X	Capital
	O&M

2015 Capital – Electric Operation

Project/Program Title	Storm Hardening of Overhead System
Project Manager	Jonathan Russell
Project Number	
Status of Project	Ongoing
Estimated Start Date	2013
Estimated Completion Date	**2018**
Work Plan Category	Reliability

Work Description:

Emergency Management data predict that the Northeast Region will experience an increase in severe storms in the future. Currently, Category 1 and 2 hurricanes affect the region once every 19 years and major hurricanes, Category 3 or greater, affect the region once every 74 years.

In 2011 and 2012, our overhead system experienced severe damage from Hurricane Irene and Superstorm Sandy. In addition to these larger named storms, we experienced a number of large, unnamed storms that were also devastating, including the February 2010 snowstorm, March 2010 Nor'easter and October 29 2011 snowstorm. Each of these storms resulted in significant customer interruptions and long restoration times.

Recent experience indicates that the number of these events is increasing. Prior to 2010, the last year with more than one devastating storm was 2006. The damage caused by the January 2006 ice storm and the remnants of Tropical Storm Ernesto in 2006 also resulted in significant customer interruptions and long restoration times. Since weather forecasts indicate storms of this nature are expected to increase, Con Edison is faced with the challenge of operating a vulnerable overhead electric system in an area with an overgrown urban forest.

Con Edison's mission is to provide energy services to our customers safely, reliably, efficiently and in an environmentally sound manner. The time for complete restoration for each of these storms was up to a week or more. This is an extreme burden on our customers resulting in spoiled food, lack of heat, inability to use technology, and often displacement from home. To meet our customer's expectations for shorter duration outages and less regional impact, we must look at ways to harden the existing overhead system to prevent damage.

To this end the Company will implement the following strategies to make the system more resilient to these wide scale storms.

Overhead Distribution Equipment Upgrade & Retrofitting

Distribution circuit hardening will reduce damage to distribution circuits and expedite restoration efforts after storm events. This program involves three sub-programs:

- reducing the number of customers served from each feeder segment
- installing isolation switches on open wire spurs off of the main circuit line
- improving resiliency on targeted supply circuits

Reduce Circuit Segment Size

Our overhead system upgrade plan will limit storm impact to customers by reducing the number of customers served by an overhead circuit segment to fewer than 500 customers wherever economically practical designs can be implemented.

Automatic isolation devices, such as fuses, reclosers, and Kyle switches, operate automatically to isolate the extent of an outage and maintain service to customers on the upstream side of the isolation device without the need for operator intervention or a physical repair. 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 (automatic isolation) device. By hardening the system in this manner, we will reduce the number of customers that are impacted as a result of a single point of damage on the system, such as a downed 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.

We are also installing sectionalizing switches (both SCADA-ready and manual) that are designed to reduce the number of customers between circuit segments. In case of permanent faults occurring on the overhead system, the sectionalizing switches allow for rapid restoration of the non-faulted segment. The technology used to provide automatic fault isolation has it limits, and in the areas where it makes good operational sense these switches will be installed in addition to automatic devices. The Company's goal of approaching 500 customers per segment offers the best balance between reliability and expenditure given the current system configuration. It is worth noting that in the process of creating the overhead storm hardening program the Company developed the spur loop system which achieves great reliability and operational benefits in terms of customer impact during an outage. It allows two different points of the main circuit run to be tied together such that a fault in that area can be backfed from the other part of the circuit. In addition the ability to feed both ways on a spur allows for rapid isolation of any faulted section and quick restoration without a repair.

Other innovations in this area include the addition of more automatic devices on our 4kV system and 7 recloser automatic loop schemes which pushes the limit of the technology beyond what was previously possible.

We have identified approximately 632 locations where we can deploy additional automatic devices to reduce circuit segment size with the goal of reducing the number of customers served in that segment at an average cost of $71,000. Specifically, we plan the following at an estimated cost of $8 million in 2014, $14 million in 2015, and $14 million in 2016:

- Deploy vacuum reclosers – intelligent switches that can automatically detect faults and isolate portions of feeders without operator intervention – at 581 locations. We installed 46 units in 2013. We plan to install 115 units in 2014, 208 units in 2015, and 212 units in 2016.

- Install Supervisory Control and Data Acquisition (SCADA) enabled switches in 51 locations where additional automatic switches cannot be added. These switches, called gang switches, are remotely controlled devices that allow operators to determine the location of a fault and isolate damaged sections from the control room, without having to dispatch a crew to the location. Having specific information on where the fault is located also allows our operators to narrow down where on our system a repair may be needed. We installed 0 units in 2013. We plan to install 51 units in 2014, 0 units in 2015, and 0 units in 2016.

SCADA Isolation Switch Schedule

	Completed	2014		Planned for	Planned for
	in 2013	Planned	Completed	2015	2016
	4 kv Reclosers				
Brooklyn/Queens	0	20	2	40	40
Bronx/Westchester	0	0	0	68	72
Staten Island	0	20	0	30	30
	13 kv Reclosers				
Bronx/Westchester	46	52	2	0	0
Staten Island	0	0	0	70	70
	27 kv Reclosers				
Brooklyn/Queens	0	23	23	0	0
	27 kv Gang Switches				
Brooklyn/Queens	0	51	0	0	0

Isolation of Open Wire Spurs from Feeder Main Runs

Our overhead distribution system relies on a combination of main feeder lines and branch lines (also known as 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 wire is 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 cause outages to the main feeder line, which impacts many more customers than those fed from the spur. To reduce the risk that damage on spurs will affect main feeder lines, we are installing isolation devices (fuses, fuse bypass switches, and automatic sectionalizing switches) on open-wire spurs and sub-spurs that are more than two spans in length (i.e., the distance between three utility poles). These devices are designed to isolate faulted spur sections from the feeder main run. The fuse bypass switch technology allows us to add fuses where not previously possible since our system is heavily tied to neighboring circuits for use during emergency conditions.

We have identified approximately 3,500 locations where these isolation devices can be deployed. We installed 2,548 units in 2013. We plan to install 660 units in 2014 at an estimated cost of $5.7 million. We have identified approximately 300 additional locations for sub fusing of our circuits in 2015 in Staten Island (estimated cost of $3 million). 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.

Combined Fuse and Fuse Bypass Installations

		2013	2014 YTD July*	2014 YE Projection
Installations	Brooklyn/Queens	672	257	400
	Bronx/Westchester	1,425	90	200
	Staten Island	451	42	60
	Total	2,548	389	660
Unit Cost	Brooklyn/Queens	$ 10,800	$ 11,098	$ 10,800
	Bronx/Westchester	$ 5,000	$ 5,040	$ 5,000
	Staten Island	$ 4,400	$ 2,968	$ 4,400
	Weighted Average	$ 6,423	$ 8,819	$ 8,461

Improving Resiliency on Targeted Supply Circuits

In 2007, Con Edison commissioned a study to examine the costs and feasibility to underground our overhead facilities. The study developed an estimated cost to underground overhead feeders based on the characteristics of six typical feeders (three in Staten Island and three in Westchester) and an underground loop-type system design consisting of cable installed in a conduit and manhole system with underground vault transformers and with switching by a combination of vault-type automatic sectionalizing switches and manual single phase vacuum switches and disconnectable splices. At that time, the study estimated the cost of undergrounding our overhead facilities to be approximately $6.2 million/mile. The Company's 2013 update of the study estimated the cost to be $8.2 million/mile.

An expenditure of $100 million would underground about 12 miles of the overhead system. Undergrounding portions of the overhead system offers several benefits including reduced storm outages, improved roadway esthetics, reduced automobile-to-pole collisions, and reduced tree trimming costs. But undergrounding has a number of significant drawbacks including high cost, significant cost to residential and commercial customers to connect to the new underground service, exposure to corrosive conditions underground, longer service restoration time when outages do occur, and maintenance cost that is considerably higher than an overhead system

In view of the high cost of undergrounding and these other considerations, storm resiliency can be achieved more broadly and efficiently and as effectively by deploying a variety of measures that will a) improve circuit performance in overhead areas that have experienced relatively more storm damage and b) strengthen specific distribution facilities that supply municipal and commercial infrastructure and facilities that provide critical community needs following severe storms.

In lieu of directly burying the power lines as the sole solution, we will look to deploy ***aerial*** cable systems as a predominant method of enhancing reliability during storms. An aerial cable system has a number of features that improve resiliency during storms. These include a durable, insulated underground-type cable that is suspended by a sturdy, non-current carrying, steel messenger cable. Compared to open wire, aerial cable is less likely to fault on contact with tree limbs, less likely to be downed by tree contact, and more likely, compared to non-insulated open wire, to remain energized if dislodged from the pole. In addition, we will look to create more ATS (Automatic Transfer Switch) fed transformer systems. An ATS-supplied transformer system creates two service supplies (a preferred and a redundant alternate) that provide a back-up service for a customer if one service supply fails. With many of the supply feeders being partially underground and partially aerial cable, the chances of the customer remaining in service during storms are significantly higher. For those areas where additional measures are warranted, we can employ PME (pad mounted equipment) switches. PME switches provide operational flexibility to add generators or other back-up sources to maintain service in the event that distribution supply is interrupted. PME switches can support micro grid operation for further community flexibility.

These measures will be deployed in the following programs to improve resiliency on targeted supply circuits: (1) improving auto-loop circuits, (2) installing circuit-specific measures to harden services to specific customers, and (3) selective undergrounding.

Improvement of Auto-Loop Reliability

As part of our continuing push to make our overhead supply feeders more reliable, the Company has developed a modeling technology known as NNRI (Non Network Reliability Index) to assist our engineers in evaluating the impacts of various portions of this project. This model takes into account past performance, current circuit conditions and projected weather patterns to forecast predicted reliability. These simulations result in circuit rankings that can be compared before and after a proposed improvement. This tool will be invaluable as we continue to improve the reliability of auto-loop systems with the following measures:

- Introducing additional supply feeders to allow for continued service during feeder outages
- Dividing large auto-loops into several smaller loops
- Upgrading wire and pole sizes to improve storm resiliency
- Use of "Hendrix Aerial Cable" which has been proven to be more resilient than traditional open wire design
- Sacrificial components such as breakaway hardware and detachable service cable and equipment to prevent pole and customer equipment damage during storms

Auto-loops will be selected for improvements based on the following criteria:

- Non-Network Reliability Index (NNRI) ranking
- Impact during Superstorm Sandy and previous storms
- Availability of alternate supply
- Supply to critical infrastructure such as hospitals etc.

We plan to spend approximately $33 million to improve the following auto-loops in 2015 See attached files "2015 Brooklyn-Queens Auto-Loop Improvement Projects" and "Ongoing and Proposed Bronx-Westchester Auto-Loop Modifications 2013-2015"):

Fleetwood Loop in Westchester		**$1.700,000**
Van Nest Loop in the Bronx		**$700,000**
Mt Vernon Loop in Westchester		**$1,900,000**
Banksville Loop in Westchester		**$3,700,000**
Laurel Hill Loop in Queens		**$4,500,000**
Dyker Loop in Brooklyn		**$3,000,000**
Gravesend Loop in Brooklyn		**$8,500,000**
Marine Park Loop in Brooklyn		**$9,000,000**

Total $ 33,000,000

Installing Circuit Specific Measures

This program will develop circuit-specific solutions to harden services to critical customers such as hospitals, pumping stations, and community shopping centers that provide essential needs following a storm (gasoline station, supermarket, bank, etc.). These measures will include aerial cable systems and redundant feeds to ATS supplied transformer systems, and PME switches. In addition, Kyle spurs, directional ties, and gang switches will be utilized. We plan the following work to storm harden specific circuits to improve reliability (see attached file "Circuit Specific Measures"):

Storm-Harden Supply Circuits to Critical Infrastructure (Westchester and Bronx):

Installation Type	Quantity	Cost
Extend Aerial Feeders and Install ATS	32	**$20,000,000**
Emergency Tie to Alternate Aerial Feeder	27	**$11,000,000**
Install UG Network Transformers	7	**$8,000,000**
Create Secondary Network Pocket	10	**$9,000,000**
Additional Feeder to Hospital	1	**$3,000,000**

Total $ 51,000,000

Selective Undergrounding

Undergrounding of distribution equipment will be used both selectively for extended runs of overhead circuits and as a component of a location-specific approach that develops the optimal mix of measures to improve storm resiliency on specific supply circuits.

The undergrounding projects chosen for the 2015 Storm Hardening budget were the conversion/relocation to underground of 7 miles of open wire cable on feeders 33R06 and 33R04. These two feeders were chosen because of their critical supply to our 4kV Unit substations (Canterbury(06), Nassau(06), Nelson(04)) and critical customers (Staten Island University Hospital South (both 04 & 06), Tottenville H.S. (both 04 & 06), Seaview Hospital (04), and the College of Staten Island(06)). The justification for this work is twofold. The benefit of converting open wire 33kV to underground and aerial cable improves their performance during weather events. Our open wire circuits continue to be impacted by wind and lightning and this would greatly improve their performance. We are also relocating our circuit off of the Railroad right of way. We continue to experience difficulties in gaining access and the repairs involve extra costs due to renting special equipment (railroad buckets and cranes) and the additional man hours spent working this remote location.

Install Aerial Cable and Underground Cable to Reduce Dependence on Open Wire:

Feeder 33R06 in Staten Island		**$17,100,000**
Feeder 33R04 in Staten Island		**$7,900,000**

Total $ 25,000,000

We also plan to install underground cable sections to support ATS transformer systems providing redundant overhead and underground supplies – in one case to a municipal town hall, fire station, and police station, and in another case to a water works plant (see table above "Storm-Harden Supply Circuits to Critical Infrastructure Westchester and Bronx").

We plan to focus on feeders supplying areas that have experienced the highest storm damage impact and feeders supplying facilities that are critical to maintain community support following severe storms, such as police and fire stations, town halls, and pumping stations. We have enacted a comprehensive outreach to local governments in order to determine those facilities that are most critical to maintaining the basic necessities of their respective municipalities. In addition our consultant provided an analysis of our overhead system to establish criteria for which circuits and segments to prioritize for undergrounding and or hardening via the aforementioned techniques.

We believe that this multidisciplinary approach to selectively undergrounding and hardening the most critical portions of our overhead circuits will provide the most meaningful and impactful benefits across our service area. Based on the updated 2013 study cost of $8.2 million per mile and our estimates of the proposed alternative projects, we feel this comprehensive plan will benefit far more customers than solely burying 24 miles of existing circuits.

We are also conducting a pilot to evaluate the functionality and benefit of break-away service connectors. If struck by falling trees or heavy branches, break-away devices on overhead service cables 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 to maintain public safety and can be quickly reconnected to restore service to a customer. Through the remainder of 2014 and throughout 2015, we will install approximately 1000 breakaway service connector devices in a pilot program area within various municipalities in southern Westchester(Greenburgh, Mamaroneck, Mt. Vernon, New Rochelle, Scarsdale, White Plains and Yonkers) where we analyzed historical outage data to identify specific areas with high concentrations of tree-related service cable outages and field verified that the targeted areas do in-fact exhibit significant overhead tree exposure. The average unit cost is estimated to be $1,500 per device installation. Dependent upon weather conditions over at least the next 18 months, we will to evaluate the functionality of the connectors. Specifically that the sacrificial component fails before damage to the associated pole or house connection can occur; and that they do not fail under non-catastrophic impacts. The projected cost of this program is $500,000 in 2014 and $1 million in 2015.

Justification Summary:

The purpose of the storm hardening program is to continue a strategic and cost effective method to minimize damage to the electrical system and improve overall restoration. Implementing these projects will ensure the timely transition back to normal operations of the New York City and Westchester area, its residents and businesses as the storm recedes. In addition with less damage there will be far less future restoration costs.

We will follow the standards set in Corporate Instruction CI-260-4 Corporate Response to Incidents and Emergencies which establishes guidelines for determining the appropriate level of response and mobilizing the appropriate Company and external resources in a timely manner in response to any incident. It also describes the Company's Electric Emergency Response Plan (ERP) – The Company's Electric Emergency Response Plan details the organization for the response to storms and manmade events affecting the overhead and underground electric system in accordance with the requirements of Part 105 of the Rules of the New York State Department of Public Service.

The Corporate Coastal Storm Plan (CCSP) of Consolidated Edison Company of New York, Inc. provides a comprehensive overview that attempts to identify the potential effects of a severe tropical storm and/or hurricane, prepare strategies to mitigate these identified risks, and guides the subsequent corporate response to such an event. This guide focuses on ensuring public and employee safety while maintaining and restoring the integrity of our energy delivery services.

Adhering to these processes will also help to ensure that EH&S compliance, resource conservation, risk reduction and alternate design considerations are incorporated in the early planning and design stages of project work.

Spill reporting is a primary concern during major storms and these programs would limit the amount of transformer spills by preventing damage to the overhead system.

By hardening the system in the above outlined manner, we will reduce damage during a storm event, allow for repairs to be deferred to after a storm event by allowing for isolation of damage and ensuring continuity of the community by focusing on the key town centers that are necessary for our customers to function. This approach saves our customers money by reducing response costs and also provides economic benefits by lessening impact to the community at large.

Supplemental Information:

- Alternatives:

  The alternative is to continue with our current practices. While these result in industry leading SAIFI performance on a blue sky day, the system remains vulnerable for a large storm event and our customers can expect multi-day outage events on a more frequent basis.

- Risk of No Action:

  The possibility exists that no major hurricane or storm will hit our service area, but in the event that a major hurricane does hit the Con Edison service area we will experience severe electric infrastructure damage. This damage is extremely costly to the local community, Company and our ratepayers. The blocked streets, lost power and expensive repairs take its toll on the NYC area.

- Non-financial Benefits:

  Safety will be increased by less downed wires and less areas without lights.
  Customer satisfaction will increase since power outages and outage durations will be reduced.

- Summary of Financial Benefits (if applicable) and Costs:

  Although difficult to quantify, the benefits of the program are ensuring enhanced reliability during a major storm. In addition to saving the Company and rate payers service restoration and infrastructure rebuild costs, these programs would increase economic activity in the region as life would resume to normal faster and towns will spend less time waiting for our assistance in clearing blocked roadways.

- Technical Evaluation/Analysis:

  Regional Engineering has developed appropriate prevention strategies as outlined above by changing system design and adding/upgrading infrastructure.

- Project Relationships (if applicable):

- Basis for Estimate:

Total Funding Level ($000):

Historical Spend

Actual 2010	Actual 2011	Actual 2012	Actual 2013	Historic Year (O&M only)	Actual 2014 (YTD)

Historical Elements of Expense

(Historical EOE breakout will only be completed for Steam projects/programs of $500 thousand or more and, for all other organizations, projects/programs of $1million or more.)

EOE	Actual 2010	Actual 2011	Actual 2012	Actual 2013	Historic Year (O&M only)	Actual 2014 (YTD)
Labor						
M&S						
A/P						
Other						
Total						

Request ($000):

Request 2015	Request 2016	Request 2017	Request 2018	Request 2019
125,000	124,000	N/A	N/A	N/A

[a]**Request by Elements of Expense**

EOE	2015	2016	2017	2018	2019
Labor					
M&S					
A/P					
Other					
Overheads					
Total					

[a] All contingencies were developed in accordance with the Con Edison “Estimating Cost Contingency” Guidelines.