipes, lead to over-pressurization, or result in service interruptions. By protecting our gas system from water infiltration, we will spare our customers the long and laborious process of restoring each and every gas service, which must be done one customer at a time.

To harden our gas system in the near term, we are accelerating plans to install valves to prevent water from entering high-pressure service lines through the venting system. This measure alone will reduce the likelihood of flooding-related service interruptions for 22,000 gas customers. We are also planning to replace cast iron and bare steel pipe in flood-prone areas because these types of pipe could be more susceptible to water infiltration under flooding conditions. We are also installing measures to protect critical back-up systems at our Liquid Natural Gas (LNG) plant for inundation during a storm surge.

Installing Vent line Protection Valves to Prevent Water Infiltration

Water infiltration into the vent-line of high-pressure service could result in damage due to over-pressurization of downstream customer equipment. To mitigate the risk of over-pressurization during future flooding events, Con Edison plans to install vent-line protection devices referred to as "float-check valves." These valves will prevent over-pressurization of the customer's internal gas equipment due to flooding by preventing water infiltration through the vent-line in a flood condition, and thus allow customers in flood-prone areas to retain their service during flood events. These valves became commercially available in late 2012, after six years of research and development by Con Edison, the industry's national Gas Technology Institute, and several equipment vendors. We have identified approximately 3,700 existing high-pressure services within hurricane flood zones that would benefit from this new hardening measure. We will install approximately 950 valves in 2013 and the remaining 2,750 in 2014.

Replacing Cast Iron and Bare Steel in Flood Zones

Leaking and/or weakened low-pressure cast iron and bare steel gas pipes can result in water infiltration into the distribution system during a coastal flood. Water infiltration, in turn, can result in poor system pressure, customer outages, and potentially hazardous interruptions of service.

As a result of Sandy, Con Edison's gas system had almost 400 service outages affecting over 4,200 customers in the Bronx, Manhattan, Queens, and Westchester. Customer outages resulted from water that infiltrated into the gas mains, mainly caused by shifting ground conditions that occurred during flooding and by long-term corrosion that occurs on bare steel pipe. Another source of water infiltration is damage to customer equipment located in flooded basements, which then allows water infiltration into the low-pressure distribution system from the customer's side of the service.

To reduce the potential for similar or more significant damage in future storms, the Company will initiate a targeted low-pressure cast-iron and bare-steel replacement program in flood-prone areas. By replacing this pipe with plastic or protected steel pipe, we will reduce the likelihood of water infiltration. Evaluation of pilot areas throughout flood zones began in 2013. Initial mapping and prioritization of segments for replacement will be performed in 2014. The Company plans to replace in 2015 and 2016 between 15,000 and 20,000 feet of cast iron and bare steel pipe in areas with the greatest risk to customer service reliability. During Phase II of Working Group 1, the Company plans to provide a more detailed plan to replace low-pressure cast-iron and bare-steel main in flood-prone areas in 2015 and 2016.

LNG Plant Hardening – New Switchgear and Batteries and LNG Salt Water Pump House

The LNG plant provides peaking and contingency supply of natural gas to the firm gas customers. The plant's automatic fire protection system utilizes an electric motor driven fire pump. The electric motor and the diesel engine and their associated fire pumps, are located within a pump house located alongside Luyster Creek, the water source for the fire pumps. The pump house also contains electrical switchgear for the electric motor and the battery bank for the diesel engine. The transformers and high tension vaults (HTV) for the 27kV feeder supply to the electric motor is adjacent to the pump house. A storm surge similar to Sandy could flood the pump house, with electrical switchgear for the electric motor and the battery bank for the diesel engine and could flood the HTVs for the electric motor, and thereby render the electric motor driven fire pump and the diesel engine driven back-up pump inoperable. This project installs and elevates new outdoor switchgear and elevates both the HTVs and the pump house, including the battery bank to the FEMA plus three feet flood elevation level. The project will also install moat walls around the pump house.

LNG Plant Hardening – Elevate Diesel Blackstart Generator

The LNG plant has a back-up diesel driven electric generator enabling the plant to maintain 100% operational capability during an electric contingency from the loss of the three 27 kV feeders supplying light and power. The blackstart generator is installed at an elevation that leaves it vulnerable to a high storm surge. This project raises the unit to the FEMA plus three feet flood elevation level.

Gas System Projects and Costs

In the rate case, Con Edison presented plans to install vent line protection valves to prevent water infiltration on high pressure services and to replace cast iron and bare steel in flood zones from 2014 through 2016 at a total estimated cost of $38.1 million, including $4.8 million in 2014. In the rate case, the Company stated that the need for storm hardening at the LNG plan was being studied but proposals and costs had not yet been developed and reflected in the revenue requirement.

During the collaborative meetings of Working Group 1, Con Edison presented plans to harden critical back-up facilities at the LNG plant in 2014 at an estimated cost of $2 million.

Gas System Project Work Scopes

A description of the project scope and cost to implement the four gas system storm hardening projects discussed above can be found in Appendix H: Project Details.

H. Tunnel Storm Hardening

Tunnel Storm Hardening Objectives

During Sandy, water entered several tunnel facilities, including the First Avenue, Ravenswood, Astoria, Hudson Avenue, Flushing, and 11th Street tunnels. These tunnels contain steam mains, gas mains, and/or high voltage electric feeders that may need to be de-energized for safety if the tunnels are significantly flooded.

Protecting the First Avenue Tunnel from Water Infiltration

During the storm, significant flooding and a power outage forced the First Avenue Tunnel out of service. The entrances to this tunnel consist of street-level vent gratings that allow water to enter the tunnel during a coastal flood. Tunnel de-watering pumps could not be operated due to the power outage; as a result, the tunnel was flooded by over 500,000 gallons of water. The resulting damage required a lengthy restoration process of pumping out the water, replacing steam pipe insulation as well as other repairs, and restoring service.

To prevent future flooding of the First Avenue Tunnel, Con Edison has designed and fabricated vent cover plates that can be installed prior to a storm. These plates will prevent floodwater from entering the tunnel through the open vent gratings. The design incorporates a vent stack to bleed ambient heat and steam from the tunnel, a new closure plate at the 36-inch steam-main point of entry, and backup power generation so that pumps can remain operational during a power outage. This project allows faster restoration of steam service and may allow the steam main to remain in service, depending on the nature of the weather event. It also prevents street-level water infiltration that can damage electrical circuits, controls, piping and tunnel structures. This hardening project will be completed by the end of 2013.

Protecting Tunnel Entrances from Water Infiltration

With the exception of the First Avenue Tunnel, all of our tunnels have “head-house” entrances that are in close proximity to bodies of water. Currently, these head-houses are either sheet metal or masonry structures that are not designed to withstand coastal flooding. To protect the tunnels against future storms, hardened and reinforced concrete structures will be constructed to replace the existing head-houses. The proposed hardening projects for Astoria, Ravenswood, Hudson Ave, 11th Street, and Flushing Tunnels are projected to be completed in 2015 and 2016. The goal of the project is to provide the head-houses and tunnels with perimeter hardening and protection from flooding. The design basis for all storm-hardening work will meet the FEMA plus three feet flood elevation. The project consists of raising the equipment in the yards surrounding the headhouses above flood levels and protecting equipment such as oil-water separators by constructing flood-barrier walls. The plan also provides for emergency back-up power.

As part of the entrance-hardening plan, certain head-houses will be rebuilt to acceptable standards, while others will be hardened with flood doors and floodgates. Other control measures being taken to prevent water from infiltrating the tunnels include the construction of barrier walls and the sealing of cracks and other penetrations in the interior tunnel walls. We will also add improved pumping operations to pump out water that infiltrates. Lastly, we will install remote cameras and lighting for remote monitoring.

Tunnel Projects and Costs

In the rate case and during the collaborative meetings of Working Group 1, Con Edison presented plans to storm harden the First Avenue Tunnel in 2013 at an estimated cost of $0.5 million and a preliminary plan to harden tunnel head houses in 2015 and 2016 at an estimated cost of $60 million. During Phase II of Working Group 1, the Company plans to provide a more detailed plan for hardening tunnel head houses in 2015 and 2016.

Tunnel Project Work Scopes

Con Edison plans to implement tunnel head house hardening projects during 2015 and 2016. A description of the project scope and cost can be found in Appendix H: Project Details.

VI. Con Ed Project Prioritization

A. Prioritization Approach

Background

Con Edison's portfolio of storm hardening projects is designed to mitigate the impact of severe weather events on Con Edison's customers and systems. Working Group 4 "Risk Assessment / Cost Benefit Analysis" is tasked with developing analytical tools for assessing the merits of the Company's storm hardening projects. The goal of these projects is to lessen the impact of severe events on Con Edison's customers and systems.

In satisfying this aim, there are two related deliverables: (1) risk assessment and prioritization and (2) economic cost value analysis.

1) Risk Assessment and Prioritization

Working Group 4 developed a risk assessment and prioritization model to gauge in terms of risk reduction to customers and critical infrastructure both the collective impact of Con Edison's programs and their relative merits across different components of the Company's system. This represents a revision of preliminary work that Con Edison presented to the Staff and the Working Group. The output of this 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.

The model establishes the value of each of Con Edison's storm hardening initiatives in terms of the magnitude of the reduction in risk at each targeted asset. This metric helps to demonstrate a cost causality linkage between capital funding allocated for storm hardening and the reduction in risk obtained via that investment. Key components of the model are:

- Location-specific information regarding high-rise residential buildings and municipal critical infrastructure, e.g., hospitals and water treatment facilities;
- Location-based flood probabilities provided through proprietary New York City inundation models;
- Wind damage probabilities derived from historical wind gust frequency distributions;
- Costs to storm harden Con Edison's facilities; and
- Projected outage durations in absence of and after implementation of effective storm mitigation.

The intention of the model is a prioritization of risk reduction under the assumption that all of the proposed storm hardening programs will be undertaken. The model is not intended to establish a threshold below which particular projects would be deemed as not viable and eliminated from consideration. This risk reduction ranking illustrates that the proposed capital funding for the storm hardening programs are being appropriately allocated to maximize risk reduction to the most critical assets. The risk prioritization ranking is not a standalone litmus test of project value. If overall funding for storm hardening were to be reduced, the Company would not necessarily eliminate the programs displaying the lowest degree of risk reduction. The Company would apply engineering judgment reflecting system design and operating characteristics and experience in the selection of eliminated programs while considering the prioritization ranking.

It is anticipated that the risk prioritization and assessment model will evolve further based upon contributions made during the Collaborative meetings. Another direction for model enhancement would be the incorporation of a variability parameter for the storm probabilities. This would allow for a dynamic running of the model over a range of possible outcomes.

An area that offers immediate opportunity for model extension would be an application of the methodology to the alternative resiliency strategies being developed by Working Group 2. The specific benefits of those programs will require an articulation that can be transformed into numerical risk reduction measures. If that can be accomplished, the alternative resiliency approaches can not only be evaluated on a risk reduction basis but also blended into and assessed with the Company's portfolio of the more traditional storm hardening projects described in this report.

The potential use of the risk assessment and prioritization model to evaluate heat event risks and their reduction was considered and found to be unsuitable for two reasons: first, the radically different physical impact of heat on electrical infrastructure when compared to either flooding or wind damage, and second, the existence of a comprehensive network system model (Network Reliability Index or NRI) for the quantification of heat and load related risk.

2) Economic Cost Value Analysis

A formal economic cost/value model, which can be applied to the storm hardening projects that were examined in the risk assessment and prioritization model, is being contemplated. Due to data assembly, analytical complexity, and other limitations, this is a longer term goal that will not be completed during the November 2013 reporting horizon of the Collaborative. . Further, its commencement should be dependent on a cogent demonstration of its ability to provide additional insights into the relative value of storm hardening programs consistent with the rigorous engineering based approaches currently employed.

If developed, this model is intended to quantify, in monetary terms, the benefits of each storm hardening project including, internal cost savings and avoided societal costs. This model is anticipated to 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 – augmenting, but not contradicting, the more scientifically based engineering analytics traditionally used to identify capital investments.

In both cases, the analytic approaches are intentionally limited to the evaluation of risks and vulnerabilities that have been previously identified outside of the Collaborative. Additionally, they will be applied to the evaluation of programs and projects that have been identified and defined outside of the Collaborative – initially focusing on the same set of projects being evaluated within Working Group 1 "Storm Hardening Design Standards and 2014 Projects."

B. Project Risk Assessment and Prioritization

Quantification of Asset Outage Impacts and Risks

The risk assessment and prioritization methodology estimates the vulnerability of individual electric system assets based on the impact of electric system damage to customers and supporting critical infrastructure, the duration of an electric service outage, the likelihood of those assets being affected by either flooding or wind damage, and the reduction in vulnerability of those assets because of storm hardening initiatives.

For example, a transmission station powering multiple distribution networks serving a large population and expansive critical infrastructure located in a flood-prone location would rank relatively high on the risk-prioritization scale. At the other end of the spectrum, an asset that supplies energy to a smaller population that would only be impacted by a more extreme but less likely storm would be ranked lower on the risk prioritization scale. Between these two extremes, any other possible combination of event likelihood, duration, and population/infrastructure footprint can potentially be captured via this methodology. In particular, this would include high frequency events of either short duration or limited population/infrastructure impact.

The elements that factor into the risk and risk-reduction metrics are:

A. **Population** - both indigenous and commuting population. The number of people affected by power outages is a fundamental informational building block. Residents served by a particular utility asset represent the residential population affected. Commuting population is a proxy for commercial employment in affected areas and, to a degree, captures the magnitude of economic disruption due to an outage. Basically, the greater the number of people affected, the more pronounced is the impact of the power outage.
B. **Critical infrastructure** - public and private facilities needed to support the health and safety of communities. This category includes hospitals, police and fire stations, municipally owned buildings (schools, etc.), nursing homes, adult care centers, subways and commuter rail lines, waste water treatment plants, and tall buildings. Disruption of power to any critical facilities can have a detrimental impact on the health, safety, or quality of life of the population. Concentrations of tall buildings must also be considered because outages can also strand or isolate significant numbers of people on higher floors of buildings without elevator service and water supply.
C. **Outage duration** - perhaps the single most exacerbating factor when electrical power is interrupted. In general, shorter outages although disruptive, do not have the same degree of negative impact on quality of life and society’s ability to function as do longer outages. When combined with large populations and/or dense critical infrastructure, outage durations have a multiplier effect on the magnitude of the disruption caused by the power loss. All else being equal, the longer a power outage lasts the worse are the social and economic impacts of the interruption.

Event Likelihood Estimation

Con Edison electric system equipment can be damaged by a variety of elements, particularly flooding and wind. Substation and underground (UG) transmission and distribution assets are essentially impervious to wind damage, but, to varying degrees, are vulnerable to flood waters. The overhead distribution systems, although designed to industry standards in regards to direct wind effects, are susceptible to secondary damage from trees taking down poles and wires. To adequately address flooding and wind damage in the risk and risk reduction measures, separate analyses were carried out based on the nature of a storm's impact on an asset.

For those assets affected by coastal flooding (transmission and area substations, underground distribution facilities), a storm surge inundation prediction model developed by the New York City Mayor 's Office of Long Term Planning and Sustainability was used to quantify the degree of exposure to damage each targeted asset has in regards to both its current and future design configurations. This model derives estimates of the most probable surge levels at specific asset grid locations on the electric system by employing data from FEMA's ADCIRC (Advanced Circulation) Model for storm surge inundation analysis and adding customized overland wave modeling. Future impacts of sea level rise were considered in the surge inundation calculations. The model cross references these levels with the known asset elevation at any given location providing for an estimate of the probability of flood waters exceeding the resiliency measure currently in place or planned. This probability represents the likelihood of flood damage occurring at any particular facility within the coastal areas of New York City.

No comparable storm surge inundation models have been developed for coastal areas within Con Edison's service territory but outside of the boundaries of New York City (i.e., Westchester County). In reviewing its Coastal Storm mitigation plan, the Company has determined that the impact of storm surges on coastal assets in flood prone areas of Westchester County can be adequately dealt with via the placement of localized temporary protection around equipment and the ability to switch supply among alternate circuits when necessary. When an inundation model for Westchester County is developed by concerned stakeholders, resulting asset flooding probabilities can be incorporated into the Risk Assessment and Prioritization Model as needed.

The impact of wind damage to overhead assets was calculated, by geographic area (Westchester, Staten Island, and Queens), using a combination of historical daily wind-gust frequencies and the likelihood of damage given those frequencies. This combination reflects the probability of multiple ranges of wind gusts on the overhead system and provides for a natural weighting of the damage anticipated to this system over the course of the time period considered. These data were also examined for the possibility of changes in wind conditions due to climate change. Review of these maximum daily wind gust data focused on the nature of repeated patterns and indications of increases or decreases in the daily wind gust magnitude by county to determine if there were any significant changes in daily wind gusts over time. In all cases, a consistent cyclical pattern emerged with wind gusts tending to be higher on average during winter periods and moderating to a degree during the fall and spring. No meaningful increasing or decreasing trend was evident in the data across the time frames indicated.

In closing it is important to note that we do not purport to be climate change specialists and have undertaken the analysis described in an effort to enhance the value of the Risk Assessment and Prioritization Model as a decision tool. In all cases regarding the impact of climate change on our service territory, we will defer to established conclusions of specialists in that field when such information is available.

With the inclusion of these inundation and wind impact findings, we can estimate the magnitude of risk reduction with the implementation of each improvement.

By combining the total population and critical infrastructure affected and the total outage duration together with an estimate of the likelihood of either flood or wind damage, an aggregate risk measure computed over the life of an asset can be developed.

Expressed algebraically:

PT = Population Total

D = Outage Duration

I = Event Impact = PT * D expressed in “event customer-hours”

p = Probability of flood or wind damage

R = Risk = p * I or in other words, “expected event customer-hours”

Mitigation of Impacts (Risk Reduction)

Risk reduction is defined here as the implementation of one or more strategies designed to either reduce the number of customers affected by an outage, reduce the duration of that outage, or reduce the likelihood of the outage occurring. These strategies are not mutually exclusive and can be combined in different ways to optimize the risk reduction on an asset by asset basis. A particular strategy or strategies applicable for one asset may not be viable at another location. The storm-hardening initiatives presented by Con Edison in the rate case address the specific steps that will be required by asset or by system to mitigate risk. Therefore, the quantification of risk reduction described here takes the results of that analytical effort as a starting point.

Measuring the magnitude of risk reduction follows immediately from the computation of each asset’s risk measure as described above, calculated before and after storm hardening efforts are applied. Risk reduction is defined as the difference between an asset’s risk measure pre and post resiliency efforts.

Expressed algebraically:

RB = Risk before resiliency efforts (current design)

RA = Risk after resiliency efforts (new design)

Δ R = Risk Reduction = RB - RA

Or using the individual risk factors defined previously:

$$\Delta R = (pB * PT * DB) - (pA * PT * DA)$$

Where pB and pA are the flooding or wind damage probabilities before or after the resiliency efforts, respectively, and DB and DA are the outage durations before or after the storm hardening initiatives, respectively.

Ranking 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. The results of the application of this approach to the assets identified as requiring storm hardening efforts can be found in Appendix G: Collaborative Presentation Materials in the attached file titled Risk Assessment and Prioritization Model. Additionally all of the following charts contained within this section of the report are based on data or results appearing within that Risk Assessment and Prioritization Model file.

Project Cost

Each storm-hardening project listed on the risk assessment and prioritization worksheet has an associated project capital cost that was presented in a rate case white paper exhibit supporting the specific resiliency actions. A direct comparison (i.e., ratio) of risk reduction to project costs on a project by project basis, although providing a general sense of the association of risk reduction to proposed capital funding, suffers from distortions introduced by nuances in particular program characteristics. For example, a "Too Big to Fail" asset such as the East 13th Street Transmission station with a risk reduction to cost ratio of 1,462 seems on the surface to compare "unfavorably" to the comparable ratio of 67,092 for the Mohansic load area located in upper Westchester County. The program for Mohansic, one of the smallest load areas on the Con Edison system, consists of the inexpensive installation of fuses at targeted locations. Relative to the small population of customers and supporting infrastructure in the Mohansic load area, this is an extremely cost effective solution. Storm hardening of the East 13th Street transmission station on the other hand, consists of the installation of flood barriers and the raising up of critical equipment within the station, all extremely expensive operations. Although the impact of the loss of East 13th Street is substantial and widespread, as demonstrated by the loss of ten lower Manhattan networks for about four days following Sandy, the higher costs for protecting it against inundation tends to dampen its associated risk reduction to cost ratio.

To circumvent this issue and yet appropriately capture the efficient allocation of storm hardening capital funding, a triaging of risk reduction and associated costs into descending groupings of ranked risk reductions derived through the Risk Assessment and Prioritization Model is provided on Chart I below.

Chart I

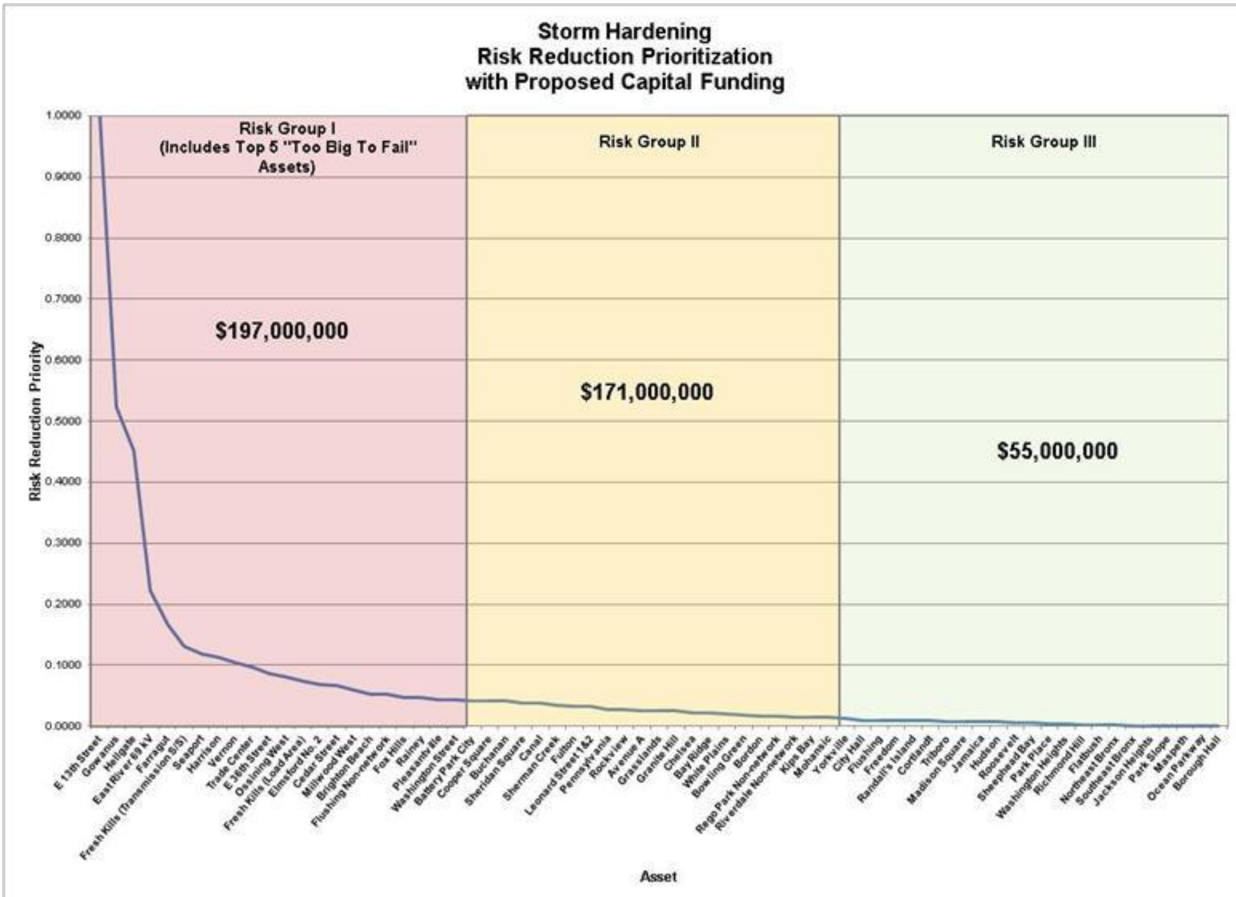


Chart I is obtained from a descending ranking of asset risk reductions derived through the Risk Assessment and Prioritization model and associated to a summary of the proposed capital costs of the targeted assets appearing within each of the three risk priority groups. So for example, the 22 highest ranked risk reduced assets are aggregated into Risk Priority Group I and comprise a proposed capital investment of $197 million for storm hardening projects. Comparable logic applies in the determination of the proposed expenditures for the other two lower risk priority groups. The five “Too Big to Fail” assets referred to in this and subsequent charts in this section are, in decreasing risk reduction order, the transmission stations: East 13th Street; Gowanus; Hellgate; East River 69kV; and Farragut.

Another way to examine storm hardening investment is through a display of risk reduction per $1,000, again within risk priority grouping. Chart II captures these results.

Chart II

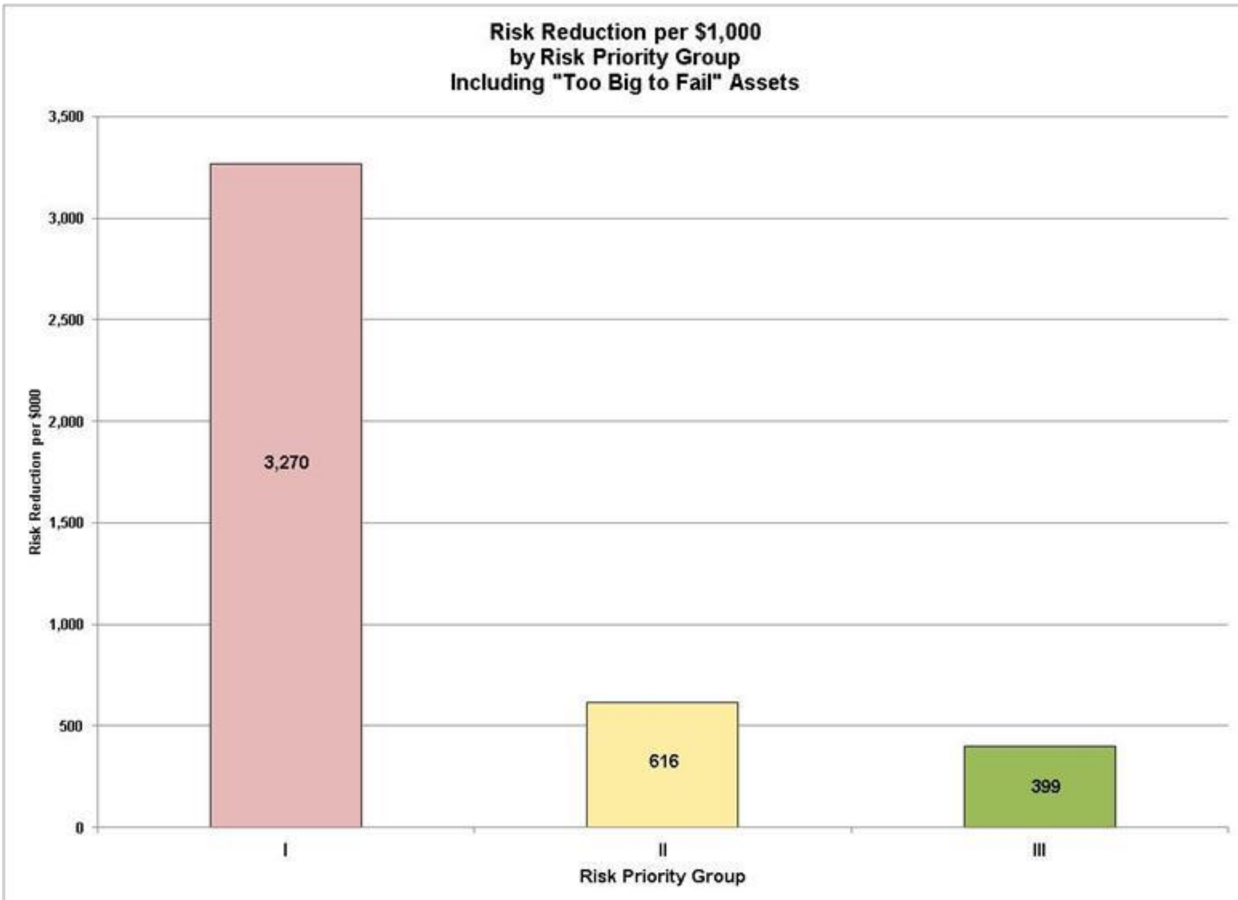


Chart II displays a significant risk reduction per $1,000 benefit in prioritizing the storm hardening projects in the order indicated by the Risk Assessment and Prioritization model.

In Chart I, the impact of all of the risk reduction programs is visually dampened when viewed within the context of the five "Too Big to Fail" assets. To highlight the relative merits of the remaining programs, Charts III and IV provide the same information as contained in Charts I and II but exclude the top five "Too Big to Fail" contributors. All risk reduction values from the Risk Assessment and Prioritization Model and all associated costs remain the same.

Chart III

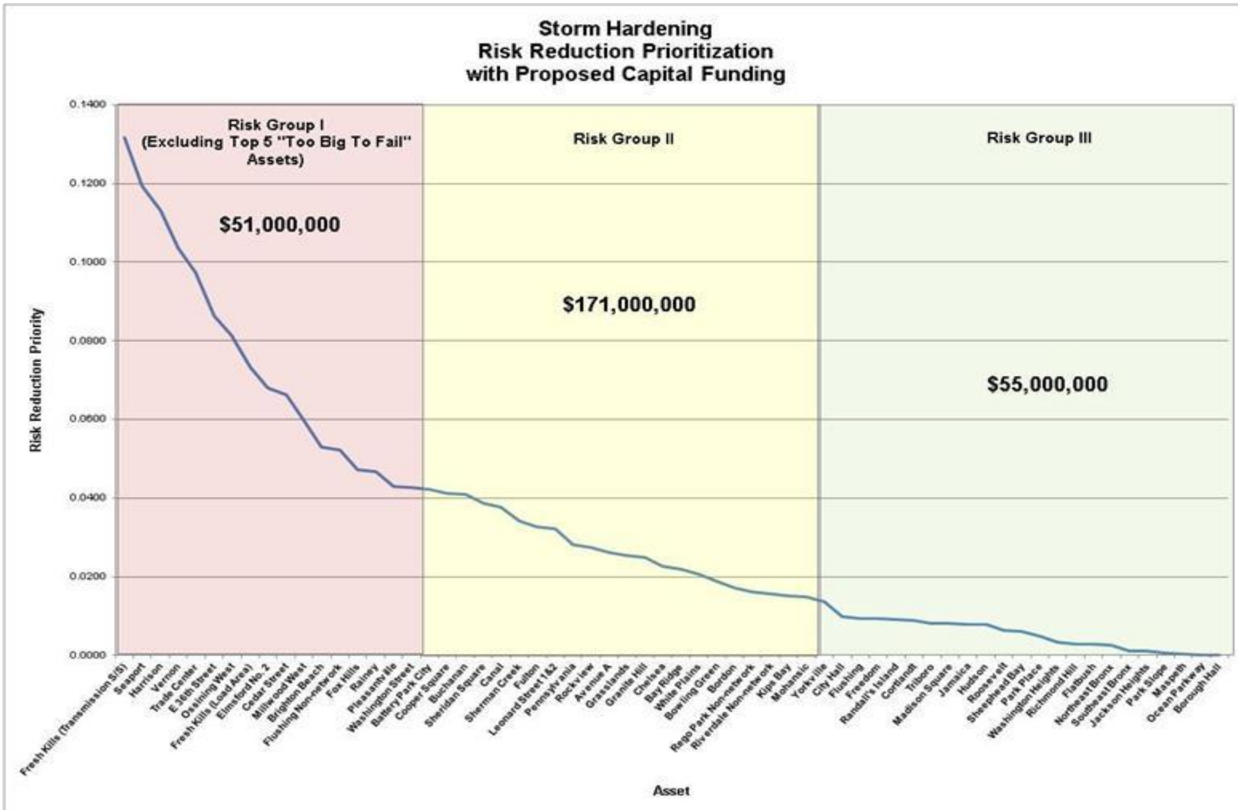
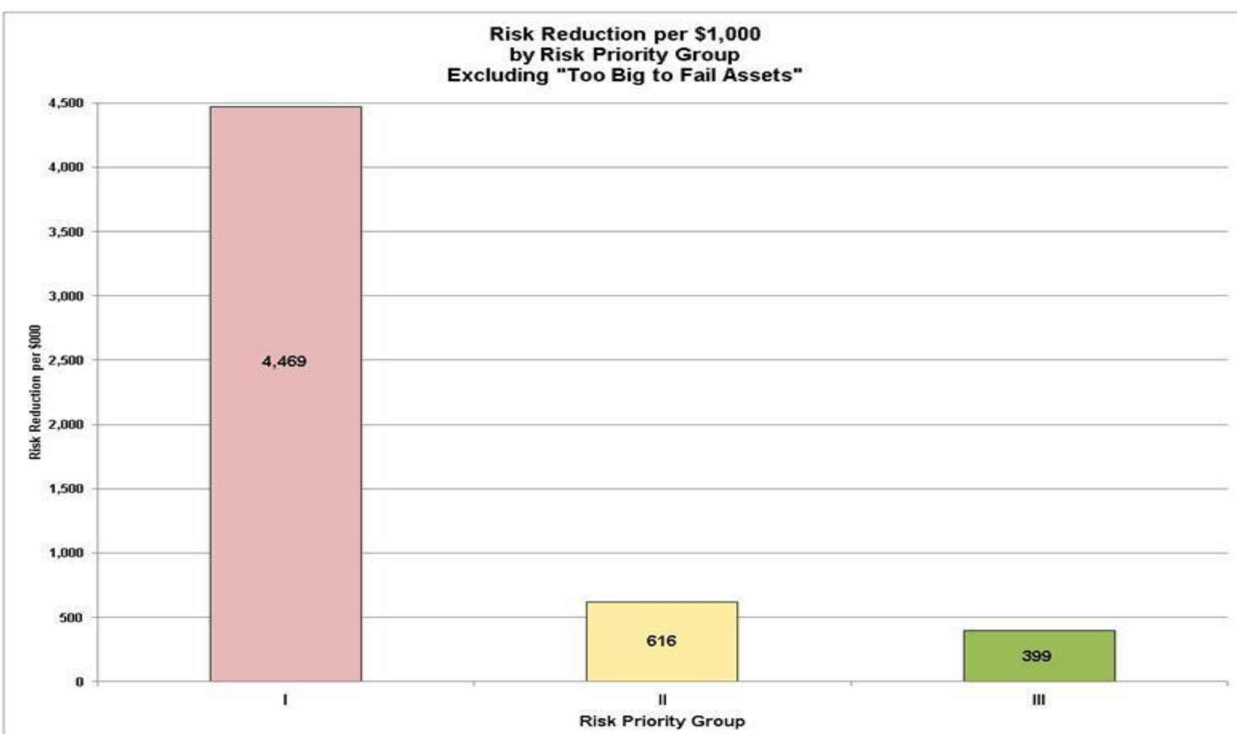


Chart IV



When the top five “Too Big to Fail” asset contributors are excluded from the risk reduction per $1,000 computations displayed on Chart IV, the now slightly truncated Risk Group I displays an even greater risk reduction per $1,000 value. This indicates a consistency in the prioritized allocation of capital funding for risk reduction across assets both with and without the presence of the five major risk reduction contributors. In summary, the relative ranking and risk reduction per $1,000 prioritization of targeted company assets is consistent with optimal allocation of funding principles.

C. Future Efforts on Alternative Risk Assessment and Prioritization Approaches

Economic Cost/Value Approach

As mentioned previously, another analytical tool under consideration and discussed at length among Working Group 4 members is a model that considers the relative value of each storm-hardening program from an avoided economic-cost perspective.

This view considers not only the reduction in risk associated with resiliency efforts but also a quantification of that risk reduction in monetary terms. While this is a more ambitious undertaking, it has benefits. More specifically, by quantifying the benefits of a project in monetary terms, it becomes possible to directly compare the benefits to the cost, in equivalent dollar terms. This will provide additional data, and when considered alongside the risk prioritization of each project, can help in answering difficult questions like, how much should be spent on increased resiliency?[24]

[24] For additional information, refer to Appendix F: Working Group 4 Scope of Work (Phase 2).

VII. Cost Impacts

Contingency Factor

After its rate case filing on January 25, 2013, the Company further developed its initial storm hardening concepts, refined project scopes, and developed designs for storm hardening projects planned for construction from 2014 to 2016. The Company's Preliminary Update filing on March 25, 2013 provided more detail regarding project scope while generally maintaining project costs at the levels initially filed. Thus, the total projected costs for Electric Substations and Transmission, Gas Distribution, Tunnels, and Steam and Electric Generation Stations remained the same while the total projected costs for the Electric Network Distribution projects increased from $180.0 million to $181.0 million, and the projected costs for the Electric Overhead Distribution projects, excluding undergrounding of select overhead circuits, decreased from $60 million to $55.1 million.

In preparation for the 2013 hurricane season that started on June 1, 2013, Con Edison storm hardened the substations and the electric and steam generating stations that were operationally impacted by flooding during Sandy. The measures installed at these facilities were designed to maintain the operation of the facilities in flood conditions similar to those experienced during Sandy. At the same time, the Company continued to refine its project scopes and designs for additional storm hardening measures to be installed from 2014 to 2016 and to accommodate the projects to a flood protection design standard based on FEMA plus three feet. The Company's work in constructing flood protection measures in advance of the 2013 hurricane season also contributed the refinement of project scope and design development for the 2014 to 2016 work.

As a result of this ongoing project development work, Con Edison presented to Collaborative Working Group 1 updated costs for its 2014 to 2016 substation projects as follows:

Table 8: Summary of Substations with 2014 Work Scopes

Station ($ millions)	Storm Hardening Project Cost (2014-2016) @ 60% Contingency (March 2013 Update)[25]	Original 2014 Funding Request (Jan 2013)	Total Storm Hardening Project Cost @ 30% Contingency (June 2013 FEMA + 3')	Current 2014 Funding Request (June 2013 FEMA + 3')
East 13th Street	105.1	32.0	120.7	32.0
East River Substation	7.3	1.4	9.8	1.4
Gowanus	13.0	2.5	14.7	2.5
Goethals	25.6	9.7	25.7	9.7
Fresh Kills	18.0	7.0	17.5	7.0
East 36th	3.5	1.0	3.0	1.0

[25] The March 2013 Update refers to the additional detail that was filed in the rate cases on March 25, 2013 to support the Company's storm hardening white paper exhibits.

Street				
East 15th Street	9.0	2.8	9.2	2.8
Trade Center	2.9	1.2	1.5	1.2
Seaport	4.6	1.0	2.6	1.1

Collaborative Working Group 1 examined the Company's inclusion of a construction contingency factor in its estimates of substation storm hardening projects. The Company used a 60% contingency in its initial estimates to reflect the degree of uncertainty in scope and design detail for these projects. This level of contingency is typical for the initial cost projection for projects that are uncertain in scope and design. Con Edison had not previously constructed storm hardening projects of this nature and consequently developed its initial estimates on the basis of roughly analogous work from other historic jobs, for example, the cost to build a platform, but without any of details regarding the specific construction characteristics required for the particular storm hardening project. Through summer 2013, the Company's confidence level in the accuracy and completeness of the scopes of work increased, enabling firmer estimates of project costs and decreasing the contingency allowance for uncertainty to 30%.

Using the FEMA plus three feet flood protection design standard also resulted in the addition of five new substations that are impacted by the higher flood control elevation and require storm hardening measures during 2014 to 2016.[26] In addition, further site assessment and evaluation has resulted in a reduced priority for Academy substation, West 49th Street substation and 59th Street Pier Cooling Plant, and these projects will be deferred beyond 2016. The funding of $8.6 million planned for these stations during 2014 to 2106 will instead support flood protection measures at the additional five substations and the overall increased 2014-2016 costs for the substations listed in Table 8: Summary of Substations with 2014 Work Scopes .

The Company's update filing in the rate cases forecast total expenditures of $60 million for substations in 2014, the rate year. While the cost of some individual projects have changed and new projects have been added and others reduced in scope with the use of the new flood protection standard, the Company believes that $60 million remains a reasonable projection of total cost for 2014 substation storm hardening work.

FEMA plus Three Feet Design Cost Impact

The estimated costs for protection of facilities from flooding presented in Con Edison's initial and updated rate case filings were based on a design standard that has been replaced with the use of the June 2013 FEMA flood maps plus three feet as the design standard. The Company incorporated this revised design standard at the same time that the Company, consistent with its standard project design process, has been refining the project scope, construction design, and cost estimate for each facility. The Company's updated estimates of substation project costs, presented to Working Group 1 and

[26] The five substations are Farragut, Rainey, Vernon, Avenue A, and Leonard Street. The Farragut project will commence in 2014 and continue into 2015. The projects at the other four substations will commence in 2015.

summarized in Table 8: Summary of Substations with 2014 Work Scopes above, reflected both the new flood protection design standard and overall project cost refinement as the scope and design of projects have been refined. Because the Company incorporated the revised flood protection design standard simultaneously with its refinement of overall project costs, the Company cannot isolate the specific impact of the new flood protection design standard on the overall cost of the various flood protection projects. In addition, the Company's initial project scopes anticipated that the 2014-2016 projects would later be designed to a higher flood control level, and the initial cost estimates accommodated potential costs for an as-yet-undetermined final design level.

FEMA plus Five Feet Design Cost Impact

Collaborative Working Group 1 asked Con Edison to examine how the costs of selected projects would be affected by use of a flood protection design standard based on June 2013 FEMA flood maps plus five feet. The Company examined four representative sites – two transmission substations, a generating station, and a public utility regulating plant, which circulates and cools transmission feeder dielectric fluid. The Company examined the cost to raise the perimeter protection of the facilities to the higher flood protection level. The Company generally did not quantify costs associated with raising the protection level for equipment within the facilities but did find a variety of situations where physical interferences or other factors would require complex and very costly flood protection measures that could not be readily scoped and estimated.

The following table compares the current estimated cost of protecting to June 2013 FEMA 100-year floodplain plus three feet (FEMA + 3') to the cost of protecting to the June 2013 FEMA 100 year floodplain plus five feet (FEMA + 5') at four selected stations.

Table 9: FEMA + 5 Feet 100-year Floodplain Storm Hardening Costs ($ millions)

Station	Storm Hardening Project Cost to Achieve FEMA + 3'	Storm Hardening Project Cost to Achieve FEMA + 5'	Delta Between + 3' and + 5'	% of FEMA +3 Original Project Cost	Scope Impacts
East 13th Street	120.7	141.6	20.8	17%	- Reinforce parts of perimeter - Replace other perimeter walls - New flood doors - Watertight louvers - Additional transformer cooling - Higher equipment platforms - New lifting control cabinets
East 15th Street	9.2	12.4	3.3	36%	- Reinforce parts of perimeter - Replace other perimeter walls - New flood doors - Higher equipment platforms - New lifting control cabinets
Goethals	25.7	28.1	2.5	10%	- Higher sheet piles - Raised platform for diesel
East River Generating Station	55.5	65.1	9.6	17%	- Replace perimeter walls - Watertight louvers - New rollup doors

As noted, this table does not fully capture the impacts of protecting to FEMA plus five feet. The Company attempted to capture major cost drivers, mainly related to perimeter protection, which would result from moving to a higher flood control level. The costs associated with these drivers are summarized in the table above. As can be seen, these drivers for only four stations add approximately $36 million to the cost of flood protection. Additional costs would be incurred to raise protection levels for interior equipment at some facilities. For example, mechanical equipment in the East River Generation Station would likely have to be raised as well, but this could have a significant and complex impact on the hydraulics of the steam system within the station.

In addition, the protection of equipment at the higher level can present ancillary issues, often related to operating impacts, which must be addressed as well. An example would be the 345kV transformers at East 13th Street. The cost to protect the transformers at East 13th Street up to the FEMA plus three feet level is included in the current $120.7 million estimate. This cost includes protection for the control cabinets and protection equipment that could inadvertently trip the transformer during severe flood conditions. While the body of the transformer is watertight, flood waters at the FEMA plus five feet level would reach the tertiary bushings on some transformers resulting in arcing and critical failure of the unit. Therefore, some transformers would have to be raised to meet that higher design standard. This effort would require raising the overhead bus, other adjacent transformers, and various other connected equipment throughout the station. The complexity associated with this type of project was not further examined and the associated cost was not estimated and is not reflected in the $20.8 million incremental cost to meet FEMA plus five feet at East 13th Street.

Protecting equipment to a FEMA plus five feet design standard at each facility would also require an evaluation of the personnel safety, operational, and cost effects. For example, if the associated control cabinets for the transformers were moved to a raised platform that meets the FEMA plus five feet level, an operator having to access the raised equipment would be within the safety clearance from the overhead 345kV bus.[27]

The flood protection measures that the Company plans to install will meet, but generally will not exceed the FEMA plus three feet flood protection level. The majority of measures, such as, concrete walls, raised platforms, and masts for lifting panels, will be designed and constructed to meet the specific flood control level and will, in most cases, not exceed that level as this would lead to additional complexity and cost. Nonetheless, the following flood protection measures will exceed the FEMA plus three protection level:

East 13th Street Control Room

The office area on the second floor that will be the new location of the control room is at an elevation of that equates to FEMA plus 6.8 feet.

Other measures to protect the 13th Street substation, such as raised platforms for equipment and lifting relay panels, etc. are being designed to meet the FEMA plus three feet design criteria.

[27] As discussed previously, the design of Con Edison's flood protection projects initiated in 2014 to 2016 and subsequently until changed will be based on the 1% annual flood hazard elevation (100 year floodplain) established in FEMA's June 2013 Preliminary Work Maps plus three feet of freeboard (FEMA plus three). The Company will review this standard at least every five years.

Farragut Substation Perimeter

The scope of work for the perimeter protection will use precast concrete sections that are 4 feet in height. The precast option is more cost efficient. The elevation of the precast perimeter equates to FEMA plus 4.8 feet.

Rainey Substation Perimeter

The precast perimeter protection wall equates to FEMA plus 5.3 feet.

Vernon Substation Perimeter

The precast perimeter protection wall equates to FEMA plus 3.3 feet.

VIII. 2014 Climate Change Vulnerability Study

Climate Change Projections/Potential Impacts to Infrastructure/Probabilities

Severe weather events that cause customer outages have been more prevalent in recent years. When measured by customer outages, five of Con Edison's top-10 storms (see table 2 below) have occurred within the last three years. Sandy and Tropical Storm Irene (Irene) came from the tropics, with strong winds and storm surge that caused extreme damage. Snowstorms and Nor'easters have also impacted Con Edison's system and customers. In addition, severe summer thunderstorms have spawned several tornados and downbursts.

Table 10: Historical Storm Comparison

Historical Storm Comparison		
Date	**Type of Storm**	**Customers Interrupted**
29-Oct-12	Superstorm Sandy	1,115,000[28]
28-Aug-11	Tropical Storm Irene	203,821
13-Mar-10	Nor'easter	174,800
29-Oct-11	Nor'easter	135,913
9-Sep-85	Hurricane Gloria	110,515
2-Sep-06	Tropical Storm Ernesto	78,300
25-Feb-10	Snow	65,200
18-Jan-06	Wind / Rain	61,486
31-Mar-97	Nor'easter	45,180
19-Oct-96	Nor'easter	41,830

Generally, the historical trends in the New York City metropolitan area[29] for temperature, precipitation, and sea level indicate a rise with time. This is in agreement with the various climate projections of the New York City Panel on Climate Change (NPCC), Intergovernmental Panel on Climate Change (IPCC), National Oceanic and Atmospheric Administration (NOAA), and others (all global outlooks), that predict a continued upward trend in the same parameters over the next several decades.

Over the 138-year period of record at Central Park, the yearly average temperature has risen by about 4.0°F or 1.4°F every 50 years. The number of 90°F or greater days has grown by about nine days or about 3.3 days per 50 years. Despite the rise in temperature and number of 90°F or greater days, the number and duration of heat waves has not shown a large increase over this period.

Since 1876 the amount of precipitation has risen by about 8.75 inches or 3.2 inches every 50 years. The number of heavy rain events has also risen. Rain events leaving more than 2 inches of accumulated rain have increased by about 1.5 days.

---

[28] Includes Nor'easter Athena

[29] As measured at the NOAA Central Park weather observation station.

According to the NPCC report, sea level has risen 1.1 feet since 1900.

Additional discussions of storm impact and weather events are provided in Appendix B: Con Edison's Energy Systems: **Overview**.

Climate Forecasts

Climate scientists continue to study weather and climate trends. Recently, the NPCC completed its projection of future climate impacts in New York City. Whereas weather trends are based on the observations of historic conditions, the science of forecasting future climate conditions is based on both climate model-based percentile outcomes, and qualitative projections of peer-reviewed scientific literature. The NPCC projects that by mid-century, higher temperatures and sea levels are extremely likely, and extreme events in the form of heat waves, heavy downpours, and coast flooding are very likely to increase in frequency and intensity. Table 11: NPCC Climate Projections identifies several key findings of the NPCC.[30] For additional NPCC findings, and discussion of climate projections being conducted by other scientific and governmental organizations, please refer to Appendix B: Con Edison's Energy Systems: Overview

Table 11: NPCC Climate Projections

Climate Variable	Baseline (1971-2000 unless otherwise noted)	Year	Middle Range (25^{th} to 75^{th} percentile)[31]
Air Temperature	54° F	2020s	+2.0° F to +3.0° F
		2050s	+4.0° F to +5.5° F
Sea Level Rise	0 inches (Baseline 2000-2004)	2020s	4 to 8 inches
		2050s	11 to 24 inches
Number of heat waves/year	2	2020s	3 to 4
		2050s	5 to 7
Flood heights associated with the 100-year-flood at the Battery	15.0 feet	2020s	15.3 to 15.7 feet
		2050s	15.9 to 17 feet

The NPCC report, and others, point to a dynamic system. While the reports do not show precise alignment among their quantitative projections, they do appear to have uniform alignment on the direction and magnitude of those projections. Specifically, for our region, those directions appear to be:[32]

[30] NPCC, Climate Risk Information 2013: Observations, Climate Change Projections, and Maps. The City of New York. http://www.nyc.gov/html/planyc2030/downloads/pdf/npcc_climate_risk_information_2013_report.pdf June 2013.

[31] NPCC has supplemented the middle range projections with a low-estimate and a high-estimate which range from 2-11 inches by 2020s and 7-31 inches by 2050s, respectively.

[32] This is meant to be a general synthesis of the reports.

- Increased average surface air temperatures by 2050;
- Increasing number of extreme heat days (including consecutive days);
- Decreasing number days below freezing;
- Increasing precipitation; and
- Increasing sea level rise.

These trends may manifest themselves as greater electric demand on the distribution system, larger storm surges impacting and damaging coastal infrastructure, and soil more commonly saturated – resulting in increased damage from wind/rain events.

2014 Climate Change Vulnerability Study

As of June 1st, 2013, the immediate storm hardening measures Con Edison has taken at its substations and generating stations have been completed and distribution system hardening had begun. The Company is now planning its resiliency investments for the next one to three years.

A key element of the Company's approach to improving resiliency going forward is to understand how weather and climate may be changing and how those changes will impact the Company's infrastructure. In the rate cases, Con Edison, New York City, and other interested parties agreed on a flood protection design standard for projects that Con Edison will commence in 2014, and the Company has adopted that standard for future flood protection projects and will review this standard at least every five years. However, a number of other system and equipment design standards (as reflected in Table 12: Design Standards Considerations) require additional analysis related to the effects of climate change.

Table 12: Design Standards Considerations

	Prior Con Edison design standard	Current Con Edison design standard
Flood	• FEMA 2007 100-yr floodplain plus two feet	• FEMA 2013 100-yr floodplain plus three feet
Wind	• 98 mph wind • 45 mph plus 0.5 inch of ice	• *(Under review)*
Temperature variable	• 86°F	• *(Under review)*
Heat waves	• Two per year • Four days long	• *(Under review)*

A shared understanding on key climate and weather factors is an essential building block in determining design standards and consequent infrastructure investments necessary to improve system resilience in the future.

The Company is proposing a "2014 Climate Change Vulnerability Study" project and report that synthesizes the current scientific information from credible sources and the most up-to-date models on climate change, identifies the infrastructure that might be affected, and develops a shared understanding among Collaborative participants. Details of the project scope can be found in Appendix C: 2014 Climate Change Vulnerability Study Outline.

IX. Conclusion

Sandy was the most harmful and destructive storm our region has ever seen. Over 8.5 million customers in eight states, including 1.15 million of Con Edison's customers, lost power as a result of the storm. The National Hurricane Center estimates that the storm caused over $50 billion in damage to homes and businesses up and down the eastern seaboard.

Con Edison continues to strive to keep the power flowing and our vibrant region energized in all circumstances. Con Edison has developed a comprehensive resiliency plan to storm harden its energy system infrastructure to better enable the Company to provide safe, reliable, reasonably-priced energy services to our customers in an era of changing weather patterns and more frequent and increasingly destructive storms. To fortify our Electric, Gas, and Steam systems against future storms, we are strengthening our infrastructure so it can better withstand harsher conditions, particularly coastal flooding and high winds. In the near term, this has involved installing measures in advance of the 2013 hurricane season so that substations and generating stations that were operationally affected by Sandy can withstand a storm similar to Sandy. Longer term, we are preparing for more intense storms, which involves measures such as further increasing the height and strength of perimeter and interior walls and barriers, installing emergency diesel generators to keep critical equipment online, relocating a major substation control room to a higher elevation, hardening overhead networks to withstand stronger winds and contact with tree branches, and replacing cast-iron and bare steel pipe in flood zones.

Con Edison has presented its resiliency plans in its pending electric, gas and steam rate cases and has reviewed these plans with the parties to the Storm Hardening and Resiliency Collaborative. The Company continues to look for ways to improve its resiliency initiatives through input from our customers, stakeholders and regulators. The Collaborative has provided Con Edison a valuable forum for obtaining such input and examining an array of solutions to better protect our region, and to prepare for our future.

Con Edison is presenting this Report to the Public Service Commission to summarize the work of the Collaborative to date, to recommend further initiatives for the Collaborative in 2014, and to present for the Commission's consideration Con Edison's proposed plans for resiliency work to commence during the period of 2014 to 2016.[33]

The Company looks forward to participating in Phase 2 initiatives of the Collaborative as may be approved or directed by the Commission. The Company's participation in these ongoing efforts is premised on the reasonable expectation that any Commission approval or direction associated with new initiatives would provide for full recovery of any incremental capital and O&M expenditures associated with such efforts, by surcharge, adjustment to base rates, deferral or as otherwise determined by the Commission.

[33] The Collaborative Parties will file comments on this Report on December 20, 2013.

X. Recommendations

Con Edison proposes that the revenue requirement established in the Commission's Rate Order to be issued in the Company's pending rate proceedings (Cases 13-E-0030, 13-G-0031, and 13-S-0032) (Rate Order) reflect the following capital expenditures for storm hardening measures during the period of the rate plan established in the Rate Order:[34]

Table 13: CECONY Capital Expenditures for Storm Hardening

($ Millions)	2013	2014	2015	2016	Total
Electric Substations	30.0	60.0	70.0	80.0	240.0
Electric Network Distribution	21.0	72.5	60.5	52.0	206.0
Electric Overhead Distribution	19.6	15.0	115.0	112.0	261.6
Transformers	10.0	12.5	11.3	11.4	45.2
Electric Transmission	3.9	4.9	2.0	2.0	12.8
Electric and Steam Generation	18.4	42.8	51.5	52.3	165.0
Gas and Tunnels	2.1	6.8	41.6	51.7	102.2
Telecommunications	0.0	1.3	2.7	2.6	6.6
Facilities	0.0	0.0	5.0	5.0	10.0
Total	**105.0**	**215.8**	**359.6**	**369.0**	**1049.4**

Con Edison proposes that the Commission's Rate Order approve the following Phase 2 work initiatives for the Collaborative Working Groups:

- **Working Group 1: Storm Hardening Design Standards and 2014 Projects**
  - Sponsor Con Edison's 2014 Climate Change Vulnerability Study as outlined in this Report;
  - Review storm hardening initiatives that commence in 2014; and
  - Examine Con Edison's storm hardening project plans under development for initiation in 2015, including undergrounding of electric overhead distribution facilities, tunnel hardening, gas main replacement in flood zones and steam distribution projects.
- **Working Group 2: Alternative Resiliency Strategies**
  - Identification of potential alternative strategies to achieve resiliency or mitigation of the impact of future extreme weather;
  - Development of ranking of strategies based on cost-effectiveness in coordination with related work underway in Working Group 4; and
  - Development of a proposal to Commission regarding alternative resiliency solutions.

[34] While the rate cases are considering rates for the twelve month period ending December 31, 2014, the rate case parties are discussing whether they can reach agreement on submitting for the Commission's consideration a Joint Proposal that would establish rates for a multi –year period.

- **Working Group 3: Natural Gas System Resiliency**
    - Study and attempt to quantify the leakage rate of known Type 3 leaks; and
    - Develop proposal to the Commission for a program to reduce Type 3 leak backlog.
- **Working Group 4: Risk Assessment / Cost Benefit Analysis**
    - Attempt to develop a formal economic cost/value model that can be applied to the storm hardening projects that were examined in the working group's risk assessment and prioritization model developed during Phase 1 and to the alternative resiliency strategies being developed by Working Group 2; and
    - Examine extension of the risk reduction and prioritization methodology to the alternative resiliency strategies being developed by Working Group 2 in order to evaluate the alternative resiliency approaches on a risk reduction basis.

Appendix A: Collaborative Parties

Collaborative Working Group One

Storm Hardening Design Standards and 2014 Projects

- New York State Department of Public Service Staff
- New York State Office of the Attorney General
- New York Department of State Utility Intervention Unit
- New York State Department of Environmental Conservation
- City of New York
- County of Westchester
- Environmental Defense Fund
- Pace Energy and Climate Center
- Columbia Center for Climate Change Law
- NYU School of Law
- New York Energy Consumers Council
- Consolidated Edison Company of New York, Inc.

Collaborative Working Group Two

Alternative Resiliency Strategies

- New York State Department of Public Service Staff
- New York State Office of the Attorney General
- New York Department of State Utility Intervention Unit
- New York State Department of Environmental Conservation
- City of New York
- County of Westchester
- Environmental Defense Fund
- Columbia Center for Climate Change Law
- New York Energy Consumers Council
- Consumer Power Advocates
- NYU School of Law
- Pace Energy and Climate Center
- Public Utility Law Project
- Utility Workers Union of America, Local 1-2
- Consolidated Edison Company of New York, Inc.

Collaborative Working Group Three

Natural Gas System Resiliency

- New York State Department of Public Service Staff
- New York State Office of the Attorney General
- New York State Department of Environmental Conservation
- City of New York
- Environmental Defense Fund
- County of Westchester
- Columbia Center for Climate Change Law
- Consolidated Edison Company of New York, Inc.

Collaborative Working Group Four

Risk Assessment/Cost-Benefit

- New York State Department of Public Service Staff
- New York State Office of the Attorney General
- New York Department of State Utility Intervention Unit
- New York State Department of Environmental Conservation
- City of New York
- County of Westchester
- New York Energy Consumers Council
- Utility Workers Union of America, Local 1-2
- Columbia Center for Climate Change Law
- Environmental Defense Fund
- Energy Initiative Group LLC
- NYU School of Law
- Public Utility Law Practice
- Consolidated Edison Company of New York, Inc.

Appendix B: Con Edison's Energy Systems: Overview, Superstorm Sandy Impacts, Current Weather Conditions, and Climate Forecasts

Overview of Con Edison Energy Systems and Smart Grid Initiatives

Service Territory

Con Edison transmits and delivers energy to the nine million people of New York City and Westchester County, covering 604 square miles. Our investments in innovative technology, advanced analytical tools, and comprehensive design have made us an industry leader in energy systems.

Con Edison provides electric service to 3.3 million customers in New York City, except the Rockaway peninsula, and most of Westchester County, including homes, businesses, hospitals, and government authorities, among others. Con Edison's electric system is 8.5 times more reliable than the rest of the nation's utilities.

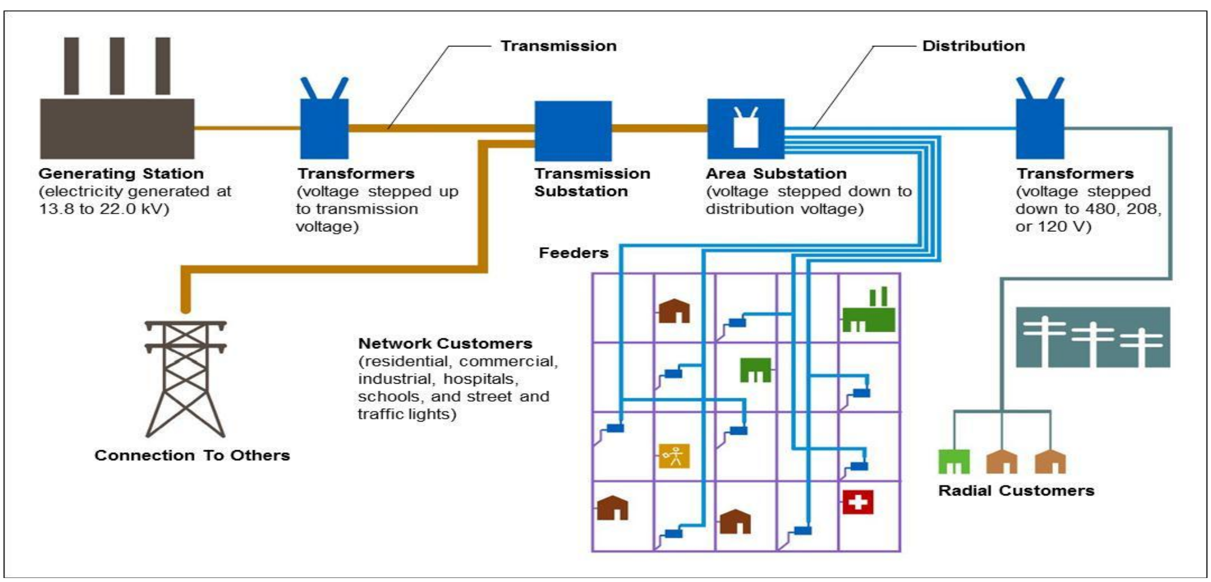
Con Edison transmits and delivers natural gas service in Manhattan, the Bronx, and northern Queens and almost all of Westchester. Con Edison also owns and operates the world's largest district steam system, providing steam service in much of Manhattan. See Gas System Overview and Steam System Overview for more details about those respective systems.

Electric System Overview

Electricity is delivered through approximately 94,000 miles of underground cable and almost 37,000 miles of overhead cable.

As shown in Figure 2, Con Edison's electric power delivery system is comprised of three distinct sub-systems: generation, transmission, and distribution. Electricity travels from a generating station and is then transported at high voltages (500kV, 345kV) often over long distances toward our service territory. Once it gets within the vicinity our service territory, the voltage is reduced at transmission substations to sub-transmission levels (138kV, 69kV). Within our service territory, area substations step down the voltage to the distribution level (4kV, 13kV, 27kV and 33kV). From the area substations, high-voltage primary feeders distribute the power and feed a secondary system of low-voltage cables. In Figure 2, two different types of distribution systems (network and overhead) are shown.

Figure 1: Electric System Overview



Distribution System

Con Edison has two different electric distribution systems, the overhead system and the network, or underground system. . The Company has a total of 2,300 primary voltage distribution feeders supplying these systems.

Con Edison's distribution system has been recognized as one of the most reliable nationally. It has received the ReliabilityOne™ National Annual Award each year for the past six years (2008 through 2013) for demonstrated sustained leadership, innovation and achievement in the area of electric reliability. The selection criteria for the ReliabilityOne™ National Award are both quantitative and qualitative including:

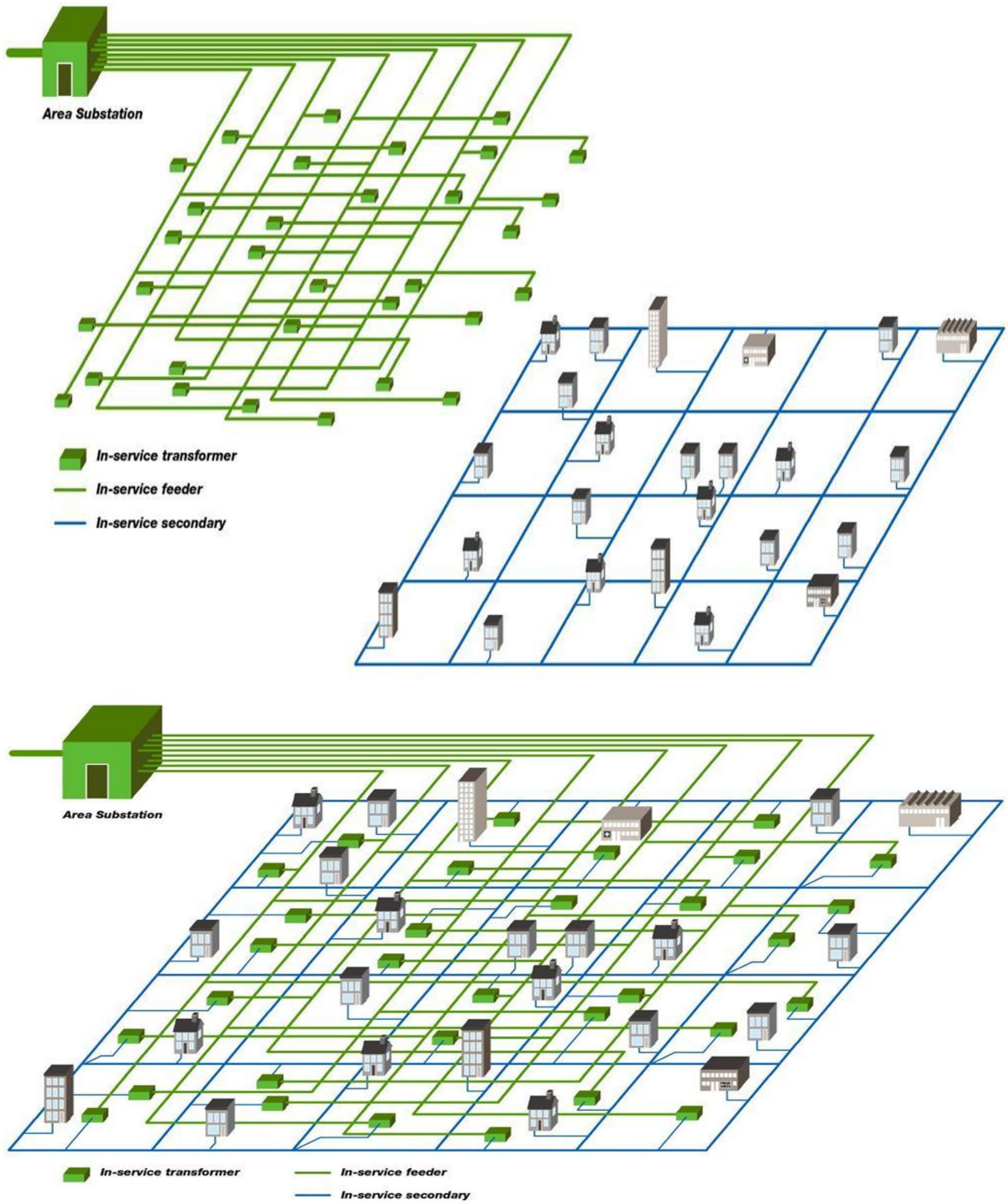
- superior regional performance;
- sustained performance over time;
- improved performance over time;
- leadership in outage data collection and reporting systems, processes, procedures and controls;
- organizational and cultural focus on reliability;
- communication, planning, preparation, and response to major outage events;and
- contributions to regional system security and reliability.

The ReliabilityOne™ Awards recognize the top five utilities nationally on reliability of electric service. PA consulting (a global consulting firm) has measured Con Edison's reliability as 85% better than the industry average.

Network Design

Approximately 86% of the electricity delivered by Con Edison is carried by the underground network distribution system. About 74 percent of our customers are served by the underground, or network system. The network system is segmented into independent grids supplied by primary feeders at 13kV or 27kV with a series of transformers that step the voltage down to 120 Volts to supply service at the customer level.

Figure 2: Network Design Distribution System



The network is designed to have two distribution feeders (13kV or 27kV) out of service without interrupting customers – N-2 design. The system is designed to withstand two feeders out of service during the forecasted summer peak load without interrupting service to customers.

Overhead Design (Non-Network)

Approximately 14% of the electricity delivered by Con Edison is carried by the overhead distribution system. About 26 percent of customers in Con Edison's service territory are supplied by the overhead system in Westchester County and Staten Island and parts of the Bronx, Brooklyn and Queens. The most common overhead design is auto-loops and 4kV overhead grids. Auto-loops and some 4kV grids are designed so that if one primary supply feeder goes out of service, customers would not lose service. Some 4kV grids are designed so that if two primary supply feeders go out of service, customers would not be interrupted. Again, the system is designed to withstand the peaks reached on the hottest forecast summer day and operates with one or two feeders, depending on design, out of service without impact on the customer.

The network system provides superior reliability when compared to the overhead system because there are multiple and alternative paths for the electricity to flow through and reach customers and it is largely located underground where it is shielded from the effects of wind, trees, ice, lightning, and damage from vehicles. In addition, each network is designed to operate independently of every other network. As a result of this design, a problem in one network cannot affect customers in another network.

Gas System Overview

Con Edison's gas service territory (Figure 3) covers 471 square miles in Manhattan, Bronx, Westchester and parts of Queens. Con Edison serves approximately 1.1 million firm customers and approximately 900 large-volume interruptible customers, that is, customers who can switch to another fuel source at times of high demand, typically during extremely cold weather. Seven of the interruptible customers are in-city gas fired power generation plants. (Service area and customer statistics are shown below).

Figure 3: Con Edison Gas Service Territory

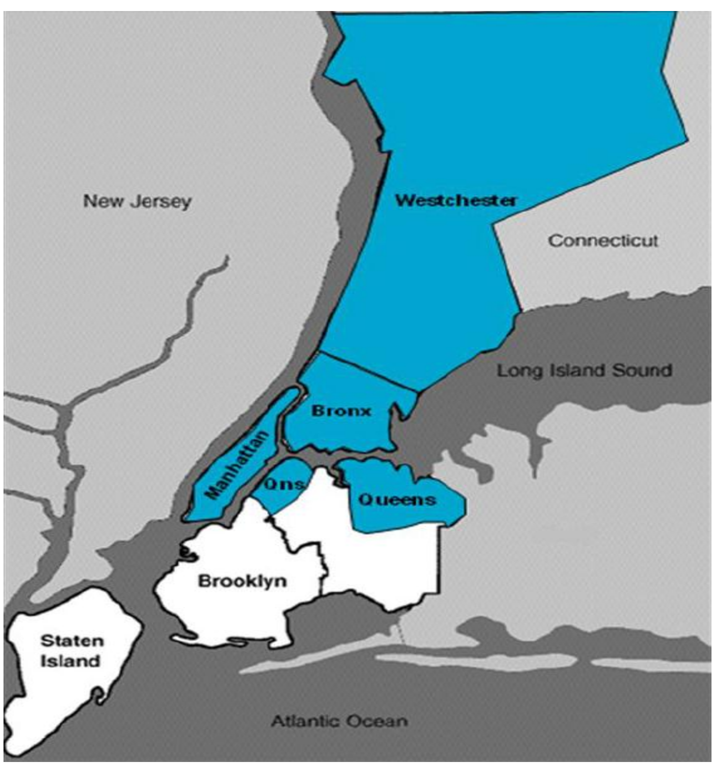
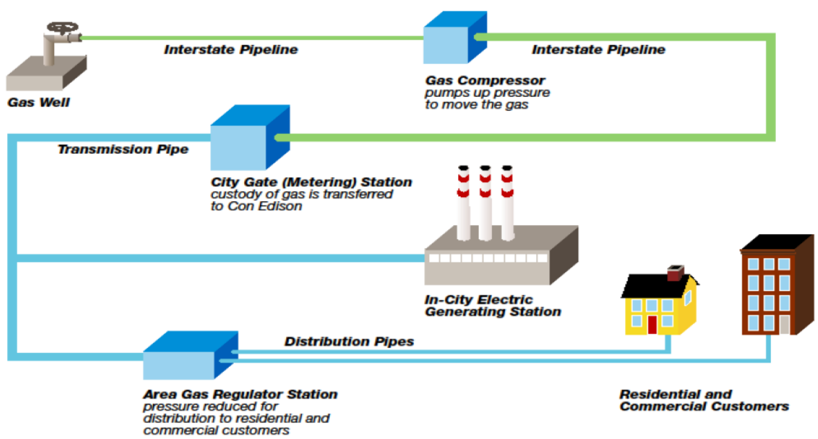


Figure 4: Service Area Statistics

	Square Miles of Gas Service Area	Customers
Bronx	41	296,000
Manhattan	23	336,000
Queens	40	200,000
Westchester County	367	223,000
Total	**471**	**1,055,000**

The Company's natural gas system consists of more than 4,359 miles of pipe transporting approximately 300 million dekatherms (MMDt) of natural gas annually. Gas is transported from interstate pipelines into the Con Edison system. Since the early 1800s, we have installed gas pipes under almost every street and/or sidewalk in our service territory (except in northern Westchester).

Figure 5: Illustration of Con Edison Gas System



Homeowners and apartment buildings depend on natural gas for their space heating, water heating, and cooking needs. There are approximately 670,000 cooking gas customers and 270,000 heating customers. Our customers include the largest cooperative housing development in the world and the largest public housing authority in North America.

Commercial enterprises, including 47 Fortune 500 companies, and commercial buildings require natural gas for heating, combined heat and power generation, and as a fuel for transportation. Con Edison serves approximately 60,000 commercial heating customers and another 60,000 commercial non-heating customers.

Our approximately 900 large volume, dual fuel, interruptible customers include in-city electric and steam generation units. Nearly 75 percent of NYC's in-city electric power generation and 57 percent of steam capacity is dependent on natural gas as a primary or backup fuel. Reliability of gas service is critical to these generation customers and to our service area's electric and steam customers.

Steam System Overview

For over 130 years, the steam system has provided customers with reliable heating and steam-driven air conditioning. Con Edison owns and operates the 10th largest district energy system in the world, and the largest in the United States. It is the largest steam system in the world. Steam service is available south of 96th Street in Manhattan. The system currently serves approximately 1,720 metered customers. Among Con Edison's steam customers are many of New York City's landmarks: Empire State Building, United Nations, and One World Trade Center. In terms of sales, the primary load centers are Midtown, Lower Manhattan/Downtown, the Upper East Side, and the Upper West Side.

The distribution system contains approximately of 105 miles of main and service pipe with steel piping for the mains and a combination of steel and brass for service and condensate piping. The system operates as one continuous network, and the physical location of the piping is directly correlated to the location of generation supply sources and customer demands. The design parameters for the system are 400 psig at 475°F and 200 psig at 413°F. The steam is produced by five Company owned and operated generating stations, and one contracted steam supply facility. Each facility houses multiple generation units, which provides for system reliability and backup-up plans.

The Company-owned steam facilities are the East River, 59th Street, 60th Street, 74th Street, and Ravenswood generating stations. The Brooklyn Navy Yard Cogeneration Partners supply steam via an energy sales agreement. The total capacity of the steam system is about 11,676 Mlb/hr. Over 60 percent of the steam supplied by Con Edison is produced through cogeneration technology, with the remainder produced through gas and oil-fired units.

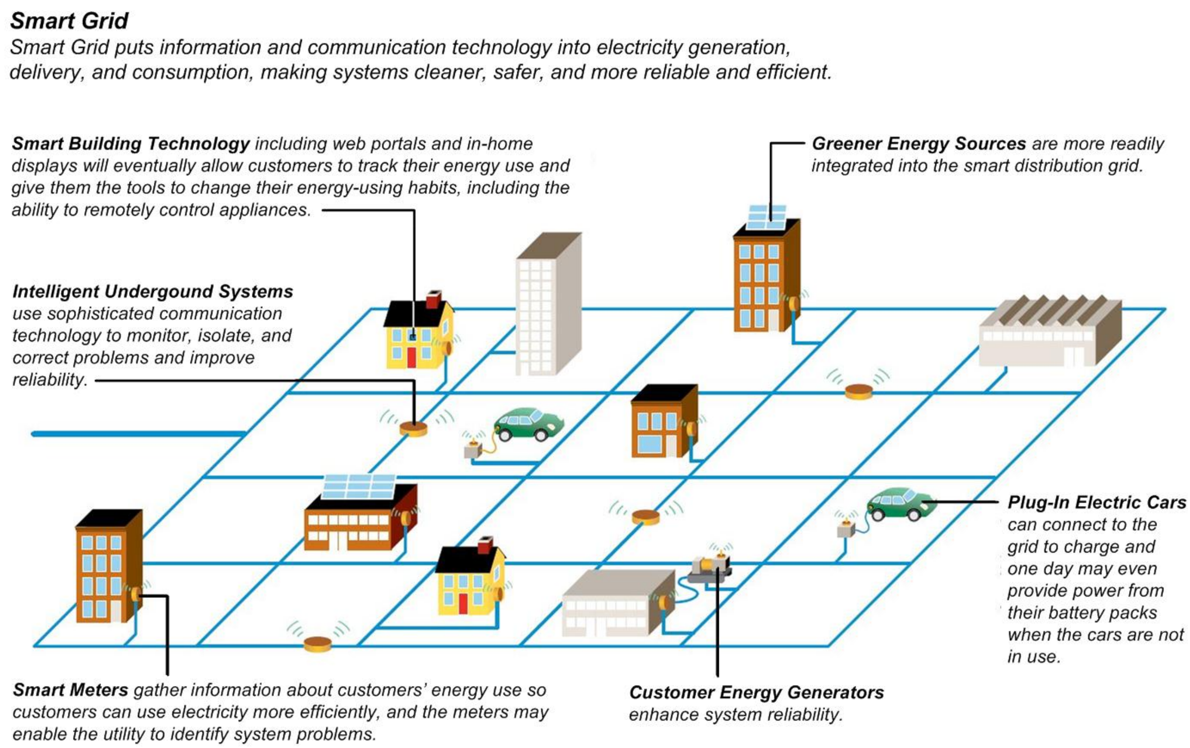
The steam system design criteria as it pertains to generation is as follows: N-1, or loss of the largest unit, which means continuous service, supplied at an average gage pressure in excess of 125 pounds; a Loss of Load Expectation <1, which means that supply cannot meet demand for 1 day in 1 year, which is equated to 24 hours of pressure below 125 psig in a 1 year period; and a 1 in 3 chance of Design Weather, 30-year temperature look back with the Design Temperature Variable occurring between the 10th and 11th year.

Con Edison Smart Grid

Smart Grid is an industry term that generally describes how customers and the utility have more information and control over aspects of electricity usage and system performance through advanced monitoring and technology.

Con Edison has been leading multiple initiatives across the utility industry to test and develop smart grid technologies that provide enhanced control over the grid, including operational flexibility, and resiliency. A smart grid also allows customers to better control their energy use. Figure 6: Elements of a Con Edison Smart Grid Implementation illustrates the key elements of the Company's Smart Grid implementation.

Figure 6: Elements of a Con Edison Smart Grid Implementation



Major elements of the Company's smart grid strategy include:

- Continuing to develop and demonstrate emerging Smart Grid technologies with less certain benefits
    - Comprehensive demonstration in Long Island City
    - Department of Energy Secure Interoperable Open Smart Grid Demonstration Project
- Implementing innovative designs and smart grid technologies with proven benefits
    - Department of Energy Smart Grid Investment Grants

Long Island City Smart Grid Pilot

The Long Island City Pilot completed in 2011, is the Company's most comprehensive Smart Grid application. It included the installation of Advanced Metering Infrastructure devices, home area networks, solar panels, remotely controlled feeder switches on underground feeders, and transformer and network protection monitoring. The Company also filed two grant applications for Federal stimulus funding with the U.S. Department of Energy. The Energy Department awarded Con Edison $181.0 million for the Company's Smart Grid Investment Grant and Demonstration Project.

The Company expects a range of benefits from our Smart Grid initiatives, including the proof of concept of new wireless monitoring and control technologies, vast new data collection opportunities on distributed supply and customer demand patterns, and secondary model validation from the increased demand and power flow data. Information and telecommunication improvements continue to help reduce cost and improve performance of our electric system.

The Smart Grid demonstration in Long Island City included 1,500 smart meters, 300 home area networks, transformer and network protector monitoring and control, electric vehicle charging, feeder reconfiguration and a common communication system. Supporting data management for the control center and engineering applications was also implemented. The pilot successfully demonstrated the following Smart Grid technologies:

- Proof of concept for new wireless monitoring and control technologies;
- New data collection opportunities on distributed supply and customer demand patterns;
- Secondary model validation from the increased demand and power flow data;
- Expanded system monitoring capability;
- Further implementation of 3G applications; and
- Proof of concept associated with the ability to support the interconnection to new renewable power supplies.

Secure Interoperable Open Smart Grid Demonstration Project

The Company's long-term objective is to develop a smarter grid that will capture the full benefits of improved and additional monitoring, modeling, and control. The long-term goal is to enable targeted demand response by integrating customer-owned demand response resources into our grid operations. The Department of Energy funded Smart Grid Demonstration Project is consolidating the Company's Smart Grid initiatives under a single master information system and control technology:

Some long-term objectives of the Secure Interoperable Open Smart Grid Demonstration Project are to:

- Manage and adapt to new distributed generation supplies such as solar and EV recharging;
- Integrate control of building management systems and other demand response resources, such as distributed energy storage through third-party service providers;
- Minimize or eliminate distribution system stress by enabling targeted demand response;
- Migrate to preventive maintenance; and
- Maintain cyber security over transmission and distribution network operations and energy usage.

We are investing the $45.0 million American Recovery and Reinvestment Act (ARRA) Smart Grid funding to support the Secure Interoperable Open Smart Grid Demonstration Project. We are receiving an additional $45.0 million in funding and working with companies from different industries, such as manufacturing and higher education.

Innovative Designs and Technologies – Third Generation System of the Future (3G)

Central to the smart grid vision are design options that increase asset utilization, increase operational flexibility, reduce the risk of large outages, reduce street congestion, facilitate the use of new technology, reduce, avoid or defer costs, and maintain service and reliability. The Company is developing 3G design to meet these objectives. These design concepts include:

- Sub Networks;
- Substation asset sharing;
- Transferable feeder groups;
- Distribution substations;
- Intelligent underground auto-loops; and
- Low voltage migration concepts.

Sub-Networks for Increased Grid Resiliency

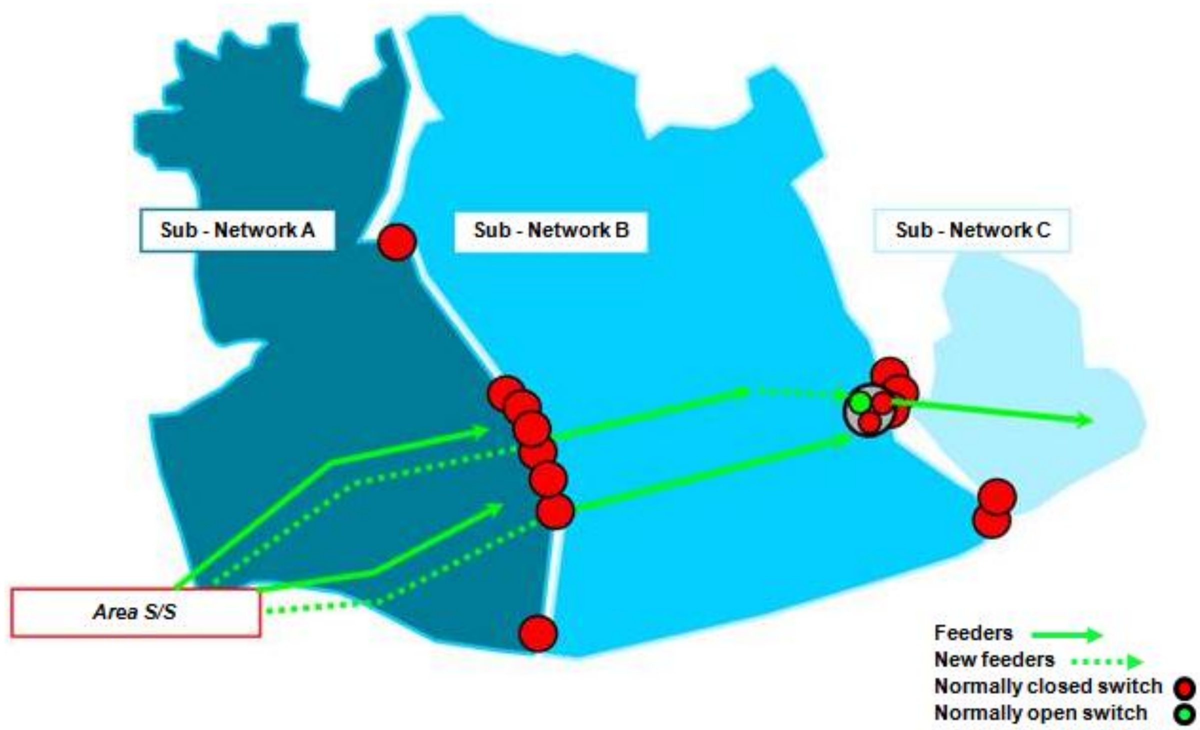
Since Sandy, Con Edison has been developing flood mitigation designs for the transmission, substation, and distribution system. The Company has created innovative 3G designs called sub-networks to increase network flexibility during storms or heat waves.

The conventional method to mitigate a storm impact on the distribution network is to create new networks along flood lines by rearranging feeders and isolating the secondary grid. The proposed 3G approach is the sub-network concept. The goal is to isolate flood zones and to minimize the risk of cascading outages without rearranging the majority of the feeders in both networks.

Con Edison is installing the sub-network design in Lower Manhattan networks. Sub-networks, circuit breakers and medium voltage switches split the secondary grid to enhance network control along flood zone boundary lines before or during a storm.

Another example of an integrated solution is in the Flushing network where we have implemented intelligent underground auto-loops between sub-networks in an existing large network. This design combines concepts to reduce the likelihood and severity of a large network outage, and provides increased operational flexibility. By using switches along natural boundaries, a part of the network can be isolated during a cascading network event, thereby insolating part of the network and reducing severity of the event. The intelligent underground auto-loops can be used during normal operations to isolate feeder failures and to restore the un-faulted portion of the feeder. We are constructing this project as part of the Smart Grid Investment Grant; a diagram is provided below:

Figure 7: Illustration of Intelligent Underground Auto Loop Configuration



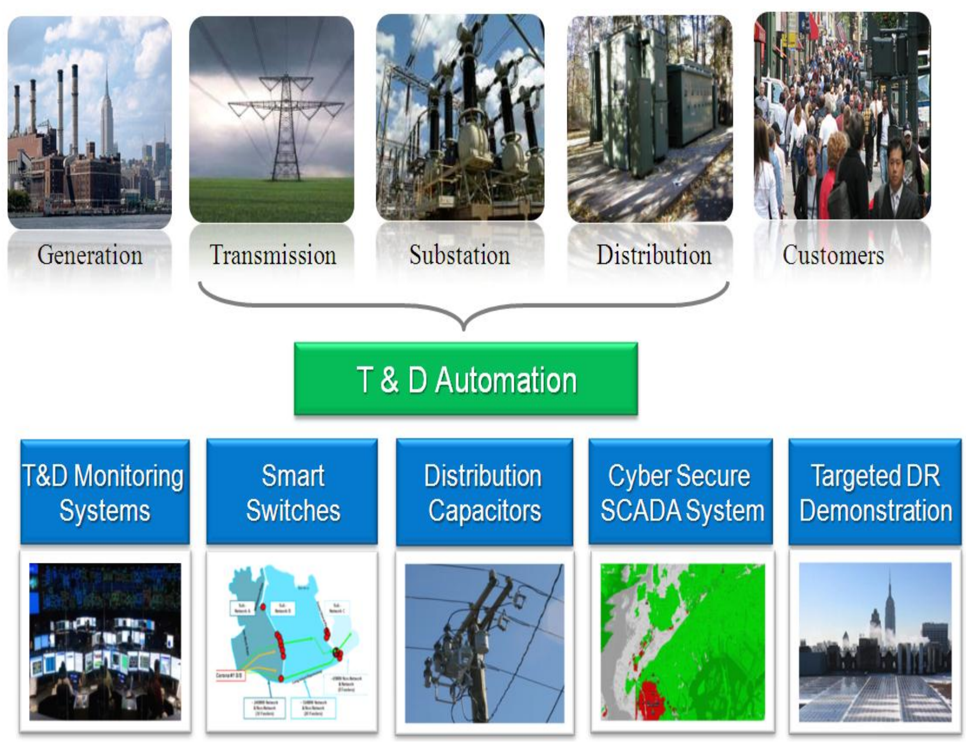
In the diagram, three sub-networks are established. Network feeders continue to run throughout the network, with sectionalizing switches at the sub-network boundaries to isolate each sub-network. Two intelligent underground auto-loops are established using one-way sectionalizing switches as well as three-way switches. The switches and loop configurations will be equipped with remote monitoring and control and automation.

Department of Energy Smart Grid Investment Grants

Under the Smart Grid Investment Grant projects, the Company is investing $260.0 million in transmission and distribution automation.

The projects includes distribution automation, dynamic modeling and simulation, and energy efficiency initiatives which address Con Edison's ongoing challenges of maintaining reliability of service, improving grid resiliency and meeting the demand on resources. By implementing advanced system capabilities like rapid restoration and grid reconfiguration, achieving efficient delivery through system losses reduction, enhancing data visualization, and integrating smart grid technologies, the project attains new capabilities for the Company's electric system. Figure 8: Illustration of Smart Grid Technologies being deployed under ARRA Grants illustrates the technologies under the Investment Grant Project.

Figure 8: Illustration of Smart Grid Technologies being deployed under ARRA Grants



The distribution automation component includes strategic programs that put Con Edison's electric distribution system on the road to the future. The programs include:

- Installing intelligent SCADA-controlled sectionalizing switches on underground and overhead systems;
- Expanding secure monitoring and communication systems;
- Implementing advanced computational intelligence for automated system restoration; and

- Expanding distribution automation to advance self-healing grid operations and increase system resiliency.

The dynamic modeling and simulation component integrates data to generate, predict, and visualize information on the secondary grid through dynamic modeling and a distribution simulator. This will enable enhanced visualization of information and improve our modeling capabilities.

The energy efficiency component accommodates distributed generation, increases energy efficiency and reduces system losses. The major objectives are:

- Provide greater visibility and expand automation and control of one of the world's most complex distribution systems;
- Establish cyber-secure and scalable communication platforms;
- Boost decision support systems with sensor feedback to improve predictive models that identify, isolate and rectify system vulnerabilities; and
- Expand monitoring and control elements to adapt to dynamic conditions of the service area.

Enhanced monitoring and control increase grid resiliency and operational flexibility. These investments will produce long-term improvements in system performance during major events and lower costs. Advances in communications, such as Smart Grid technologies, will continue to give us greater visibility into the status of our transmission and distribution systems.

As a result of Sandy, the Company expanded the deployment of intelligent SCADA controlled switches and remote monitoring components under the Smart Grid Investment Grant projects to reduce customer impact, expand system monitoring, and allow isolation of critical customer facilities.

Storm Hardening and Resiliency Guiding Principles

The goal of Con Edison's storm hardening investments is to reduce total customer outages by reducing the impact of wind/flood damage and improving restoration. We plan to do this by making investments guided by the following four principles:

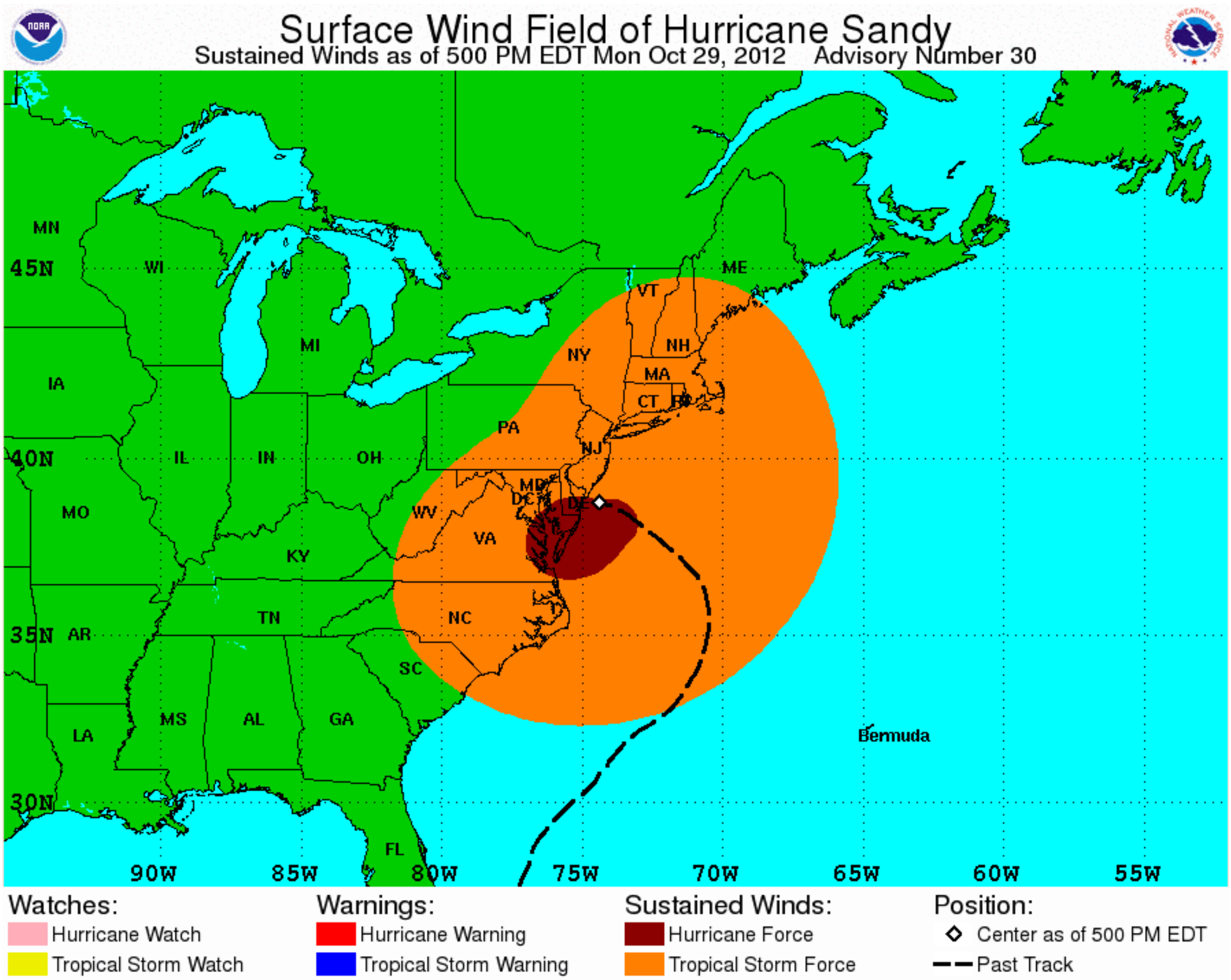
1. **Protect infrastructure** – Relocate and envelope equipment to minimize exposure to wind and water infiltration.
2. **Harden components** – Strengthen equipment to withstand water inundation and tree damage.
3. **Mitigate impact** – Improve flexibility to allow for advanced flow controls around damage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

Weather and Impact on Infrastructure

Sandy Experience

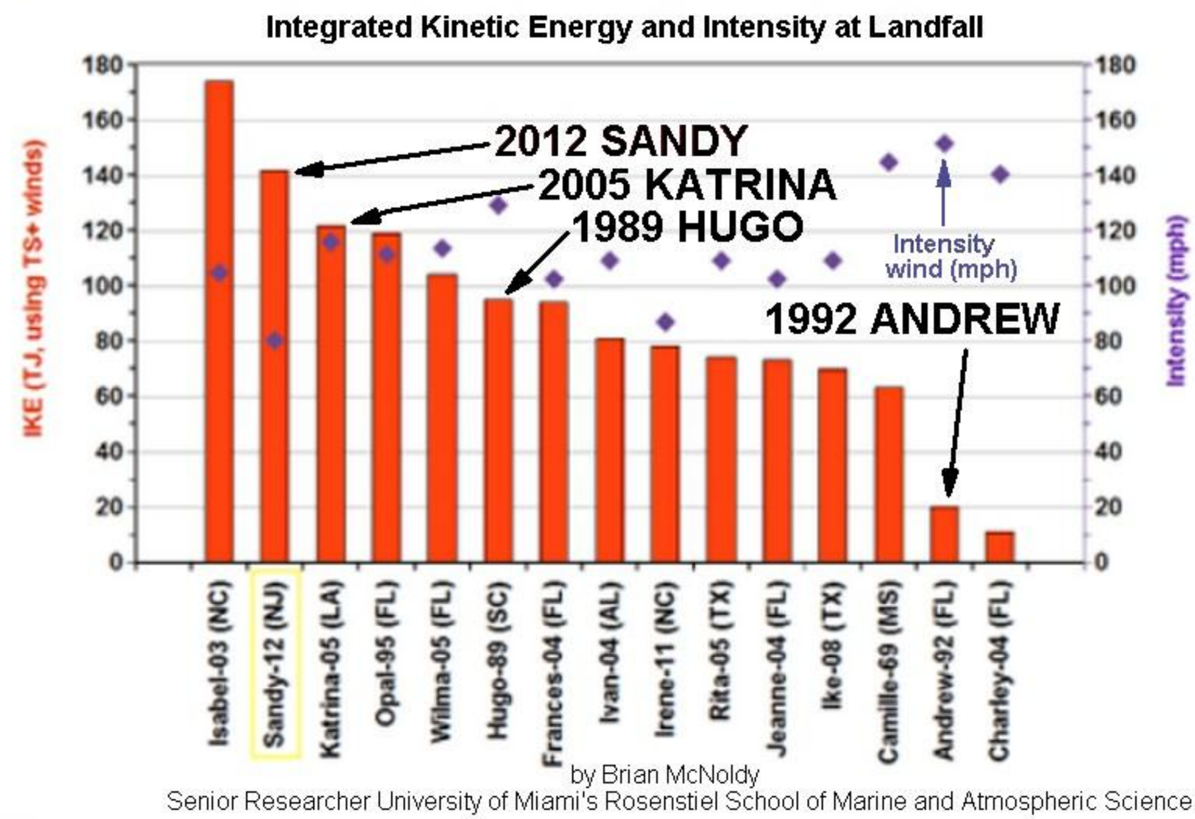
Sandy was the most powerful and devastating storm to strike the New York City metropolitan area in at least 200 years. It was the largest tropical system ever recorded in the Atlantic Ocean basin, with tropical storm force winds extending 820 miles as seen in the figure below.

Figure 9: Sandy Surface Wind Field Map



The storm covered approximately twenty percent of the United States as it moved up the East Coast. Sandy also had the lowest central pressure ever recorded in a tropical system north of Cape Hatteras, North Carolina. Using a scientific scale that measures energy within a storm system Figure 10: Storm Kinetic Energy), Sandy was the second strongest storm in the Atlantic Ocean basin behind Isabel (2003), and surpassed other historic storms like Irene (2011), Katrina (2005), and Andrew (1992).

Figure 10: Storm Kinetic Energy



The above factors combined to create a record breaking storm tide and severe wind conditions across Con Edison's service territory, making Sandy the most destructive storm to strike the Company's systems and infrastructure in its history.

Sandy's actual storm surge of 14.06 feet exceeded all official forecasts, surpassing a reported historical record set in 1821 by nearly three feet. More recently, the 1992 Nor'easter brought the worst flooding we had experienced up to that time, with a storm surge that was 4 ½ feet lower than Sandy.

CECONY Infrastructure Impact

Sandy caused more than one million customers to lose electric power – five times the number of outages caused by Irene in 2011. One-third of our steam customers lost service during Sandy, and another 4,200 customers experienced gas outages because of the storm.

Table 14: Sandy and Irene Pole & Transformer Usage

Estimated Pole & Transformer Damage			
SANDY Estimated Totals as of Nov. 30			
Location	**Poles**	**Transformers**	**Cable [miles]**
Bronx/Westchester	699	718	72.06
Brooklyn/Queens	209	93	60.63
Staten Island	64	111	10.76
Total CECONY	972	922	143.46
IRENE Totals			
Location	**Poles**	**Transformers**	**Cable [miles]**
Bronx/Westchester	46	133	12.30
Brooklyn/Queens	15	14	17.03
Staten Island	30	15	1.78
Manhattan	-	1	0
Total CECONY	91	163	31.11

Table 15: Sandy and Nor'easter Customer Outages

Super Storm Sandy and Nor'easter	Customer Outages
Bronx	75,406
Brooklyn	143,088
Manhattan	235,451
Queens	160,893
Staten Island	179,530
NYC Total	794,368
Westchester	320,926
Con Edison System Total	1,115,294

Sandy's damage to our overhead system alone was record-breaking. Five times as many overhead customers lost power during Sandy compared to those who lost service during Irene. In terms of physical damage, five times as many poles and two times as many transformers were damaged comparing Sandy to Irene. In all, 78 percent of the overhead system was impacted by Sandy.

The distribution system also experienced many supply feeder outages due to high winds, toppled trees, and flood conditions. During Sandy, there were 488 feeder outages, compared to 132 with Irene. The 488 feeder outages equal to approximately three months of summer supply feeder activity.

Table 16: Historical Storm Comparison

Historical Storm Comparison		
Date	**Type of Storm**	**Customers Interrupted**
29-Oct-12	Super Storm Sandy	1,115,000[35]
28-Aug-11	Hurricane Irene	203,821
13-Mar-10	Nor'easter	174,800
29-Oct-11	Nor'easter	135,913
9-Sep-85	Hurricane Gloria	110,515
2-Sep-06	Tropical Storm Ernesto	78,300
25-Feb-10	Snow	65,200
18-Jan-06	Wind/Rain	61,486
31-Mar-97	Nor'easter	45,180
19-Oct-96	Nor'easter	41,830

Normalization and Recovery Costs

As a result of Sandy, the Company incurred significant costs ($322 million) to repair and replace equipment and to restore service. Expenditures in Steam and Gas Operations were $9 million and $3 million, respectively. The remaining $310 million was incurred within Electric Operations; $81 million was associated with capital and removal costs. The balance of $229 million included $12 million of Company straight time labor and $217 million in incremental costs (overtime, mutual aid and other outside support).

Recent History of Acute Weather Events

Five of Con Edison's top-10 storms from a customer outage perspective have occurred within the last three years. All have been coastal type storms. As we have noted, Sandy and Irene were tropical origin with long duration strong winds and storm surge flood type impact and damage.

On October 29, 2011 an unprecedented early season snowstorm left up to a foot of heavy, wet snow across the Con Edison service territory. This sticky, packable snow clung to the tree branches weighing them down. In addition, due to a late fall warm spell, most of the trees had leaves on them, which provided additional surface area for snow to collect. The storm caused significant tree damage across the territory and large customer outages on the overhead electrical system.

The March 13, 2010 Nor'easter, had wind speeds up to 75 mph, and came on the heels of a heavy winter snow season. The melting snow combined with several inches of rain from the storm itself and a storm earlier in the week resulted in saturated soil that weakened the support system of the trees causing them to fall under high wind conditions.

On February 25, 2010, up to three feet of heavy, wet snow fell across the Con Edison service territory breaking tree branches which impacted the company electrical infrastructure.

[35] Includes Nor'easter Athena

Other smaller-scale weather events have affected Con Edison's service territory. Severe summer thunderstorms have spawned several tornados and downbursts (strong thunderstorm winds) that caused smaller, highly localized customer service interruptions.

In New York City, 60 percent of tornado activity has occurred during the last six years. There have been 13 tornados in New York City since 1950, eight of which have occurred since 2007. In Westchester County, the numbers are not so dramatic. Nine tornados have touched down within the county since 1950. The data shows no increase in activity in recent years. There has not been a tornado reported in Westchester since 2006.

Summer 2013 will be remembered for the seven day heat wave that gripped the city with 90°F and greater temperatures from July 14 to 20. On average two to three heat waves (defined as three or more consecutive days with 90°F or greater temperatures) occur in New York City during the summer. A seven-day heat wave is rare and has occurred only seven times since 1869.

New York City will have approximately 16 days with 90°F or higher temperatures during the year, most of which occur during the months of June, July, and August. Summer 2013 was an about average year for 90°F days but the last three years have all been above normal. The highest number of 90°F or greater days in recent history was 2010 with 37 days above 90°F observed. Thirty or more 90°F days in a year has happened only 10 times since 1869.

Temperature trends in New York City indicate that the area is warmer than it has been in the past. The average yearly temperature in New York City is about 55°F. 2012 was the warmest year on record at Central Park with an average temperature of 57.3°F. Summer 2010 and 2011 also make the Top-10 warmest year list at 56.7°F, and 56.4°F respectively. July 2010 was the second warmest month ever and July 2013 was the seventh warmest month on record.

The New York City area receives approximately 50 inches of precipitation every year. 2011 was the second wettest year on record with almost 73" of precipitation. That amount can be attributed to record breaking August precipitation when nearly 19" of rain fell. August 2011 was the wettest month ever in New York City.

Current Weather Conditions and Climate Forecasts

Reliable weather records date back only about 150 to 200 years in most locations, yet Earth has been in existence and producing weather for over four billion years. This is important for context, when trying to relate a single weather event or statistic to what is happening in terms of climate. Although they are related, weather and climate are not the same. Weather occurs in the short term, and can be highly variable for periods of time that from a human perspective seem long, but when examined within the context of climate is actually short. On their own, a single discreet weather event, regardless of how severe, may or may not be due to, or an indicator of climate change.

Climate must be thought of as the long-term weather trends and changes to the atmosphere, which are a result of human or naturally caused phenomenon. For example, "climate normals" are what weather and climate scientists use as a baseline to determine how the climate may be changing. These normals are based on the historical record of weather observations all over the world. A climate normal incorporates at least a 30-year period for temperature and precipitation. These normals are updated every 10 years with new data.

Nonetheless recent weather events cannot be ignored as an indication for what may be to come. New York City has kept weather records since 1869. Elsewhere around the region weather records date back to the 1940s. An analysis of temperature and precipitation data shows that the climate of the region is changing. Over the recorded history, the general trends for various temperature and precipitation related metrics show an increase above climatological normals.

Temperature

The yearly average temperature for New York City based on the 1981-2010 climate normal is 55.3°F. Over the 138-year period of record the yearly average temperature has risen by about 4.0°F or 1.4°F every 50 years. The summer period is when the company focuses on temperatures because high heat and humidity drive electricity demand which can cause problems on the electric system. Meteorological summer is defined as the three months of June, July, and August. The average summer temperature in New York City is 74.8°F based on the 1981-2010 climate normal. The average summer temperature has risen about 2.7°F since 1876, or approx. 1°F every 50 years. If just the peak temperature from each of the three summer months over the last 138 years is considered (a maximum of the maximums) the rate of increase is slower than the average summer temperature by almost a full degree Fahrenheit. What this may mean is that while the overall summer temperature profile is rising, the extremes are not rising as quickly or becoming more frequent.

Historical data shows that the winter season has actually been warming faster than the summer season. Meteorological winter is defined as the three months of December, January, and February. The average winter temperature for New York City during those three months is 35.5°F based on the 1981-2010 climate normal. Over the 138 year period of record the average winter temperature has risen by approximately 4.4°F or 1.6°F every 50 years. That is almost a 2°F greater increase than the summer temperature rise.

Days in which high temperatures reach 90°F or greater in New York City occur approximately 16 times per year. As mentioned earlier, most of these days occur during the months of June, July, and August. The number of 90°F days has grown by about nine days in 138 years or about 3.3 days per 50 years. Although the data shows an increase in days over 90°F, the number of heat waves has not increased much as a result. The number of heat waves, defined as three or more consecutive days that high temperatures reach 90°F or greater, occur on average 2-3 times per year. Since 1876, the number of heat waves has gone up by about 1.4 per year. The duration of heat waves has increased even less, only adding about 1/3 of a day since 1876.

Con Edison uses temperature variable (TV) as a design basis to rate its electrical equipment. The current design basis is a TV of 86°F. The TV is a weighted average of the 3 highest hours of dry bulb and wet bulb temperature forecasted on the current day, and the observed wet and dry bulb from the previous two days. The Company has temperature variable data going back to 1997. Despite the rise in summer temperatures and increase in 90°F or greater days, the TV reaching or exceeding 86°F is not occurring more frequently by any significant amount (0.21 days). In fact, even lower thresholds like a TV of 84°F is not showing an increase over the 17-year observation period.

Precipitation

The yearly average precipitation is approximately 50” per year. Since 1876, the amount of precipitation has risen by about 8.75” or 3.2” every 50 years. The number of heavy rain events has also risen. Since 1876, rain events that had more than 2” of accumulated rain have increased by about 1.5 days.

Sea Level

According to the NPCC sea level has risen 1.1 feet since 1900 at the Battery.

NPCC Climate Change Forecast

Whereas weather trends are based on the observations of historic conditions, the science of forecasting future climate conditions is based on both climate model-based percentile outcomes, and qualitative projections of peer-reviewed scientific literature. The New York City Panel on Climate Change has been convened by Mayor Bloomberg to provide up-to-date scientific information and analyses to inform critical infrastructure owners of the risks posed by climate change. Specifically, the NPCC projects that by mid-century, temperatures are extremely likely to be higher, total annual precipitation will likely increase, higher sea levels are extremely likely, and extreme events in the form of heat waves, heavy downpours, and coast flooding are very likely to increase in frequency and intensity.[36]

[36] New York City Panel on Climate Change, Climate Risk Information 2013: Observations, Climate Change Projections, and Maps. The City of New York. http://www.nyc.gov/html/planyc2030/downloads/pdf/npcc_climate_risk_information_2013_report.pdf June 2013

Table 17: NPCC Climate Projections

Climate Variable	Baseline (1971-2000 unless otherwise noted)	Year	Middle Range (25th to 75th percentile)
Air Temperature	54 F	2020s	+2.0° F to +3.0° F
		2050s	+4.0° F to +5.5° F
Precipitation	50.1 inches	2020s	0 to +10 percent
		2050s	+5 to +10 percent
Sea Level Rise	0 inches (2000-2004)	2020s	4 to 8 inches
		2050s	11 to 24 inches
Number of days/yr max temp at or above 90 F	18	2020s	26 to 31
		2050s	39 to 52
Number of heat waves/year	2	2020s	3 to 4
		2050s	5 to 7
Average heat wave duration (in days)	4	2020s	5 to 5
		2050s	5 to 6
Number of days/yr with min temps at or below 32 F	72	2020s	52 to 58
		2050s	42 to 48
Number of days/yr with rainfall at or above 2 inches	3	2020s	3 to 4
		2050s	4 to 4
Annual Chance of today's 100-year-flood (measured at the battery)	1.0	2020s	1.2 to 1.5 percent
		2050s	1.7 to 3.2 percent
Flood heights associated with the 100-year-flood	15.0 feet	2020s	15.3 to 15.7 feet
		2050s	15.9 to 17 feet

The NPCC is not able to quantitatively forecast the impact of extreme events due to the uncertainty at local scales being incompatible with quantitative projections. However, the NPCC determines a qualitative "direction of change," and the likelihood of occurrence for extreme events that may have an impact on utility infrastructure. Specifically, the NPCC projects that heat indices are very likely to increase, both directly due to higher temperatures and because warmer air can hold more moisture. Additionally, downpours are very likely to increase, and tropical cyclones are more likely than not to increase in frequency and intensity.

U.S Dept. of Energy

The U.S. Department of Energy released a report in July, 2013, U.S. Energy Sector Vulnerabilities to Climate Change and Extreme Weather, as a synthesis of known and projected future climate drivers. The report identifies three major climate trends within known literature that are relevant to the energy sector:[37]

- Increasing air and water temperatures;

[37] US. DOE. U.S Energy Sector Vulnerabilities to Climate Change and Extreme Weather. DOE/PI-0013. http://energy.gov/sites/prod/files/2013/07/f2/20130710-Energy-Sector-Vulnerabilities-Report.pdf. July 2013

- Decreasing water availability in some regions and seasons; and
- Increasing intensity and frequency of storm events, flooding, and sea level rise

The DOE relies heavily on three reports for its future climate projections; the 2013 National Oceanographic and Atmospheric Administration (NOAA) report, Regional Climate Trends and Scenarios for the U.S. National Climate Assessment, the 2009 U.S. Global Change Research Program Global Climate Change Impacts in the United States, and the 2012 IPCC report Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. The DOE uses these sources to project changes in U.S. national climate averages. Specifically:

- By 2050, annual average temperatures across the United States are projected to increase by approximately 2.5° F to 2.9° F.
- In the future, frequent and intense downpours, and the proportion of total rainfall coming from heavy precipitation is likely to increase across the U.S.
- Future sea level rise may be as much as one to four feet by 2100, but when combined with the uplift or subsidence of land, the impact will vary by location. For example, a two foot rise in overall sea level will result in a 2.3 foot rise in New York City.

NOAA

The U.S. National Oceanographic and Atmospheric Administration presents regional climate projections in its 2013 report, Regional Climate Trends and Scenarios for the U.S. National Climate Assessment, wherein we can identify approximate values for temperature and precipitation. Specifically, NOAA projects that under a high emissions scenario[38] the Northeast may see a 4.5-5.0°F increase in temperature from current averages by 2070, and a 3 to 9 percent increase in precipitation. Additionally, NOAA projects that the number of high temperatures days[39] for the northeast will increase by five to 10 days per year, and days that reach below freezing will decrease by 20 to 25 days.

Global Climate Trends – 2013 IPCC Report

On September 27, 2013 the Working Group 1 to the International Panel on Climate Change (IPCC) issued a Summary for Policymakers of their contribution to the IPCC's Fifth Assessment Report, Climate Change 2013: The Physical Science Basis. While the complete report will not be released until later in 2013, the summary identifies key conclusions of the yet-to-be-released final report. Among the key climate variables discussed above, the IPCC findings suggest no significant departures from the NPCC, DOE, or NOAA projections already discussed.

The IPCC finds that 1983-2012 was the warmest 30-year period in the Northern Hemisphere of the last 1400 years. In the short term, global mean surface temperatures will likely increase by 0.5° - 1.25° F within the next 20 years. However, by the end of this century surface temperatures will increase from between 0.5° – 3.0° F under a low-GHG emissions scenario, to as much as 4.7° - 8.6° F under a high-GHG

[38] The IPCC projects impacts from climate change based on the results of models using scenarios of various greenhouse gas emissions and greenhouse gas concentrations. These scenarios represent different narrative storylines about possible future social, economic, technological, and demographic developments.
[39] NOAA defines a high temperature day as the max daily temperature exceeding 95 degrees

emissions scenario.[40] Contrasts in precipitation between wet and dry regions and seasons are expected to increase, with many mid-latitude wet regions (e.g. the Northeast United States) likely to experience increases in mean precipitation. Finally, the IPCC projects that sea level rise by the end of the century will likely be in the range of 0.26 m to 0.55 m for the low-GHG emissions scenario and up to nearly 1 m for the high emission scenario.

Potential drivers of infrastructure impact

The referenced reports point to a dynamic climatological system. While the several climate reports identified and summarized here cannot be considered an exhaustive list, they represent a fair sample of the best information currently available for infrastructure owners to use while planning for long-duration projects. Furthermore, while the reports do not show precise alignment with their quantitative projections, they do appear to have uniform alignment on the direction and magnitude of those projections. Specifically, for our region, those directions appear to be:[41]

- Increased average surface air temperatures by 2050;
- Increasing number of extreme heat days (including consecutive days);
- Decreasing number days below freezing;
- Increasing precipitation; and
- Increasing sea level rise.

These trends may manifest themselves as greater electric demand on the distribution system, larger storm surges impacting and damaging coastal infrastructure, and soil more commonly saturated – resulting in increased damage from wind/rain events.

[40] Four concentration-driven climate model simulations, Representative Concentration Pathways (RCPs), are used in the report: RCP2.6 (lowest greenhouse gas emissions), RCP4.5, RCP6.0, and RCP8.5 (highest).

[41] This is meant to be a general synthesis of the reports,

Appendix C: 2014 Climate Change Vulnerability Study Outline

Background and Overview

As of June 1st, 2013, the immediate storm hardening measures Con Edison has taken at its substations and generating stations have been completed in preparation for the 2013 hurricane season and distribution hardening work has begun. The Company is now looking forward at the next one to three years of storm hardening investments.

The Company's approach to improving resilience balances the risk imposed by storms equal in character to those experienced historically and the potential for storms of even greater magnitude plus other climate risks created by the changing climate. The Company's immediate measures were determined by vulnerabilities exposed during Sandy. Analysis of impacted infrastructure identified a number of facilities at high risk of future coastal flood events. The Company elected to protect these stations in advance of the 2013 storm season.

In addition, Con Edison is benchmarking with utility companies throughout the world on transmission and distribution system design. After Sandy, Con Edison engaged in technical discussions on extreme weather events and climate change with other utility companies.

Some of the weather events considered were hurricanes, major overhead storms, flooding, earthquakes, tsunamis, tornadoes, ice storms, prolonged extreme temperatures, and drought. Utility companies face different risks to their energy infrastructure because of factors such as geographical locations and system design. The discussion encompassed major topics such as crisis communication, planning and mobilization, procurement and logistics, and storm hardening. Con Edison will continue to communicate and collaborate with utility companies on these important topics.

A key element of the Company's approach to improving resilience is understanding how climate change will affect the future magnitude and frequency of storms and how such storms and other climate changes will impact infrastructure and customers. Con Edison highlights these considerations below.

Figure 11: Design Standards Considerations

	Prior Con Edison design standard	Current Con Edison design standard
Flood	• FEMA 2007 100-yr floodplain plus two feet	• FEMA 2013 100-yr floodplain plus three feet
Wind	• 98 mph wind • 45 mph plus 0.5 inch of ice	• *(Under review)*
Temperature variable	• 86°F	• *(Under review)*
Heat waves	• Two per year • Four days long	• *(Under review)*

In the rate cases, Con Edison, New York City, and other interested parties agreed on a flood protection design standard for projects that Con Edison will commence in 2014, and the Company has adopted that standard for future flood protection projects and will review this standard at least every five years. The Company has begun efforts to identify additional storm hardening requirements based on this standard. However, a number of other key design standards (as reflected in Figure 11: Design Standards

Considerations) require additional analysis of the effects of climate change. A shared understanding on these key weather factors, as well as those applicable to flooding, is an essential building block in determining the system and equipment design standards and the infrastructure investments required to mitigate the effects of climate change.

Climate Change and Impact on Infrastructure

Con Edison's equipment and systems are exposed to various weather conditions including storm surge, wind, rain, snow, ice, temperature variations, humidity, and heat waves. These conditions influence our system design and equipment procurement standards as well as required capital investments to continually deliver reliable energy to our customers.

The New York City Panel on Climate Change ("NPCC"), convened by Mayor Bloomberg, released its climate projections in June 2013. The NPCC projects that our climate will continue to change to one that by mid-century will include higher temperatures, increased precipitation, and higher sea levels. In addition, extreme weather events such as heat waves, heavy downpour, and coastal flooding will be more frequent and severe. However, neither the NPCC report, nor reports or forecasts on climate change issued by other agencies, including the US Department of Energy, National Oceanic and Atmospheric Administration, and Federal Emergency Management Agency, address all the key inputs that are required for Con Edison to review its design standards, such as:

- **Temperature variations** - NPCC forecasts change in average yearly temperature in the 2020s and 2050s; however, Con Edison's design standards require a more detailed understanding of summer temperature and humidity forecasts, both of which are currently not addressed.
- **Wind** – NPCC does not include projections of wind speed and duration.
- **Precipitation** – NPCC does not include forecasts of types of precipitation (e.g., rain, snow, ice) and the frequency of such events.

Con Edison is committed to understanding the impact of climate change and supports a study to supplement the existing body of work already conducted, and specifically consider the impact of climate change on Con Edison's infrastructure.

Approach to Assessing Long-Term Climate Change Impacts to Infrastructure

The Company is proposing a climate study that synthesizes current scientifically credible views on predicted climate change, the output of the most up-to-date climate model, identifies the potential effects on utility infrastructure, and incorporates input from Collaborative participants. The goal is to develop a shared understanding on the impact of climate change to Con Edison's infrastructure; further quantify climate change risks and uncertainties; consider revisions to system and equipment design standards; and develop a risk mitigation plan.

Con Edison proposes the following outline for the study.

Scope of Work

A. Analyze/ synthesize relevant background information on climate change to enable Collaborative to consider available data.

    1. Identify the specific climate hazards to be analyzed, initial items include:

a. Sea level
b. Storm surge and flooding
c. River flooding
d. Extreme heat events (intensity and duration)
e. Extreme wind conditions
f. Extreme precipitation
g. Increases in groundwater elevation

2. Identify/summarize existing climate change reports:
    a. NPCC
    b. DOE
    c. IPCC
    d. NYSERDA
    e. USGCRP
    f. Historical trends in New York City and Westchester
3. Identify gaps in the existing climate risk information and take steps to fill them to the extent practicable, explaining the degrees of uncertainty involved, and facilitate collaborative understanding for why the following data points and projections are uncertain:
    a. Wet bulb temperature projections and/or humidity projections
    b. Summer temperature increases vs. average annual temperature increases
    c. Probabilities of weather events of specified magnitudes by year
    d. Mapping of extent of storm surge on infrastructure
    e. Effect of future conditions (especially temperature) on demand profile
    f. Identify conditions prone to occur simultaneously
4. Synthesize findings and provide perspectives on climate change
5. Present findings to the collaborative
6. Facilitate discussions with collaborative to develop shared understanding on climate change

B. Given shared understanding on climate change, highlight and summarize potential impact climate change has on design standards and identify risks. Initial considerations include:
    1. Identify infrastructure design standards affected by climate change
        i. Temperature - warmer air / ground temperatures and heat waves
            1. Transmission / distribution cable and equipment ratings impact
            2. Transmission forced cooling efficiency
            3. Soil dry out – affecting thermal / electrical soil resistivity
            4. System electrical losses
            5. Customer electrical demand
            6. Colder air / ground temperatures with snow / Ice
            7. Overhead Transmission / Distribution line design (Physical loading, sag, etc.)

8. Electrical clearances
9. Structures (buildings, towers, buses, pothead stands, etc.)
10. Pad-mount equipment
11. Equipment and right-of-way access

ii. Wind

1. Overhead transmission / distribution line design
2. Mechanical loads
3. Clearances
4. Structure design (towers, poles, terminations / insulators, pole top equipment)
5. Other facilities (communication lines)
6. Open Air Substations
7. Structure design
8. Debris blown into open air bus

iii. Flooding - rainfall / storm surges

1. Station water discharge
2. Vegetation management (transmission / distribution)
3. Equipment / structure corrosion effects
4. Equipment flooding (substation, underground equipment, etc.)
5. Erosion
6. Pad-mount equipment – transformers
7. Equipment buoyancy – tanks/reservoirs, OWS, structure loading, manholes,
8. Equipment access

iv. Lightning

1. Higher frequency and intensity – impact on the overhead transmission and distribution systems

2. Facilitate discussions with collaborative to develop shared understanding on design standard changes required to address climate change

C. Con Edison to develop risk mitigation options

1. Update Risk Assessment and Prioritization Model from Working Group IV based on climate change perspectives
2. Apply Risk Assessment and Prioritization Model to establish prioritized list of potential projects
3. Develop risk mitigation options for prioritized risks
4. Apply Working Group IV approach (cost/value model)

Appendix D: Working Group 2 Scope of Work (Phase 2)

Scope/Workplan/Schedule

Background

At the August 8, 2013 meeting of the Collaborative convened by Judge Stein, as one of the four working groups, Working Group 2 (Alternative Resiliency Strategies) formed to examine and make consensus proposals on strategies for system efficiency and management of emergency conditions, including microgrid projects, strategically sited distribution generation, energy efficiency, demand response and interactive meters. Judge Stein's expectation was that this group's work would require time beyond the filing of Con Edison's report, and she suggested that the group propose for the Commission's consideration a scope of work to be conducted during a second phase of the Collaborative.

Working Group 2 has met three times. At the September 17 meeting, Con Edison made presentations on energy efficiency, distributed generation, and electric vehicles, and the SmartGrid Consortium made a presentation on microgrids. At the October 3 meeting, the City of New York and the Pace Center for Climate Change made a presentation on their DG collaborative and the group discussed its proposed scope. At its October 7 meeting, the Environmental Defense Fund made a presentation on time-variant pricing, and the Staff of the Public Service Commission made a presentation on smart meters for the residential class. To the extent possible, this draft draws on and is informed by the discussions in WG2 meetings and submitted comments, but issues either beyond the scope of WG2 or not a resiliency strategy are not incorporated.[42]

Working Group Scope

Working Group 2 (WG2) proposes to (1) identify alternative strategies to achieve resiliency or mitigation of the impact of future extreme weather, including heat and storms, on Con Edison's customers. WG2 has identified the following alternative approaches to resiliency for further examination: distributed energy resources, which includes distributed generation (DG) (such as combined heat and power generation (CHP) and renewable generation), microgrids, energy efficiency (EE), demand response (DR), electric vehicles (EVs), and time-variant pricing (such as time-of-use (TOU) rates). WG2 also proposes to (2) seek to undertake a quantitative examination and ranking of cost-effectiveness in coordination with related work underway in Working Group 4; and (3) develop a proposal to Commission regarding alternative resiliency solutions.

More specifically with respect to these approaches, DG is a customer-sited source of generation. DG ranges from turbines supplying large buildings with both electricity and steam to rooftop solar

[42] For example, the suggestion by NYU Law and EDF to review the Public Service Law is beyond the scope of this Collaborative and the suggestion of Local 1-2 of UWUA to examine workforce staffing is beyond the expertise of the Collaborative and would result in a debilitating dilution of the Collaborative's focus on core resiliency issues.

photovoltaic panels on a residence. Notably, during Sandy, some customers with DG did not lose energy. Microgrids are configurations of load, generation, and sometimes, energy storage that are connected to the grid the majority of the time but customers are able to disconnect from the grid and continue normal operations under exceptional circumstances. DR is customer-sited reduction of energy use such as paying customers to reduce energy use during a heat event. EE are customer-sited tools as simple as insulation and new appliances that use less energy or use energy more efficiently. EVs are customer-plug-in electric vehicles. Time-variant pricing structures may enable customers to reduce or shift peak load during extreme heat events. Some of these approaches can provide energy in an emergency and reduce the impact and/or duration of outages while others seek to reduce energy demand thus reducing strain on the system in periods of extreme heat.

The approach to the scope of work for each of the customer-sited strategies (DG, microgrid, DR, EE, EVs) is generally the same. WG2 proposes to (1) identify technologies/solutions/opportunities, (2) review prior reports and studies, (3) undertake application of a cost-effectiveness methodology, (4) review potential benefits of strategic siting and targeting, and (5) identify regulatory issues.

The scope of work for time-differentiated pricing is somewhat different. WG2 proposes to (1) identify the feasibility of various types of time-differentiated pricing and rate structures, both in terms of regulatory and cost issues and barriers to wider customer acceptance; and (2) seek to leverage existing technologies and resources, including the potential to extract AMI functionality from existing AMR meters on a pilot scale in Westchester County and/or the Bronx, consider the feasibility of mandatory Time of Use meters for EVs, and of enhancing the effectiveness of existing programs for direct utility control of room air conditioners.

With respect to a cost-effectiveness methodology, as noted above, WG2 proposes to coordinate its efforts with the methodology being developed in WG4. With respect to all of these issues, WG2's efforts will be informed by various parallel state proceedings including, but not limited to, the Public Service Commission's decision in the within Con Edison rate cases; the NYSERDA Microgrid Report, projected for April 2014, and the Commission's reaction thereto; and the ongoing Commission proceedings addressing energy efficiency, renewable energy, the Green Bank, and plug-in electric vehicles. Moreover, nothing in this draft is intended to delay the Commission's resolution of the foregoing proceedings.

Schedule

Phase 1. WG2 completed its Scope/Workplan/Schedule for inclusion in Con Edison's report on the activities of the Collaborative.

Phase 2. WG2 proposes to implement its Workplan, as informed by the PSC's decision in the rate case, by (1) refining the alternative resiliency strategies for analysis within two months of the PSC's decision in the rate case, (2) assessing and ranking cost-effectiveness of selected alternative resiliency strategies within six months of the PSC's decision in the rate case, as informed by WG4, and (3) identifying cost-effective resiliency strategies within eleven months of the PSC's decision in the rate case.

Appendix E: Working Group 3 Scope of Work (Phase 2)

Working Group 3/Natural Gas Resiliency 2014 Project Proposal

Over the past several months, Collaborative Working Group 3 has met and discussed proposals to reduce methane leakage from Con Edison's natural gas distribution system to mitigate global greenhouse gas emissions, consistent with efforts to reduce the severity and frequency of climate change-induced extreme weather

One topic of interest to Working Group 3 is the status of Type 3 leaks.[43] Con Edison's year-end 2012 Type 3 leak backlog was 997 leaks. Currently, the time within which natural gas leaks are repaired is based on a safety classification of the leak, and Type 3 leaks do not require repair within a specified period of time (provided the leak is inspected periodically). Further, the quantity of natural gas emitted to the atmosphere through Type 3 leaks is unknown.

Working Group 3 proposes (1) to study and quantify the leakage rate of known Type 3 leaks and (2) to develop and submit to the Commission a proposed program for reducing the backlog of those leaks.

Quantifying methane emissions from Type 3 leaks and reducing their system-wide backlog accomplishes the dual resiliency goals of improving system integrity and mitigating the system's climate footprint.

Understanding the magnitude of Type 3 leaks will help prioritize their repair and provide metrics on the climate impact of those repairs. A program to reduce the backlog of Class 3 leaks would contribute to the mitigation of global greenhouse gas emissions. The evaluation of technologies for quantifying emissions from existing Type 3 leaks will support ongoing initiatives to quantify natural gas leaks on local gas distribution systems. Con Edison's implementation of a greenhouse gas emissions program would remain separate and distinct from the Company's existing gas safety program which would continue to have the highest priority.

To that end, Working Group 3 proposes the following project:

- Investigate and identify technologies that are capable of quantifying emissions from individual, existing Type 3 leaks on Con Edison's gas distribution system based on a natural gas emissions rate (cubic feet per hour) as part of a broader effort to develop a strategic prioritization plan for the repair of such leaks;
- Review the estimated emissions reduction and cost required to achieve such reduction;
- Develop a strategic prioritization plan for the repair of such leaks; and
- Make recommendations on a possible leak backlog emissions reduction program.

[43] A Type 3 leak is a gas main leak that is not immediately hazardous at the time of detection and can be reasonably expected to remain that way. Type 3 leaks are reevaluated annually at a minimum, and do not require a scheduled repair.

Approximate Timeline

- 3 months: Study workplan with methodologies;
- 9 months: Progress report to PSC;
- 15 months: Complete study;
- 18 months: Final report to the PSC with results of study and recommendations/proposals.

Structure

- Participants include Consolidated Edison, Environmental Defense Fund, [other stakeholders];
- Regular meetings to discuss progress and emerging issues.

Appendix F: Working Group 4 Scope of Work (Phase 2)

Working Group 4 “Risk Assessment / Cost Benefit Analysis” is tasked with developing analytical tools for assessing the merits of the Company’s storm hardening projects. The goal of these projects is to lessen the impact of severe events on Con Edison’s customers and systems.

In Phase 1, Working Group 4 focused on the risk assessment and prioritization model. In Phase 2 Working Group 4 is targeting its long term goal by attempting to develop a formal economic cost/value model that can be applied to the storm hardening projects that were examined in the working group’s risk assessment and prioritization model developed during Phase 1.

Quantification of economic benefits (avoided economic costs when an outage is prevented or shortened), is intended to reflect the full societal cost of an outage and would be compared, on a project by project basis, to the corresponding costs of each resiliency effort. Derivative cost/value ratios, or the development of net benefit values, can then be used as a measure of a project’s merit from a purely cost based perspective. These ratios, or net benefits, can be ranked from most-to-least cost beneficial, providing another method for prioritizing resiliency projects. Further, a simple comparison of any ratio to the break-even value of 1.00 results in an immediate indication of whether a project is, or is not, cost beneficial.

Approaching program evaluation in this manner is innovative for the utility industry. Traditionally, capital investment decisions have been based on the most cost effective manner to reduce risk on the power systems. Underlying each of the final programs is a least cost review of alternate proposals. In every case, program alternates are identified and considered based on specific system requirements. Each of these potential solutions are examined and priced out in what is ultimately a final convergence to the optimal lowest cost solution.

Since this cost-value effort represents a new approach in quantifying the value of utility investments, there are a number of areas that will require additional investigation and data to allow for the construction of a model that reasonably reflects the nature of the full societal cost of power outages and the design decisions behind the development of programs to lessen those outages. The issue here is not the conceptual framing of the process, but rather, the identification of measurable variables to adequately represent those concepts.

An interactive synthesis of Working Group knowledge and topical literature research has provided some fundamental guidance in isolating quantities that can contribute to an estimate of societal costs. These ideas will be used as a starting point in this investigation.

In assembling the numeric data to support a formal economic cost/value approach, one area of investigation involves characterization of specific customer populations and consumption patterns defined by service class (e.g., residential, small commercial, large commercial, transportation, etc.). Some foundational information has already been collected through the process of refining the risk assessment and prioritization model. The specific data being used in the risk assessment and prioritization approach, detailed above for that effort, remains available for inclusion into the formal economic cost-value model.

Proprietary data not immediately required for the risk assessment and prioritization effort, but potentially useful for the economic cost/value effort, has also been culled.

Some of the additional information includes: customer annual consumption; customer counts; residential population per high rise residential building; distribution network and load area geographic footprints; and population density.

Each of these quantities was categorized further by service class and by the Con Edison transmission, substation, and distribution assets serving those segmentations.

As indicated in working group and internal discussions and in review of previous studies, the economic impact of power outages can vary for different types of customers, and tend to be more substantial for large customers than for small customers. The existential import of power outage economic effects also differs dramatically depending on the type of customer under consideration (i.e., commercial or residential). To this end, the assembly of customer MWhrs and counts by service class referenced previously should provide a useful starting point in the evaluation of economic benefits of resiliency projects.

It is anticipated that the described level of data disaggregation would be geographically granular enough to support the development of net economic impacts to specific portions of the relevant power systems. Additionally, segmentation by customer type should appropriately reflect differences among different types of customers and the degree to which each group will benefit from the proposed resiliency programs or projects.

One area requiring further study will be the relationship of outage duration to societal-cost estimates. This relationship affects the accurate quantification of the benefits of resiliency projects that will shorten outages, and allows for more accurate comparison of the projects designed to prevent outages of different durations. When viewed from a number of perspectives, outage duration, again, appears to be a significant societal, experiential, and economic exacerbating factor in these events.

As a general rule, the longer an outage the greater the likelihood of lifestyle disruptions, economic loss, and potential safety concerns. Complicating this further is the fact that prior investigations indicate that duration impacts do not vary in a simple linear matter.

In other words, determining the societal impact of a multi-day outage is not directly computable from the multiplication of a single day outage, nor is the impact of a single day outage a simple multiplication of a single-hour outage. Depending on the customer sector, certain costs, and associated safety concerns, increase nonlinearly with outage duration.

Investigations and studies have been previously undertaken to measure and model the effects of outage duration on societal costs, but they are fundamentally survey based and service territory specific. Although some examples exist, cursory review of these investigations indicates a very wide range of cost estimates for narrowly defined outage types and geographic areas. Attempting to superimpose any conclusions drawn from these studies, in the absence of major caveats, onto the Con Edison service territory would be questionable at best.

Gathering data specific to Con Edison's service territory is crucial to adequately determining the economic impact of power outages. Accordingly, it appears that a customized survey instrument will need to be developed and used to obtain information from Con Edison's customers concerning the impact of outages of different durations, given their individual circumstances. That survey must satisfy statistical rigor and be coordinated by an agreed upon agency experienced in obtaining this type of data, so that the sample results can appropriately be generalized to the respective types of Con Edison's customers, and be incorporated into the economic cost-value model. The timeline and associated funding for this survey initiative will need to be determined with provision made for cost recovery by way of deferral, surcharge, or other method as may be approved by the Commission.

The benefits of improved resiliency are not necessarily limited to those directly experienced by customers. Con Edison can also experience benefits, which more indirectly benefit customers in the form of lower rates. For example, a successful resiliency project will reduce or eliminate the cost of repairing or replacing equipment which would have otherwise been damaged or destroyed by a storm. For this reason, the cost-value analysis should attempt to include any and all cost reductions that may result from the implementation of a program. This model should be able to factor in equipment repair and replacement costs, reduced outage restoration costs, labor cost reductions, and other operating cost savings that are expected to be achieved if the program/project is implemented.

In undertaking this analysis, all cost reductions (i.e., avoided costs) should be incorporated in a manner similar to which construction cost estimates are developed as inputs on the cost side of the equation, thereby allowing the benefits and costs to be directly compared in comparable terms.

Appendix G: Collaborative Presentation Materials

- Substation Flood Hardening Design Concepts:

  Substation Flood
  Hardening Design Co

- Substations and Generating Stations Flood Hardening Projects:

  Substations and
  Generation Stations F

- Coastal Network Flood Hardening Projects

  Coastal Network
  Flood Hardening Proj

- Overhead Distribution System Storm Hardening Projects:

  Overhead
  Distribution System S

- Gas System and Tunnels Flood Hardening Projects:

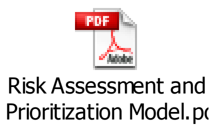
  Gas System and
  Tunnels Flood Harder

- Collaborative Information Requests:

  Staff's Collaborative
  Information Requests

- Generating Stations Flood Hardening Projects:

- Risk Assessment and Prioritization Model:



Appendix H: Project Details

Electric Substation Projects

Table 18: East 13 Street 138kV Substation/ East 13 Street 345kV Yard

Substation	East 13 Street 138kV Substation/ East 13 Street 345kV Yard
Necessity and Benefits	The loss of the East 13th St. substation during Sandy contributed to more than 220,000 customer outages in lower Manhattan for about four days. The installation of these flood-control storm hardening measures are intended to maintain the operation of the substation during tidal flooding conditions up to the design standard level.
2013 Measures Installed and Cost	• Concrete moat walls around relay houses • Concrete perimeter wall around 345kV Millhouse yard • Sump pumps in protected areas • Flood doors and louver barriers • Sealed conduit and trench penetrations with expansive foam $8.7 million
Additional Measures to Meet 2013 FEMA + 3 Feet	• Relocate control room to 2nd floor location • New Human Machine Interface (HMI) system • Lifting relay panels and relocated/elevated control cabinets • Elevated diesel generator • Circuit breakers to assist in rapid recovery
Incremental Measures Beyond Rate Case	None; project will meet FEMA plus three feet design standard upon completion. (Constraints on scheduling feeder outages required for installations of measures may extend project schedule into 2017/18 but scope will remain as indicated.)
Construction Start Date	2014
Project End Date	2017/2018
Total Project Costs (2014-2016)	$120.7 million

Alternatives Considered but Not Selected	<table><tr><th>Scope</th><th>Approx Cost</th><th>Reason Not Pursued</th></tr><tr><td>**New SF6 station on adjacent property**</td><td>$400.0 million</td><td>High cost, extended construction timeline, complicated feeders outage sequence to support construction</td></tr><tr><td>**Relocate four relay houses to 2nd floor of South Steam Station**</td><td>$32.0 million</td><td>Results in a single point of failure exposure for all relay houses and long runs of copper wiring exposed to flooding</td></tr><tr><td>**Relocate critical station equipment including pressurizing and cooling plants, relay houses, etc. to raised platforms**</td><td>$70.0 million</td><td>Spatial constraints within substation</td></tr></table>

Table 19: Goethals, Fresh Kills, and Gowanus Substations

Substations	**Goethals, Fresh Kills, and Gowanus Substations**
Necessity and Benefits	These stations were significantly damaged during Sandy and the loss of the Fresh Kills substation contributed to the shutdown of three Staten Island load areas for about half a day. Due to their location in less developed, open areas, a perimeter surge wall is the most effective protection method to maintain the operation of the substations during tidal flooding conditions up to the design standard level.
2013 Measures Installed and Cost	• Concrete moat walls around critical station equipment • Sump pumps in protected areas • Flood doors • Sealed conduit and trench penetrations with expansive foam $3.8 million (Goethals), $1.2 million (Fresh Kills), $2.9 million (Gowanus)
Additional Measures to Meet 2013 FEMA + 3 Feet	• Station perimeter sheet pile surge wall • Backup diesel generator • Pumps and redundant electric feeds
Incremental Measures Beyond Rate Case	None; project will meet FEMA plus three feet design standard upon completion
Construction Start Date	2014
Project End Date	2016

Total Project Costs (2014-2016)	$25.7 million (Goethals), $17.5 million (Fresh Kills), $14.7 million (Gowanus)
Alternatives Considered but Not Selected	

Scope	Approx Cost	Reason Not Pursued
Relocate critical station equipment including pressurizing and cooling plants, relay houses, control room, fiber optic room, etc. to raised platforms	$85.0 million per station	High cost, electrical clearance and spatial constraints, complicated feeder outage sequence to support construction
Perimeter wall with steel piles and a concrete retaining wall	Twice the cost of sheet piles	More expensive than sheet pile, pile driving equipment interferes with overhead electrical lines
Perimeter concrete secant pile wall	Six times the cost of sheet piles	More expensive and time consuming than sheet pile

Table 20: East River Substation and East 15th Street PURS

Substations	**East River Substation and East 15th Street PURS**
Necessity and Benefits	These stations were significantly damaged during Sandy. The loss of the East River substation during Sandy contributed to the 220,000 customer outages in lower Manhattan for about four days. The installation of these flood-control storm hardening measures are intended to maintain the operation of the substations during tidal flooding conditions up to the design standard level.
2013 Measures Installed and Cost	• Concrete moat walls around critical station equipment • Sump pumps in protected areas • Flood doors • Sealed conduit and trench penetrations with expansive foam $2.5 million (East River), $1.3 million (East 15th Street)
Additional Measures to Meet 2013 FEMA + 3 Feet	• Lifting relay panels and relocated/elevated control cabinets • Elevated diesel generator • Pumps and redundant electric feeds • Raised walls and flood barriers • Relocate critical equipment to raised platforms
Incremental Measures Beyond Rate Case	None; project will meet FEMA plus three feet design standard upon completion

Construction Start Date	2014
Project End Date	2016
Total Project Costs (2014-2016)	\$9.8 million (East River), \$9.2 million (E. 15th Street)
Alternatives Considered but Not Selected	<table><tr><th>Scope</th><th>Approx Cost</th><th>Reason Not Pursued</th></tr><tr><td>Relocate critical station equipment to higher elevations</td><td>$85.0 million</td><td>Potential extensive feeder outages required to support construction. Spatial construction constraints.</td></tr><tr><td>Raising cooling plants in addition to proposed scope</td><td>$12.5 million</td><td>Potential extensive feeder outages required to support construction. Feeder would need to be derated. Spatial construction constraints.</td></tr></table>

Table 21: East 36th Street, Seaport and Trade Center Substations

Substations	**East 36th Street, Seaport and Trade Center Substations**
Necessity and Benefits	These stations were significantly damaged during Sandy. The loss of the Seaport area substation during Sandy caused the shutdown of the Cortlandt network with about 2,000 customers in lower Manhattan for nearly two days. The installation of these storm hardening measures are intended to maintain the operation of the substations during tidal flooding conditions up to the design standard level.
2013 Measures Installed and Cost	• Sump pumps in protected areas • Flood doors and barriers at station openings • Sealed conduit and trench penetrations with expansive foam \$1.4 million (East 36th Street), \$1.6 million (Seaport), \$1.0M (Trade Center)
Additional Measures to Meet 2013 FEMA + 3 Feet	• Relocated/elevated electrical equipment and control cabinets • Elevated diesel generator • Pumps and redundant electric feeds • Raised flood barriers
Incremental Measures Beyond Rate Case	None; project will meet FEMA plus three feet design standard upon completion
Construction Start Date	2014

Project End Date	2016
Total Project Costs (2014-2016)	$3.0 million (East 36th Street), $2.6 million (Seaport), $1.5 million (Trade Center)
Alternatives Considered but Not Selected	<table><tr><th>Scope</th><th>Approx Cost</th><th>Reason Not Pursued</th></tr><tr><td>Raise switchgear, circuit switcher controls, etc.</td><td>$8.0 million</td><td>Potential extensive feeder outages required to support construction. Spatial construction constraints. Interior construction in active substation (vibration, dust and environmental concerns) not preferred.</td></tr><tr><td>Make pressurizing plant in cellar submersible (TC)</td><td>$4.0 million</td><td>More expensive than the proposed solution. Unique equipment requirements.</td></tr></table>

Table 22: Hellgate, Bruckner and Sherman Creek Substations

Substations	**Hellgate, Bruckner and Sherman Creek Substations**
Necessity and Benefits	These stations did not experience significant operating impact during Sandy. There was some flood water seen at each of the facilities, but it was not significant enough to damage station equipment. This was primarily due to the timing of the storm. If a similar storm hit the NYC area at a time coinciding with high tide near the Bronx, these stations would have experienced a higher level of impact and extensive damage to critical equipment. This could result in extended customer outages in the Bronx and Upper Manhattan areas. Therefore, these substations are being storm hardened to mitigate this risk.
2013 Measures Installed and Cost	None; locations were not addressed in 2013 work scope
Additional Measures to Meet 2013 FEMA + 3 Feet	• Concrete flood walls around station perimeter and/or specific critical equipment • New flood doors and barriers • Flood pumps with redundant electrical feeds • Sealed conduit and trench penetrations with expansive foam
Incremental Measures Beyond Rate Case	None; project will meet FEMA plus three feet design standard upon completion

Construction Start Date	2015
Project End Date	2016
Total Project Costs (2014-2016)	$6.35 million (Hellgate/Bruckner), $6.05 million (Sherman Creek)
Alternatives Considered but Not Selected	Full work scopes and alternatives are still in development as the projects are not scheduled to begin until 2015. Alternatives that may be considered include raising critical station equipment including control room, relay houses, pressurizing plants, fiber optic room, etc. These are expected to be high-cost, long –duration alternatives.

Table 23: Farragut, Rainey, Vernon, Leonard Street and Avenue A Substations

Substations	**Farragut, Rainey, Vernon, Leonard Street and Avenue A Substations**
Necessity and Benefits	These stations did not experience any impact during Sandy. Following the establishment of the June 2013 FEMA 100-yr floodplain plus three feet design standard, these stations were identified as at risk under the new flood control level. They have therefore been incorporated into the storm hardening program to maintain the operation of the substations during tidal flooding conditions up to the design standard level.
2013 Measures Installed and Cost	None; locations were not addressed in 2013 work scope.
Additional Measures to Meet 2013 FEMA + 3 Feet	• Station perimeter protection (pre-cast flood walls or existing perimeter reinforcement) • New flood doors and barriers • Sealed conduit and trench penetrations with expansive foam
Incremental Measures Beyond Rate Case	None identified at this time; full work scope still in development as locations were recently identified
Construction Start Date	2014
Project End Date	2016
Total Project Costs (2014-2016)	$2.9 million to address all stations subject to development of project work scopes

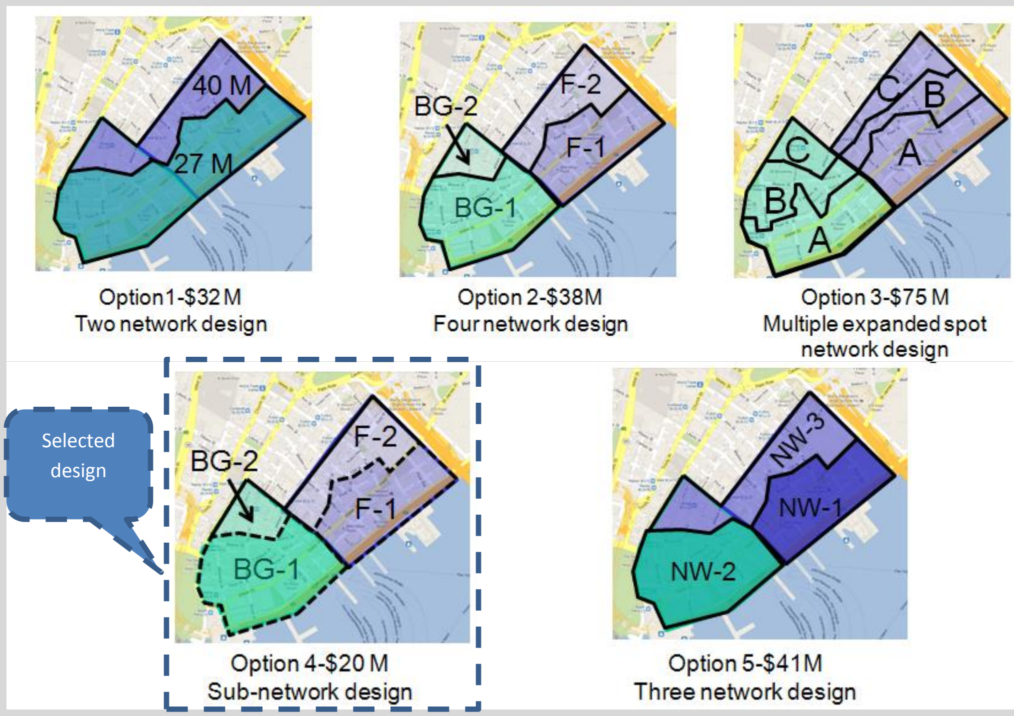
Alternatives Considered but Not Selected	Full work scopes and alternatives are still in development as these facilities were not identified for storm hardening until recently. Alternatives that may be considered include installing sheet pile walls. This is expected to be a higher-cost, longer-duration alternative.

Electric Network Distribution System Projects

Table 24: Bowling Green and Fulton Networks Reconfiguration

Project Description	**Bowling Green and Fulton Networks Reconfiguration**: Divide each network into two smaller sub-networks to allow for flood areas to be shut down during flooding.
Necessity and Benefits	As a result of the potential fire hazard created when a 460 volt installation is submerged in salt water, Bowling Green and Fulton Networks were preemptively shut down. In the Fulton network 20 of 24 feeders supply 460V critical equipment in flood prone area. In the Bowling Green network 16 of 18 feeders supply 460V critical equipment in flood prone area. Following Sandy, it took five days to restore service to the networks with a minimum number of energized feeders. To restore service, the Company had to manually block open 261 network protector switches and separate 51 transformers from feeder supply. About 28% of the switches in each network were replaced. Over half of the customers in those networks are outside of the flood zone and experienced no flood damage, including the New York Downtown Hospital on Gold Street and the New York Stock Exchange on Wall Street. Of the 6,553 customers in Bowling Green and Fulton networks, approximately half are in flood zones. To avoid entirely shutting down the Fulton and Bowling Green networks during a future flood event, we will install 21 isolation switches on network feeders in these two networks to allow the isolation of vulnerable zones while keeping the customers on higher ground in service. Opening the switches in advance of a flood event, will divide each network into an area that will remain energized and an area that will be de-energized. The net effect is that approximately half of the customers will remain in service, including the Stock Exchange and Downtown NY Hospital. This requires a new secondary boundary within the network and reinforcement of secondary and primary cable both to facilitate the de-energization plan and to expedite restoration as flood waters recede in the network and customers are ready to be restored.
2013 Measures Installed and Cost	We are on track to install 8 of the 21 switches needed for this design by the end of 2013. $8.0 million
Additional Measures to Meet 2013 FEMA + 3 Feet	The secondary cable cuts that will reconfigure the network were originally designed to minimize cost and maximize the benefits to customers that are on higher ground. The initial selection of the most cost effective boundary placed the boundary above the FEMA plus three feet standard.

Incremental Measures Beyond Rate Case	None.
Construction Start Date	2013
Project End Date	2014
Total Project Costs (2014-2016)	$21.0 million ($16 million in 2014)
Alternatives Considered but Not Selected	The Engineering team developed five proposals and cost estimates ranging from $20 million to $75 million to evaluate the best option both to ensure that customers outside of the 100 year flood zone remain in service and restore the impacted portion of the network more quickly. Examples of these proposals are seen in the figure below. Four of these options would result in permanent, non-flexible network boundaries producing a similar system design that is currently in place today and would result in a pre-emptive shut down of the entire network in advance of a storm. The use of submersible underground automatic smart switches is the most cost-effective and flexible option. It will allow operators to reconfigure the network and physically separate the flood prone area from the non-flood area leaving half of the customer in service including critical customers such as Downtown New York Hospital, the Federal Reserve, and the New York Stock Exchange.



Option1-$32 M
Two network design

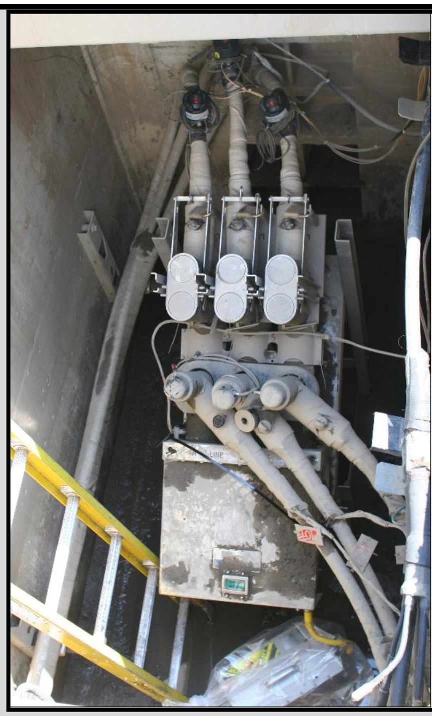
Option 2-$38M
Four network design

Option 3-$75 M
Multiple expanded spot network design

Option 4-$20 M
Sub-network design

Option 5-$41M
Three network design

Table 25: High Tension Customer Isolation Switches

Project Description	 **Switches to Isolate Customer Equipment in Nine Manhattan Networks**: Install isolation switches on primary distribution feeders to remove high tension customers automatically from the system to protect feeders from failing due to customer equipment faults due to flooding.

Necessity and Benefits	The installation of primary vacuum switches will protect network feeders from de-energizing due to faults on HTV customer equipment during a flood event. This is essential because as feeders in a network de-energize, the remaining feeders take up the network load that was carried by the de-energized feeders creating the potential for overloading those feeders with cascading effects. Had Sandy happened on a hotter day, with more load on the system, the open autos (or feeders taken out of service automatically by protection relays) that occurred as a result of HTV customer equipment faults could have required Con Edison to shut down other networks to avoid cascading feeder failures. Additionally, if the flooding had been worse, more feeders could have opened, also placing the networks in jeopardy. The installation of switches will isolate high tension vaults from network supply feeders in flood zones and prevent feeder outages if the high tension equipment is flooded. We have identified 70 such locations throughout the network system that require isolation during a flood. These switches will be installed in the following networks:

	Isolation Switches	
Network	**Category 1**	**Category 2**
4M (Grand Central)	2	0
7M (Cooper Square)	6	0
14M (Randalls Island)	0	8
16M (Pennsylvania)	0	16
18M (Battery Park)	5	16
31M (Roosevelt)	2	0
39M (Hudson)	3	3
41M (Freedom)	4	0
43M (Kips Bay)	0	5
Total	**22**	**48**

2013 Measures Installed and Cost	None of the HTV isolation switches have been, or will be installed in 2013.
Additional Measures to Meet 2013 FEMA + 3 Feet	The original plan was designed using SLOSH flood zones 1 and 2; the 2013 FEMA +3 feet flood level excludes one of these installations, thus the total scope of this project will be 69 isolation switches.
Incremental Measures Beyond Rate Case	One less switch will be installed than originally planned: -$1.0 Million
Construction Start Date	1Q 2014
Project End Date	4Q 2016

Total Project Costs	$70.0 million. Typically, the installation of the isolation switch requires construction of a new underground structure and the installation of primary and secondary conduit and associated cable, as well as the equipment for the remote operation of the isolation switch. Based on an average cost of $1.0 million per installation, the total cost for the 70 isolation switches is estimated to be $70.0 million. We plan to install 24 switches in 2014 ($24.0 million), 23 switches in 2015 ($23.0 million), and 23 switches in 2016 ($23.0 million).
Alternatives Considered but Not Selected	We currently do not have another option available to remotely isolate a HTV customer.

Table 26: Submersible Equipment (460 Volt and 120 Volt Network Protectors and Transformers)

Project Description	 **Submersible 120/208 Volt Transformers and 460Volt Network Protectors**: To reduce outage time by eliminating the need to replace damaged equipment, all network protectors and transformers (on 120 V and 460 V installations) in the flood zone will be replaced with submersible equipment.

Necessity and Benefits	If non-submersible equipment is exposed to water while energized, it can cause internal failure, and threaten the integrity of distribution feeders and their associated networks. Moreover, exposing energized equipment to water also could create a stray voltage hazard to personnel, such as first responders, exposed to floodwaters. In addition, the exposure of non-submersible equipment to corrosive salt water — whether energized or not — would result in significant damage to exposed parts, such as relays and motors. The need to repair or replace these damaged parts will lengthen the process of restoring networks to normal operating condition. To mitigate these risks, and make our low-lying networks even more resilient, we are implementing two hardening projects to install submersible equipment. Currently, Con Edison's 265/460 Volt equipment consists of a submersible transformer and a separate network protector that is not submersible and therefore vulnerable in flood conditions. The Company's 120/208 Volt units also contain some network protectors that are not submersible. Before Sandy, the Company had been installing submersible equipment in flood-prone areas only when new equipment was needed. As a result of Sandy, we are accelerating our underground equipment replacement program in two ways: (1) All 265/460 Volt units in flood zones will receive new, water-resistant network protectors. During flood events, these units will be de-energized through a combination of targeted feeder outages and the installation of flood switches. (2) All non-submersible 120/208 Volt transformer/network protector units in flood zones will be replaced with submersible units. We will remove both the transformer and protector by installing a transformer with an attached protector as a single submersible unit.
2013 Measures Installed and Cost	We are on track to install 100 120V and 10 460V submersible switches in 2013 at a cost of $150,000 and $100,000 per unit, respectively.
Additional Measures to Meet 2013 FEMA + 3 Feet	724 120 Volt and 325 460 Volt Transformers are in this floodplain, reducing the overall number of units.
Incremental Measures Beyond Rate Case	None.
Construction Start Date	2013 We plan to install about 65 submersible 120/208 Volt transformer/network protector units in 2013 ($10.0 million) (the unit cost is $150,000). We plan to install 10 265/460 Volt submersible network protector units in 2013 ($1.0 million) (the unit cost is $100,000).

Project End Date	This is an ongoing targeted program that we plan to continue beyond 2016 until all non-submersible units in the network flood plains are replaced. In addition, we plan to continue to replace units beyond the flood zone on a failure basis, with the end goal to have all of our transformers and network protectors on ground level changed to the submersible type.
Total Project Costs (2014-2016)	2014 to 2016 cost: $185 million We plan to install 150 submersible 120/208 Volt transformer/network protector units in 2014 ($22.5 million), 150 units in 2015 ($22.5 million), and 100 units in 2016 ($15 million). We plan to install 100 265/460 Volt submersible network protector units in 2014 ($10 million), 150 units in 2015 ($15 million), and 140 units in 2016 ($14 million).
Alternatives Considered but Not Selected	We developed a new submersible 460 V network protector to achieve this goal. Outside of alternative designs vetted by our vendor, no other alternatives are available.

Electric Overhead Distribution System Projects

Table 27: Reduce Circuit Segment Size

Project Description	 Reduce Circuit Segment Size: Our overhead system upgrade plan will reduce storm impact to customers by reducing the number of customers served by a single overhead circuit to fewer than 500 customers where practical. Specifically, we plan to take the following actions: • Deploy vacuum reclosers at 131 locations. These are intelligent switches that can automatically detect faults and isolate portions of feeders without operator intervention. • Install Supervisory Control and Data Acquisition (SCADA) enabled switches at 424 locations. These switches, called gang switches, are remotely controlled sectionalizing devices providing real time information that allows operators to determine the location of a fault and remotely isolate damaged sections. Having specific information on where the fault is also allows our operators to narrow down where on our system a repair may be needed.
Necessity and Benefits	By making this change, we will reduce the number of customers that are affected as a result of a single point of damage on the system. We have identified approximately 740 locations to deploy additional automatic devices that reduce segment size and the number of customers served.
2013 Measures Installed and Cost	We plan to install 30 vacuum reclosers in 2013 costing $1.5 million (the unit cost is $50,000). We plan to install 50 SCADA-ready gang switches in 2013 costing $2.5 million (the unit cost is $50,000).

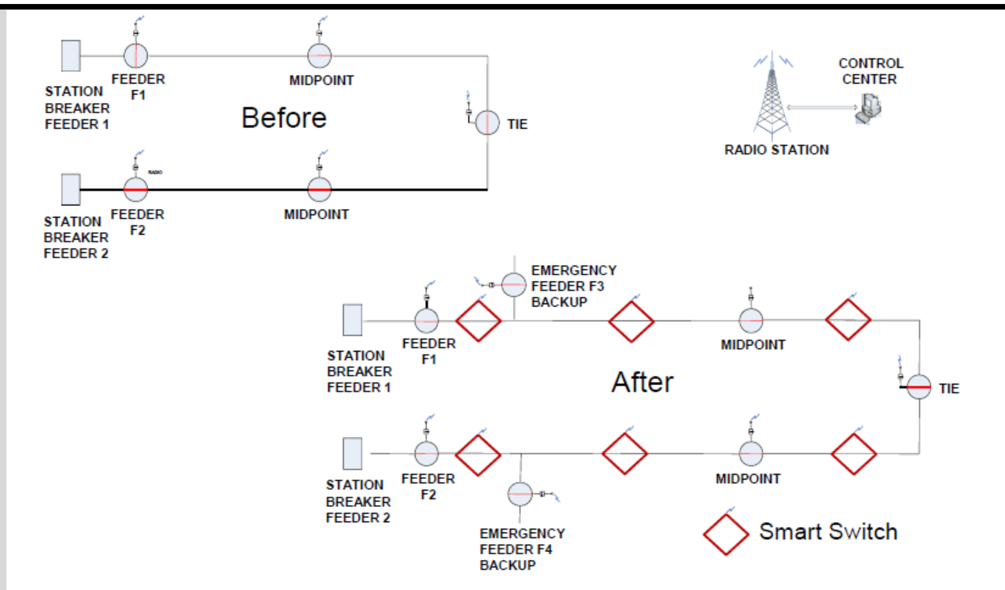
Additional Measures to Meet 2013 FEMA + 3 Feet	Not applicable
Incremental Measures Beyond Rate Case	None
Construction Start Date	2013
Project End Date	2016
Total Project Costs (2014-2016)	$19.0 million We plan to install vacuum reclosers at 113 locations at a cost of $50,000 per recloser ($5,650,000). We plan to install 30 units in 2013 ($1.5 million), 27 units in 2014 ($1.35 million), 36 units in 2015 ($1.8 million), and 20 units in 2016 ($1.0 million). We plan to install SCADA-ready gang switches at 350 locations at a cost of $50,000 per switch ($17,500,000). We plan to install 50 units in 2013 ($2.5 million), 80 units in 2014 ($4.0 million), 132 units in 2015 ($6.6 million), and 88 units in 2016 ($4.4 million). We plan to install additional units after 2016.
Alternatives Considered but Not Selected	

Table 28: Isolation of Open Spurs from Main Feeder Runs

Project Description	 **Isolation of Open Spurs from Main Feeder Runs**: Installation of isolation fusing units to prevent downstream damage impacting upstream customers. We have identified 4,000 locations for fusing of our circuits.
Necessity and Benefits	Our overhead distribution system relies on a combination of main feeder lines and smaller spurs off of the main line to distribute power throughout a neighborhood. Usually the spurs — some of which have their own sub-spurs — are strung with open wire. Open wires are generally more vulnerable to damage from contact with trees and other debris than insulated wires. In some cases, damage or faults on an open wire spur can flow up to the main feeder line, potentially causing outages for many more customers down the main line. To reduce the risk that damage on vulnerable open wire spurs will affect customers served from main feeder lines, fuses, fuse bypass switches and automatic sectionalizing switches will be added to spurs and sub-spurs with open wire that are more than 2 spans in length (i.e., the distance between three utility poles). Once the devices are installed, customers in overhead areas will be less likely to experience power outages as a result of damage to lines in other parts of their neighborhood.
2013 Measures Installed and Cost	We plan to install 3,000 isolation fusing units in 2013 at a cost of $9.0 million.

Additional Measures to Meet 2013 FEMA + 3 Feet	Not applicable
Incremental Measures Beyond Rate Case	None
Construction Start Date	2013
Project End Date	2014
Total Project Costs (2014-2016)	$3.0 million We plan to install approximately 3,000 units in 2013 with an average unit cost of $3,000 per location ($9.0 million) and the remaining approximately 1,000 units in 2014 with an average unit cost of $3,000 per location ($3.0 million).
Alternatives Considered but Not Selected	

Table 29: Auto-loop Reliability Improvement

<table>
<tr><td>Project Description</td><td>

Auto-loop Reliability Improvement: We plan to improve the reliability of our existing auto-loops — looped circuits that are fed power from both ends. The following measures will be implemented to improve auto-loop design:

Introduce additional supply feeders to allow for continued service during feeder outages by allowing power to be fed not only from both ends, but also from other points along the feeder circuit;
Divide large auto-loops into several smaller loops;
Upgrade wire and pole sizes to improve storm resiliency. Require poles in storm outage-prone areas to be 15 percent stronger and able to withstand gusts up to 110 miles per hour;
Use Aerial Cable, which is more resilient than traditional open wire design;
Implement so-called “sacrificial components,” such as breakaway hardware and detachable service cable and equipment, to reduce pole and customer equipment damage during storms

We plan to address the following auto-loops in Con Edison’s service area: Armonk loop in Westchester; Yonkers loop in Westchester; Riverdale loop in the Bronx; Graves End loop in Brooklyn; and Marine Park loop in Brooklyn.</td></tr>
<tr><td>Necessity and Benefits</td><td>Improving auto-loop reliability will:

Allow for continued service during feeder outages;
Minimize outages through more resilient cable and poles; and
Improve restoration time through breakaway hardware that reduces equipment damage.
</td></tr>
<tr><td>2013 Measures Installed and Cost</td><td>The Company is spending approximately $5.0 million in 2013 to upgrade auto-loop reliability.</td></tr>
</table>

Additional Measures to Meet 2013 FEMA + 3 Feet	Not applicable
Incremental Measures Beyond Rate Case	The company has about 140 auto-loops, Auto-loop reliability upgrade work is an ongoing program that will continue beyond 2016
Construction Start Date	2013
Project End Date	Ongoing program
Total Project Costs (2014-2016)	$20.0 million (about $6.6 million per year)
Alternatives Considered but Not Selected	

Table 30: Selective Undergrounding of the Overhead System Infrastructure

Project Description	 **Selective Undergrounding of the Overhead System Infrastructure**: This program will replace portions of the overhead system infrastructure with underground equipment in order to prevent damage from falling trees and tree limbs during wind events. The program will focus on undergrounding (1) feeders supplying areas that have experienced the highest storm-damage impact and (2) feeders supplying facilities that support vital community functions following severe storms, such as hospitals, police and fire stations, schools, and stores that sell basic necessities, such as food, medicine, gasoline, and building supplies. During 2013, the Company has been meeting with the City of New York and the municipalities we serve in Westchester County to explain the Company's selective undergrounding program and ask the municipalities to identify buildings and locations that are critical to the local government and community. By the end of 2013, we intend to compile a prioritized list of critical locations within each municipality for use in selecting circuits for undergrounding. In parallel, the Company is establishing an objective ranking of feeders based on past performance, current condition of infrastructure, and the potential for future problems. The feeder ranking will be used along with the prioritized critical location listing to select locations for undergrounding feeder sections and the order of work.

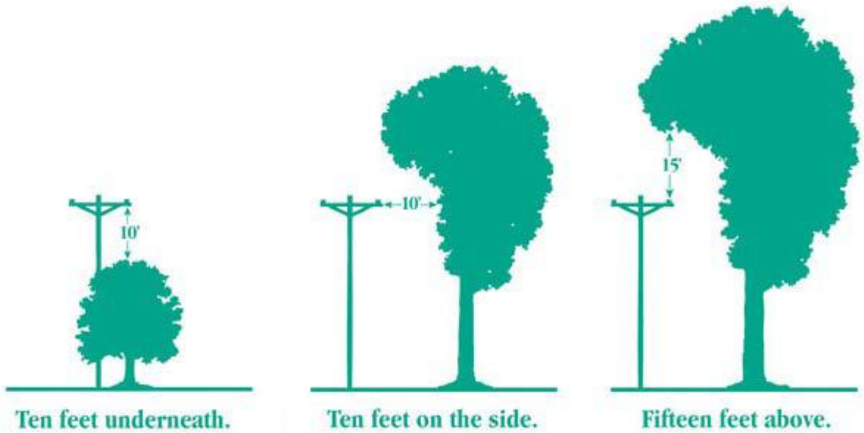
Necessity and Benefits	During the most recent coastal storms such as Irene and Sandy, the Company's overhead distribution suffered damage in the range of 0.33% to 1.84% of its total transformer population, 0.05% to 0.49% of its total poles, 0.09% to 0.42% of its total overhead wire. The number of overhead customers interrupted companywide during Irene was approximately 203,000, a record at that time, and that record was broken when Sandy hit interrupting approximately 604,600 total customers, which is 70% of the total overhead system customers. The repair times associated with each discrete damage point vary from an average three hours to put up a new span of wire or transformers to an average of 6 hours to replace a pole. Although the total damage to the Con Edison infrastructure overall is relatively small, the impact on our customers is tremendous, thus giving rise to the need for the Company to improve its resiliency. Parts of New York City and Westchester County are so heavily wooded and vulnerable to wind storm damage that the installation of protective measures on overhead power lines will be of limited value in maintaining continuous electric service during a severe wind storm. We plan to underground feeders on a selective basis in order to optimize the benefits of these expenditures. We expect to focus on feeders supplying areas that have experienced the highest storm damage impact and feeders supplying facilities that are critical to maintain vital community services following severe storms, such as police and fire stations, schools, and shopping (food, gasoline, building supplies).
2013 Measures Installed and Cost	During 2013, the Company has been conferring with local governments to determine potential undergrounding areas. The Company has met with The City of New York and the municipalities in Westchester to identify vital municipal and community locations. The Company is currently performing an analysis of the overhead distribution system to prioritize circuits and segments for undergrounding. Selection and design work for specific 2015 undergrounding projects will take place in 2014 and in 2015 for projects to be performed in 2016.
Additional Measures to Meet 2013 FEMA + 3 Feet	Not applicable
Incremental Measures Beyond Rate Case	None.
Construction Start Date	1Q 2015
Project End Date	Ongoing through 2016

Total Project Costs (2014-2016)	The program cost estimate of $200 million would allow Con Edison to underground approximately 25 miles of overhead circuits on a selective basis, providing meaningful benefits across our service area. We plan to perform this work in 2015 and 2016. We will continue to build and enhance our analytical and risk assessment processes to ensure we are optimizing our program to reduce risk, maximize benefits, and enhance customer service and response. We will continue to work with the City of New York and the Westchester County municipalities on circuit undergrounding plans and priorities.
Alternatives Considered but Not Selected	The cost to underground the entire overhead system is prohibitive. The current cost estimate is $43 billion for electric facilities alone and $65 billion including the cost for other utilities to relocate their facilities underground. In addition, homeowners and small businesses would bear a cost ranging from $10,000 to $25,000 per location to underground the actual service line to their home or business. The removal of all vegetation encroaching on the power lines would encounter resistance from local communities and in reality is not achievable. The Company will employ enhanced trimming in areas alongside its storm hardening work to optimize benefit with aesthetics and will conduct outreach within local communities to promote awareness, understanding, and support.

Vegetation Management[44]

We continue to proactively work with communities and local governments to trim trees and provide adequate clearance around overhead power lines, making it less likely that customers will experience outages during storms both large and small. In New York City we trim six feet to the side, six feet below, and 10 feet above our wires. In the five boroughs, trimming occurs on a two-year cycle for higher-voltage distribution wires (27KV and 33 KV) and a three-year cycle for lower-voltage distributions (4KV and 13KV). In Westchester, we have trimmed to 10 feet to the side, 10 feet below, and 15 feet above our wires on a three-year cycle for all voltages, since 2007. These standards reflected generally accepted industry best practices for the Northeastern United States, taking into account both the types of trees that grow here and the length of the growing season.

[44] Because the focus of Working Group 1 is capital resiliency projects that Con Edison plans to implement over the period of 2014 to 2016, the company did not present its Vegetation Management program to the working group. The company is including its Vegetation Management program in this report to provide a more complete prospective of the company's initiatives to improve the resiliency of its overhead electric distribution system.



Following the recent string of unprecedented storms and extensive damage to our overhead system caused by falling trees and limbs, we have implemented incremental vegetation management measures to reduce the likelihood that customers will experience outages.

We have taken the following steps to reduce the danger of tree damage:

- Started a “Hazard Tree” program in April 2013. The Company defines “Hazard Trees” as those that are tall enough to contact the overhead distribution system and are also dead, declining, diseased, or otherwise structurally unsound. Our inspectors, notification foresters, and contractor tree crews have been instructed to be more aggressive in identifying Hazard Trees that are rooted outside of our normal maintenance boundaries. We will then work with landowners to find agreeable solutions. All tree removals require written landowner authorization.
- Instituted a new Branch Reduction program and training module. The underlying concept of this program is to view limbs as levers that can be pulled down by snow, ice, or wind stresses. By proactively shortening the length, we can reduce the likelihood that a branch will break under weather stresses. Training for company employees and contractors in this new method is underway.
- Released a mailing to customers in North Castle, informing them of our plans to trim trees more aggressively and offering opportunities for feedback. We will also schedule community meetings to inform landowners of our plans to be more proactive in identifying hazardous trees and obtain their feedback.
- Started a study on Urban Tree Health and a Transmission Right of Way Hazard Tree Survey. We are also circulating a 2013 Vegetation Management Benchmarking Survey with other regional utilities to benchmark our vegetation management protocols and identify potential new best practices.

In addition, we are taking the following steps in 2013 and beyond:

- Meet with local municipalities, public works departments, and Shade Tree Commissions to explain the benefits of paying extra attention to vegetation management around infrastructure that is critical for the continued operations of municipalities. These ongoing outreach efforts garner support for increased tree trimming, which results in greater clearances.

- Consider revising Con Edison's engineering specifications to allow for increased tree clearance distances. We are actively pursuing support of this measure from the New York City and Westchester Parks Departments, NYC Planning Commission, NYC borough presidents, district presidents within NYC community boards, and Westchester County municipal boards and officials.
- Continue monitoring and improving our feeder segments that experience regular tree interference and are therefore more likely to have outage issues. The Company tracks tree-related outages and updates its list of worst-performing segments on a quarterly basis. We will continue to track these segments closely and patrol them to identify and preemptively mitigate areas of potential tree damage.

Electric and Steam Generating Stations Projects

Table 31: East River Generating Station

Project Description	**East River Generating Station Storm Hardening**
Necessity and Benefits	The East River Generating Station was shut down preemptively in advance of Sandy. The East River Generating Station and the steam distribution mains that emanate from the station are located in the coastal flood area. For safety reasons (potential water hammer event) the steam mains must be shut down preemptively prior to a coastal storm that is expected to result in flooding. When the steam mains are shut down, there is no outlet for the steam from East River Generating Station, and therefore the station must be shut down preemptively as well. Despite the preemptive shutdown, Sandy caused extensive damage to critical station equipment resulting in a delay returning the station to service. Storm hardening measures are critical to ensure the immediate recovery of the station and support for steam service in Manhattan.
2013 Measures Installed and Cost	• Concrete walls to contain water ingress from tunnels • Concrete walls around critical station equipment • Flood doors and barriers • Sealed penetrations and patching of walls and floors • Permanent diesel driven flood control pumps $9.7 million (Electric Generation), $0.2 million (Steam Generation)
Additional Measures to Meet 2013 FEMA + 3 Feet	• Relocate critical equipment • Permanent pumps and electric feeds for protected areas • Backup diesel generator • Sluice gates in discharge and intake tunnels • Reinforce existing station perimeter wall
Incremental Measures Beyond Rate Case	None; project will meet FEMA + three feet design standard upon completion
Construction Start Date	2014
Project End Date	2016
Total Project Costs (2014-2016)	Electric Generation: $55.5 million ($14 million in 2014); Steam Generation: $16.3 million ($4.8 million in 2014)

<table>
<tr><td rowspan="4">Alternatives Considered but Not Selected</td><td>Scope</td><td>Approx Cost</td><td>Reason Not Pursued</td></tr>
<tr><td>Install air filled bladders in all tunnels</td><td>$1.3 million annual desilting</td><td>Tunnels need to remain operational, but time to desilt and deploy bladders would interfere with operations. Annual desilting required to keep tunnel clear. Operationally not proven.</td></tr>
<tr><td>Raise or relocate all critical equipment in station basement</td><td>N/A</td><td>Not feasible. Insufficient space. Hydraulic requirements of the system won't allow moving certain equipment. Would require a full station redesign.</td></tr>
<tr><td>Install more, higher capacity pumps in lieu of raising concrete walls and flood barriers</td><td>$0.5 million per pump</td><td>Not a feasible option considering the potential volume of water. Number of pumps to meet design criteria would be extensive.</td></tr>
</table>

Table 32: 59th Street Generating Station

Project Description	**59th Street Generating Station Storm Hardening**
Necessity and Benefits	59th Street is one of the stations that are relied upon to maintain steam service during a storm event. During Sandy, the station was inundated with storm water and forced offline due to equipment damage. This contributed to the loss of hundreds of steam customers. The storm hardening measures for this station will limit the damage caused by storm water infiltration and ensure the station remains operable during a storm water inundation event.
2013 Measures Installed and Cost	• Concrete walls to compartmentalize vulnerable areas of station basement • Concrete walls around critical station equipment • Flood doors and barriers • Sealed penetrations and patching of walls and floors • Mobile diesel driven flood control pumps $4.6 million

Additional Measures to Meet 2013 FEMA + 3 Feet	• Relocate critical equipment and fire pump room • Permanent pumps and electric feeds for protected areas • Backup diesel generator • Sluice gates in discharge tunnels and blocking intake tunnels • New slab under service water pump platform
Incremental Measures Beyond Rate Case	None; project will meet FEMA plus three feet design standard upon completion
Construction Start Date	2014
Project End Date	2016
Total Project Costs (2014-2016)	$33.9 million ($10 million in 2014)
Alternatives Considered but Not Selected	

Scope	Approx Cost	Reason Not Pursued
Replace all 10 service water pumps with submersible motors and pumps	$20.0 million	Extensive costs for submersible pumps, motors, piping modifications and controls. Potential extensive outages required.
Install smaller sluice gates in 6 discharge branches to block water from entering the station	$40.0 million	Increasing the number of components increases the risk of failure. More expensive than one gate in primary tunnel.
Install air filled bladders in all tunnels	$2.0 million annual desilting	Tunnels need to remain operational, but time to desilt and deploy bladders would interfere with operations. Annual desilting required to keep tunnel clear. Operationally not proven.

Table 33: 74th Street Generating Station

Project Description	**74th Street Generating Station Storm Hardening**
Necessity and Benefits	74th Street is one of the stations that are relied upon to maintain steam service during a storm event. During Sandy, the station was inundated with water and forced offline due to equipment damage. This contributed to the loss of hundreds of steam customers. The storm hardening measures for this station will limit the damage caused by storm water infiltration and ensure the station remains operable during a storm water inundation event.
2013 Measures Installed and Cost	• Concrete walls to compartmentalize vulnerable areas of station basement • Concrete walls around critical station equipment • Flood doors and barriers • Sealed penetrations and patching of walls and floors • Mobile diesel driven flood control pumps $3.6 million
Additional Measures to Meet 2013 FEMA + 3 Feet	• Sealing intake and discharge tunnels • Relocate critical equipment • Permanent pumps and electric feeds for protected areas • Backup diesel generator • Reinforce and/or raise walls to higher flood protection level
Incremental Measures Beyond Rate Case	None; project will meet FEMA + three feet design standard upon completion
Construction Start Date	2014
Project End Date	2016
Total Project Costs (2014-2016)	$34.9 million ($10 million in 2014)

Alternatives Considered but Not Selected	<table><tr><th>Scope</th><th>Approx Cost</th><th>Reason Not Pursued</th></tr><tr><td>**Install air filled bladders in all tunnels**</td><td>$0.8 million annual desilting</td><td>Tunnels need to remain operational, but time to desilt and deploy bladders would interfere with operations. Annual desilting required to keep tunnel clear. Operationally not proven.</td></tr><tr><td>**Install more, higher capacity pumps in lieu of raising concrete walls and flood barriers**</td><td>$0.5 million per pump</td><td>Not a feasible option considering the potential volume of water. Number of pumps to meet design criteria would be extensive.</td></tr></table>

Table 34: 60th Street Generating Station

Project Description	**60th Street Generating Station Storm Hardening**
Necessity and Benefits	60th Street is one of the stations that are relied upon to maintain steam service during a storm event. During Sandy, the station experienced a small amount of flood water intrusion that did not significantly impact station operations. A difference in storm intensity or path and/or changes in the resulting flood level could cause severe impact at this station. The storm hardening measures for this station will protect to the new flood control elevation and will limit the damage caused by storm water infiltration and ensure the station remains operable during a storm water inundation event.
2013 Measures Installed and Cost	None; location was not addressed in 2013 work scope
Additional Measures to Meet 2013 FEMA + 3 Feet	• Seal penetrations • New flood doors and barriers • Valves and piping for pump discharge • Flood control pump
Incremental Measures Beyond Rate Case	None; project will meet FEMA + three feet design standard upon completion
Construction Start Date	2014
Project End Date	2015

Total Project Costs (2014-2016)	$3.0 million ($2 million in 2014)
Alternatives Considered but Not Selected	<table><tr><th>Scope</th><th>Approx Cost</th><th>Reason Not Pursued</th></tr><tr><td>**Install more, higher capacity pumps in lieu of protecting individual equipment**</td><td>$0.5 million per pump</td><td>Not a feasible option considering the potential volume of water. Number of pumps to meet design criteria would be extensive.</td></tr><tr><td>**Raise existing critical equipment to higher elevations**</td><td>$12.5 million</td><td>Significant cost. Space constraints. Potential structural loading issues. Would require complete piping reroute, as well as power and control wiring reroute. Hydraulics would need to be reevaluated.</td></tr></table>

Table 35: Ravenswood A House Generation Station

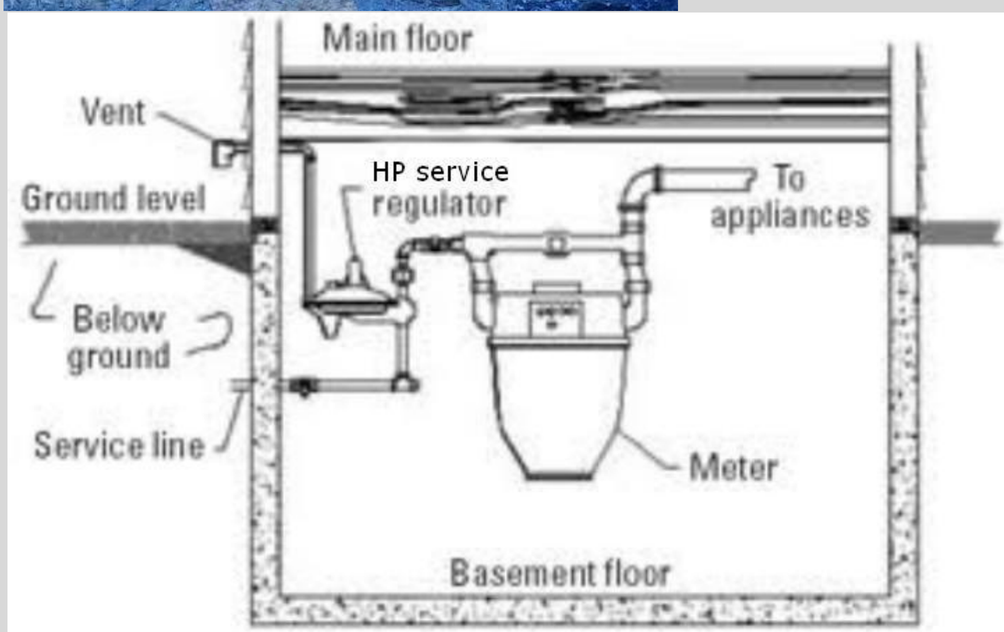
Project Description	**Ravenswood A House Generation Station Storm Hardening**
Necessity and Benefits	Ravenswood A House is one of the stations that are relied upon to maintain steam service during a storm event. During Sandy the station experienced some flood water intrusion that did not significantly impact station operations. A difference in storm intensity or path and/or changes in the resulting flood level could cause severe impact at this station. The storm hardening measures for this station will protect to the new flood control elevation and will limit the damage caused by storm water infiltration and ensure the station remains operable during a storm water inundation event.
2013 Measures Installed and Cost	None; location was not addressed in 2013 work scope
Additional Measures to Meet 2013 FEMA + 3 Feet	• Perimeter flood walls • New flood doors and barriers • Seal penetrations • Permanent pumps and electric feeds for protected areas • Backup diesel generator
Incremental Measures Beyond Rate Case	None; project will meet FEMA plus three feet design standard upon completion

Construction Start Date	2014
Project End Date	2015
Total Project Costs (2014-2016)	$3.0 million
Alternatives Considered but Not Selected	

Scope	Approx Cost	Reason Not Pursued
Install more, higher capacity pumps in lieu of raising concrete walls and flood barriers	$0.5 million per pump	Not a feasible option considering the potential volume of water. Number of pumps to meet design criteria would be extensive.
Raise existing critical equipment to higher elevations	N/A	There is not sufficient space for this alternative. Pursuing this would require a complete redesign of the station and new boiler fit out.

Gas System Projects

Table 36: Vent Line Protection ("VLP") Devices

Project Description	  **Vent Line Protection ("VLP") Devices**: Install approximately 10,000 vent line protection devices that prevent over-pressurization of customers' internal gas equipment.

Necessity and Benefits	Water infiltration into the vent-line of high-pressure service could result in damage due to over-pressurization of downstream customer equipment. To mitigate the risk of over-pressurization during future flooding events, the Company plans to install vent-line protection devices, also called float check valves. These valves will prevent over-pressurization of the customer's internal gas equipment due to flooding by preventing water infiltration through the vent-line in a flood condition, and thus allow customers in flood-prone areas to retain their gas service during flood events. Following Sandy, we identified approximately 9,200 existing high-pressure services within 2003 SLOSH Category 1 through 4 hurricane flood zones that would benefit from this new hardening measure. We have since changed the selection standard to 2013 FEMA plus three feet and have identified approximately 3,700 high pressure services within the FEMA plus 3 foot flood zones. (Because FEMA has not published new flood maps for Westchester County, we used 2003 SLOSH Category 1 and 2 to identify high pressure services in Westchester County.).
2013 Measures Installed and Cost	The Company will install approximately 950 VLPs at a cost of $0.6 million.
Additional Measures to Meet 2013 FEMA + 3 Feet	Based on the 2013 FEMA plus three feet standard for New York City locations and 2003 SLOSH Category 1 and 2 for Westchester County locations, approximately 3,700 high pressure services require vent-line protection devices.
Incremental Measures Beyond Rate Case	None.
Construction Start Date	2013
Project End Date	2014 (2,750 additional installations)
Total Project Costs (2014-2016)	$2.4 million in 2014
Alternatives Considered but Not Selected	Alternatives include raising existing vent terminus above the flood height. This option was not selected because it is not possible to raise these vent lines in all cases and the installation would be significantly more costly that installing a VLP. Another option is to take no action and just preemptively isolate high pressure mains in areas forecasted to be flooded. This action could impact service to thousands of customers depending on the forecasted storm's strength, direction, and coastal tide. It could also result in water infiltration into vent lines that could affect the operation of these services in the future.

Table 37: Leak Prone Pipe Replacement in Flood Zones

Project Description	**Leak Prone Pipe Replacement in Flood Zones**: The Company proposes to initiate the targeted replacement of low pressure cast iron and bare steel gas main in flood zones defined by the FEMA plus three feet design standard. The replacement of cast iron and bare steel pipe in flood zones with new plastic or coated and protected steel will reduce the likelihood of water infiltration and gas service outages. Evaluation of pilot areas throughout flood zones is underway, and initial mapping and prioritization of segments for replacement will be performed in 2014. The Company plans to replace mains that can potentially impact the greatest number of customers. Factors such as likelihood of flooding, number of customers served by the mains and historical outages caused by water infiltration will be used to prioritize this main replacement. Where appropriate, these mains will also be upgraded to high pressure to prevent water infiltration and to facilitate the use of trenchless technologies and smaller diameter mains to minimize replacement costs.
Necessity and Benefits	Leaking and/or weakened low-pressure cast iron and bare steel facilities can result in water infiltration into the distribution system during a coastal flood. The gas system had almost 400 service outages affecting over 4,200 customers in the Bronx, Manhattan, Queens, and Westchester. Customer outages resulted from water that infiltrated into the gas mains, mainly caused by shifting ground conditions that occurred during flooding and by long-term corrosion that occurs on bare steel pipe. Another source of water infiltration is damage to customer equipment located in flooded basements, which then allows water infiltration into the low-pressure distribution system from the customer's side of the service. Although the Company's gas system sustained a relatively small amount of direct damage from Sandy, there is a risk that in future storms, the low-pressure gas system could be compromised by damage to low-pressure gas mains and by damage to customer piping in flooded basements. These scenarios could result in water infiltration of the gas-distribution system and, due to the limited number of low-pressure valves, migration of infiltrated water into larger sections of the low-pressure gas distribution system. Such water infiltration could lead to customer outages. Furthermore, delays may occur in the service restoration process after such an event if significant repairs are needed to customer piping.
2013 Measures Installed and Cost	There is no planned targeted replacement of cast iron or bare steel in flood zones in 2013.

Additional Measures to Meet 2013 FEMA + 3 Feet	The original inventory of main identified in the rate case proceedings was 185 miles based on the 2003 SLOSH Category 1 through 4 flood zones. The inventory of mains that would be eligible for replacement based on the FEMA plus three feet standard is approximately 138 miles. The following table summarizes the approximate total miles of cast iron and bare steel within the FEMA plus 3 feet footprint.

Operating Area	Cast Iron	Bare Steel	Miles (FEMA + 3 feet)
Manhattan	39	6	**45**
Bronx	27	15	**42**
Queens	22	12	**34**
Westchester	8	9	**17**
Total Miles	**96**	**42**	**138**

Incremental Measures Beyond Rate Case	The Company is currently working to finalize a prioritization program that will target the replacement of those mains that represent the greatest threat to customer reliability.
Construction Start Date	The Company plans to begin the targeted replacement in 2015. During 2014, Con Edison plans to identify and prioritize locations, prepare design layouts, and secure contractor resources to perform the pipe replacement work during 2015 and 2016.
Project End Date	Ongoing
Total Project Costs (2014-2016)	Con Edison has proposed $33.3 million in funding for 2015 and 2016 for the initiation of this targeted replacement program. Most if not all of the initial replacement is anticipated in Manhattan where most of the water infiltration/outages occurred. The current blended cost/ft. of bare steel and cast iron main replacement in Manhattan through September 2013 is $1,643. Using this replacement cost, funding of $33.3 million would replace approximately 20,000 feet of main in Manhattan in 2015 and 2016. After 2016, the program would also replace pipe in the Bronx, Queens, and Westchester where replacement costs are lower. During Phase II of the Collaborative, the Company plans to present to Working Group 1 a range of flood zone pipe replacement options for consideration.
Alternatives Considered but Not Selected	Install isolation valves throughout the low pressure distribution system in flood zones: This alternative would allow for isolation of water-infiltrated facilities only after water infiltration/customer outages have already occurred. This action could reduce the number of impacted customers by limiting the migration of water in mains. However, given the density of potential customers impacted by preemptive isolations, this is a more effective option after facilities are impacted.

Table 38: LNG Plant Hardening – New Switchgear and Batteries and LNG Salt Water Pump House

Project Description	 **LNG Plant Hardening – New Switchgear and Batteries and LNG Salt Water Pump House**: During 2014, the Company will elevate critical fire protection equipment for its LNG plant to the FEMA plus three foot design standard. This equipment includes transformers, switchgear, and batteries along with the construction of a moat wall around the Salt Water Pump House.
Necessity and Benefits	The LNG plant serves as a peaking and contingency supply of natural gas to the firm gas customers. The plant's automatic fire protection system utilizes an electric motor driven fire pump. The back-up fire pump is a diesel engine driven pump. The electric motor and fire pump and the diesel engine driven motor and fire pumps are located within a pump house located adjacent to Luyster Creek (the water source for the pumps) making the pumps vulnerable to a high storm surge. A high storm surge similar to Sandy could impact the electrical switchgear and high tension vaults for the electric motor and the battery bank for the diesel engine rendering the pumps inoperable. This project installs new, elevated switchgear and raises the high tension vaults (HTVs) and the battery bank to the FEMA plus three feet flood elevation.
2013 Measures Installed and Cost	Not applicable
Additional Measures to Meet 2013 FEMA + 3 Feet	This project will meet the FEMA plus three feet standard.
Incremental Measures Beyond Rate Case	In the rate case, the Company stated that the need for storm hardening at the LNG was being studied, but proposals and costs had not yet been developed and reflected in the revenue requirement. During the collaborative meetings of Working Group 1, Con Edison presented plans to install new switchgear and raise the high tension vaults (HTVs) and the battery bank to the FEMA plus three feet flood elevation at an estimated cost of $1.5 million.
Construction Start Date	2014

Project End Date	2014
Total Project Costs (2014-2016)	$1.5 million (preliminary estimate)
Alternatives Considered but Not Selected	Maintain the electric power sources for the LNG plant fire pumps at their current elevations leaving them susceptible to severe storm surges. This could result in an inability to adequately and safely operate the LNG plant in the event of a fire, with the potential to adversely affect service reliability.

Table 39: LNG Plant Hardening – Elevate Diesel Blackstart Generator

Project Description	 **LNG Plant Hardening – Elevate Diesel Blackstart Generator**: This project raises the unit to the FEMA plus three feet flood elevation.
Necessity and Benefits	The LNG plant serves as a peaking and contingency supply of natural gas to the firm gas customers. The plant has a back-up diesel driven electric generator enabling the plant to maintain 100% operational capability during an electric contingency from the loss of the three 27 kV feeders supplying light and power. The blackstart generator is installed at an elevation that leaves it vulnerable to a high storm surge. A high storm surge similar to Sandy could inundate the unit rendering it inoperable.

2013 Measures Installed and Cost	Not applicable
Additional Measures to Meet 2013 FEMA + 3 Feet	This project will meet the FEMA plus three feet standard.
Incremental Measures Beyond Rate Case	In the rate case, the Company stated that the need for storm hardening at the LNG was being studied, but proposals and costs had not yet been developed and reflected in the revenue requirement. During the collaborative meetings of Working Group 1, Con Edison presented plans to elevate the diesel blackstart generator to the FEMA plus three feet flood elevation at an estimated cost of $0.5 million.
Construction Start Date	2014
Project End Date	2014
Total Project Costs (2014-2016)	$0.5 million (preliminary estimate)
Alternatives Considered but Not Selected	Maintain the blackstart generator for the LNG plant at its current elevation making it susceptible to severe storm surges. This could result in an inability to adequately and safely operate the LNG plant in the event of a power outage, with the potential to adversely affect plant operation and service reliability.

Tunnel Projects

Table 40: Hardening of Tunnel Head Houses; Flushing, Hudson Avenue, Jackson Street, Astoria, Ravenswood, and 71st St (2015/2016 projects)

Project Description

First Avenue Tunnel

Ravenswood Head House – Queens Shaft

Ravenswood Head House – Manhattan Shaft

Hardening of First Avenue Tunnel and Tunnel Head Houses – Flushing, Hudson Avenue, Jackson Street, Astoria, Ravenswood, and 71st St: Installation of flood barriers at tunnel head houses to protect steam mains, gas mains, and/or high voltage electric feeders.

Necessity and Benefits	During Sandy, water entered several tunnel facilities, including the First Avenue, Ravenswood, Astoria, Hudson Avenue, Flushing, and 11th Street tunnels. These tunnels contain steam mains, gas mains, and/or high voltage electric feeders that may need to be de-energized for safety if the tunnels are significantly flooded. During the storm, significant flooding and a power outage forced the First Avenue Tunnel out of service. In 2013, the company designed and fabricated vented cover plates that can be installed prior to a storm to prevent floodwater from entering the First Avenue Tunnel through the street-level open vent gratings used to access the tunnel. A backup power generation will be installed by December 31, 2013. The remaining five tunnels have head-house entrances that are either sheet metal or masonry structures not designed to withstand the current coastal flooding design standard. To protect these tunnels against future storms, hardened and reinforced concrete structures will be constructed to replace the existing head-houses. The goal of the project is to provide the head-houses and tunnels with perimeter hardening and protection from flooding to prevent or greatly reduce water intrusion based on the FEMA plus three feet design standard. As part of the entrance-hardening plan, certain head-houses will be rebuilt to acceptable standards, while others will be hardened with flood doors and floodgates. Other control measures include the construction of barrier walls and the sealing of cracks and other penetrations in the interior tunnel walls. We will also add improved pumping operations and emergency back-up power to pump out water that infiltrates and install cameras and lighting for remote monitoring. The project will also raise equipment in the yards surrounding the head houses above flood levels and protect equipment such as oil-water separators by constructing flood-barrier walls.
2013 Measures Installed and Cost	Hardening of First Avenue Tunnel: $0.5 million
Additional Measures to Meet 2013 FEMA + 3 Feet	Final measures and scope will be determined when tunnel head house conceptual design packages are completed by the end of 2013.
Incremental Measures Beyond Rate Case	None.
Construction Start Date	2015
Project End Date	2016
Total Project Costs (2014-2016)	$60 million ($25 million in 2015; $35 million in 2016)
Alternatives Considered but Not Selected	