Storm Hardening in a Climate Change Context

Photo credit: ConEdison

"Some of the strategies we have adopted post-Hurricane Sandy are examples of permanent adaptation to a fundamentally different future... For other parts of our system, such as overhead cables and electrical equipment, we have adopted a resilience approach to reduce service-restoration times when unavoidable impacts are felt."

Griffin Reilly, Senior Engineer, ConEdison[1]

SUMMARY

In 2012, New York City (NYC) suffered serious flood damage due to Superstorm Sandy. The storm spurred NYC to adopt a strategic approach to climate change resilience. In 2013, NYC convened an expert panel to update its city-level climate change projections. The Mayor's office also published a municipal-resilience plan calling for 250 initiatives worth a total of US$15 billion.

NYC's actions have helped to promote and shape the climate resilience decisions of ConEdison, a gas, electricity and steam provider. It is a perfect example of how cities can promote and support power utilities (see figure CS5.1). A week following Superstorm Sandy, ConEdison established a goal of hardening its critical facilities before the next hurricane season. It identified US$1 billion worth of capital investments for 2013-2016. Part of these investments had already been identified as necessary, but Superstorm Sandy and NYC's climate change projections created a need to act urgently. Furthermore, a collaboration with NYC and other stakeholders led ConEdison to approve new resilience actions.

CONTEXT

Superstorm Sandy struck NYC during high tide and a full moon on October 29, 2012. Its 14-foot storm surge was the highest recorded to date in the area. Approximately 90,000 buildings across 51 square miles were inundated.[2] With sustained wind speeds exceeding 60 miles per hour, and gusts of up to 90 miles per hour, the storm took down a large portion of the NYC's overhead power lines. A significant portion of NYC's power-distribution system was either flooded, pre-emptively shut down or overloaded (see figure CS5.2). Close to one million customers in Con Edison's service territory (including Westchester) lost power, and Con Edison's total repair and restoration costs exceeded $300 million.[3] Superstorm Sandy did not stop at the electricity system. It also had far-reaching impacts on petroleum-supply networks in the northeastern states. For instance, it caused reductions of approximately 30% in the output of several refineries over a week's time. The storm also shut down several petroleum terminals and pipelines.[4] In comparison, the natural-gas system coped relatively well, with only 84,000 customers cut off from service because of flooded pipes.[2]

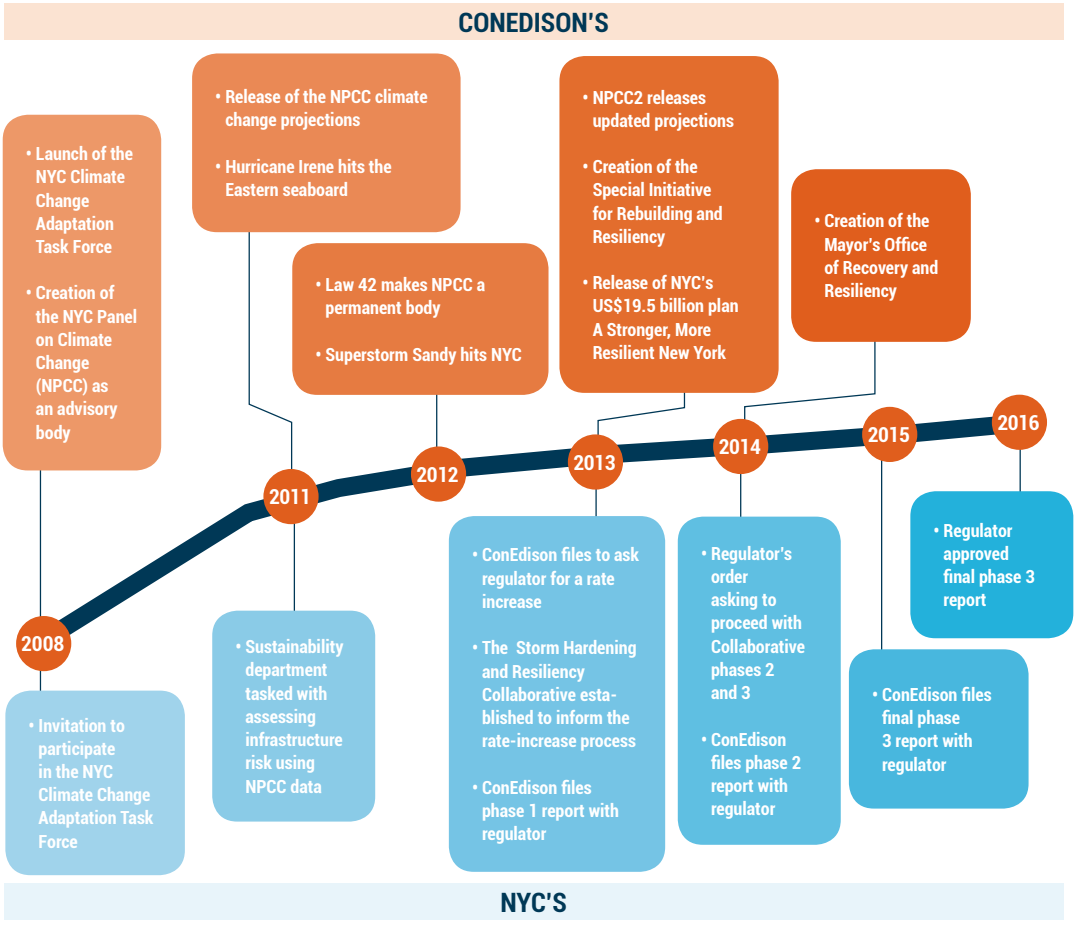
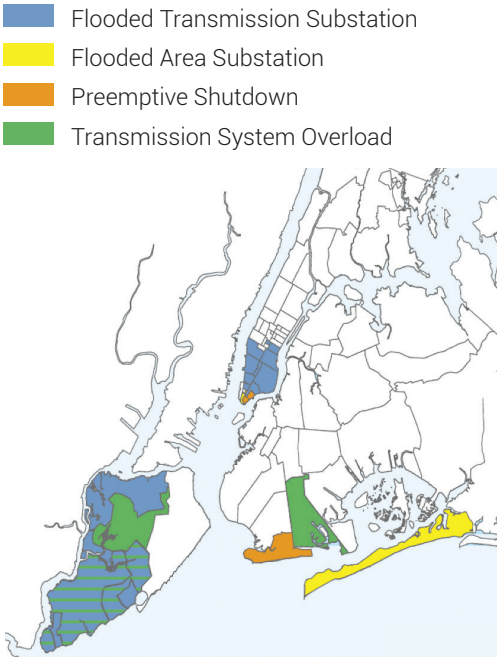


Figure CS5.1 Timeline of NYC's and ConEdison's climate resilience journey



Source: Con Edison, LIPA

Figure CS5.2 Impacts of Superstorm Sandy on NYC's power network[2]

MUNICIPAL CLIMATE CHANGE ADAPTATION RESPONSE

With more than 520 miles of vulnerable coastline, NYC is considered highly vulnerable to extreme storms and long-term climate change. In 2008, NYC Mayor Michael Bloomberg launched the Climate Change Adaptation Task Force with a mandate of developing strategies for improving the resilience of critical infrastructure to climate change impacts. The same year, and thanks to funding from the Rockefeller Foundation, the NYC launched the New York City Panel on Climate Change (NPCC) to advise and provide the Task Force with technical data and information. Comprised of experts in climate and ocean sciences, urban planning, civil engineering, law and risk management, the NPCC's outputs laid the foundation for the City's climate resilience process to date. The NPCC produced two important sets of information for climate change adaptation in NYC, namely: high-resolution projections[i], and adaptation-assessment guidelines and protocols.[5]

In September 2012, two weeks before a destructive tropical cyclone hit, NY City Council passed Local Law 42, establishing the NPCC as a permanent body required to meet twice a year to review recent scientific data on climate change and its potential implications for the City. It also stipulates that new climate change projections are to be prepared within one year of the publication of new data by the Intergovernmental Panel on Climate Change.

Superstorm Sandy prompted the City to convene a second NYC Panel on Climate Change (NPCC2) to present updated climate change projections for the 2020s and 2050s, and to establish new coastal flood-risk maps. Without explicitly linking Sandy with climate change, the NPCC2 demonstrated that unusually warm sea-surface temperatures further intensified the strength of the tropical storm. Further, the Panel noted that rises in local sea levels averaging 1.2 inches per decade, most of it due to climate change, increased the extent of flooding during the storm.[6] This new information came out a few months prior to the release of the *Preliminary Flood Insurance Rate Maps* by the Federal Emergency Management Agency (FEMA),

which established new building standards for dwellings in floodplains.

A few months following Superstorm Sandy, NYC also initiated the Special Initiative for Rebuilding and Resiliency (SIRR) to prepare actionable recommendations for rebuilding communities and assets affected by the storm, while increasing the City's overall resilience. In *A Stronger, More Resilient New York,* released in June 2013, the SIRR identified increased storm-surge height due to sea-level rises and stronger hurricanes as a major risk to NYC's electricity and steam systems both today and throughout the century (see figure CS5.3). It also flags more heatwaves as a major risk to peak-demand management from the 2020s onwards.

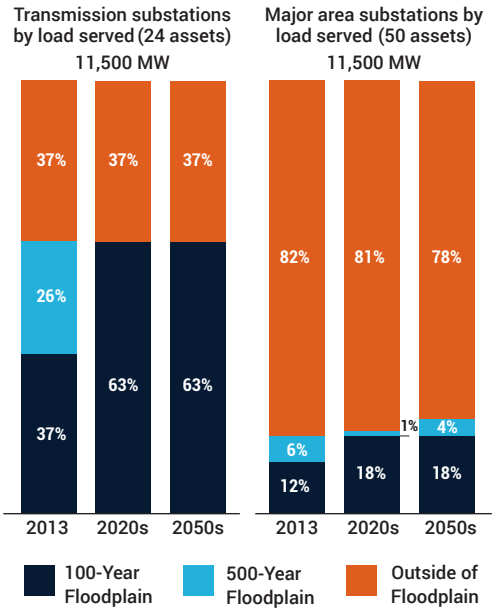


Figure CS5.3 Increased coastal flood risk for New York City transmission (left) and distribution (right) substations due to climate change[2]

SIRR's plan proposes more than 250 initiatives at a total cost of US$19.5 billion. Seth Pinsky, Director of SIRR, explained that the plan "will not only help New York City's most-affected neighborhoods to rebuild stronger and safer, but will help make New York City less vulnerable to the effects of climate change."[7] A new office, the Mayor's Office of Recovery and Resiliency, created in 2014, is responsible for implementing the plan.

CONEDISON'S STORM HARDENING AND RESILIENCY PLAN

As the City's primary distributor of electricity, gas and steam, ConEdison is an important part of NYC's climate resilience approach. In 2008, NYC's Mayor invited ConEdison to participate in the Climate Change Adaptation Task Force alongside city and state agencies, as well as other critical-infrastructure operators. Soon after the publication of the NPCC's 2011 climate change projections, ConEdison's executive leadership asked its Sustainability Department to consider what the data meant for infrastructure risk levels. As part of this high-level risk assessment, the company estimated the costs of climate-induced hazards and concluded that it could pose significant challenges to its operations.

Two weeks prior to Superstorm Sandy, several ConEdison executives met with NYC officials to discuss commissioning pilot studies to model service interruptions and the resulting economic impacts due to severe climate hazards. When Sandy

struck, these early-stage discussions moved from hypothetical to urgent reality.

"We had two hurricanes with significant impacts two years in a row; Hurricane Irene turned out to be a very good drill for Sandy", reports Griffin Reilly, Senior Engineer at ConEdison. In 2011, Hurricane Irene resulted in close to 200,000 power outages, the largest service-interruption in company history. Superstorm Sandy broke this record: more than 300 000 of ConEdison's electricity customers experienced service interruptions. Five transmission substations and 18 distribution networks across Manhattan, Brooklyn and Staten Island shut down. Operations were also reduced at an additional nine substations due to the storm. ConEdison's steam system was unable to supply one-third of its customers when the storm inundated four of six plants and many tunnels. It took two weeks to fully restore service.[2]

"We had two hurricanes with significant impacts two years in a row; Hurricane Irene turned out to be a very good drill for Sandy"
- Griffin Reilly

"As storms and coastal flooding was a well-recognized risk to our system before Sandy hit, it became clear that our immediate response after Sandy had to target improving our resilience to more severe storms" says Griffin. Rather than delaying detailed vulnerability assessments, the company leapt into action. "The week after Sandy, we had engineers in those affected substations looking into how to prevent that kind of damage." Before flood waters had receded, ConEdison's leadership team had established an internal goal to harden its critical facilities by June 1st 2013, ahead of the next hurricane season.

ConEdison's engineers identified a large portfolio of necessary resilience investments with preliminary design and cost specifications. On January 25, 2013, the company filed with the New York State Public Service Commission (NYSPSC) to propose changes to its rates in support of US$1 billion worth of investments in storm-hardening capital initiatives for the 2013-2016 period.

The goals of the company's *Storm Hardening and Resiliency* Plan are two-fold: make ConEdison's assets more resilient to climate-driven failures; and reduce the time needed to restore customer service after a disaster. The plan includes a wide range of measures, such as equipment relocation, flood walls and barriers, water pumps, submersible equipment, isolation switches on network feeders, reducing the number of customers served by single overhead-circuit segments, and burying some overhead-distribution equipment.

By June 2013, ConEdison had built more than a mile of flood defences around vulnerable critical infrastructure, and replaced or installed more than 3,000 isolation switches on its overhead network.

ConEdison's rate case with the NYSPSC triggered reactions from influential organizations such as the City of New York, the Natural Resources Defence Council and the Environmental Defense Fund, urging the company to expedite investment and incorporate climate change into system planning. Rather than engage in a traditional litigation, the NYSPSC assigned an administrative judge to the case, and urged ConEdison to engage with all interested parties by convening the Storm Hardening and Resiliency Collaborative. The Collaborative was mandated to discuss and reach agreement on ConEdison's plan, including design standards that take climate change into account.

The Collaborative met regularly between July and December 2013, and made the following critical recommendations to improve ConEdison's resilience plan:

1. Adoption of the 'three feet plus' standard, equal to three feet of additional freeboard above the updated 100-year flood depth released by the U.S. FEMA in June 2013, as the minimum standard for new Con Edison capital projects in NYC[ii]
2. Alignment with the storm-surge inundation model developed by the NYC Mayor's Office of Long Term Planning and Sustainability
3. Commissioning of a *Climate Change Vulnerability Study* to synthesize current knowledge on climate change impacts
4. Prioritization of ConEdison's plans based on cost-benefit analysis[8]

ConEdison's Griffin Reilly clarifies: "Storm and flooding preparedness is nothing new to ConEdison; we have in-house models that predict flooding boundaries across our service territory and asset portfolio based on storm-surge forecasts from government agencies. We use these models to inform our storm-readiness response, and determine where protection measures need to be put in place in advance of an incoming storm."[1] What's changed is the company's commitment to designing projects in NYC based on FEMA's 'three feet plus' flood-resilience standard. The additional three feet above FEMA's 100-year floodplain height builds leeway to cope with storm-surge uncertainty and projected rises in sea level.[iii,6] The updated design standard added significantly to project costs, though some of it is also due to design-standard refinements.[9]

LESSONS LEARNED

A large part of the US$1 billion worth of investments in ConEdison's Storm Hardening and Resiliency Plan had already been identified by the organization as necessary. "What Hurricane Sandy did was to create a need to take action on these measures right away" explains Richard Miller, Director of the Energy Markets Policy Group at ConEdison.[1] This demonstrates that climate change adaptation does not always justify 'net new' actions. It can grow out of efforts to strengthen operational excellence.

What began as a storm-hardening plan is slowly morphing into a full-fledged post-2016 climate change resilience plan that will also provide benefits during smaller storms and 'blue sky' days when outages may occur for other reasons. With increased knowledge of climate change vulnerability and capacity for resilience planning, ConEdison identified that other climate-driven

hazards deserve corporate attention. This prompted the company to include an assessment of the impacts of higher temperatures and changing humidity levels on power-load management in the scope of its Climate Change Vulnerability Study. "Even a one-degree Fahrenheit change in temperature variable used for projecting power loads would have huge impacts on future system planning," explains David Westman, former Regulatory Manager at ConEdison.[10]

Clearly, NYC's actions on climate change adaptation, specifically its role in convening the NPCC to produce updated climate change projections and its participation in the Collaborative, have provided additional drivers for ConEdison's resilience journey. It is a perfect example of how cities can encourage and support their electrical utilities in climate change adaptation.

"We identified the necessary resilience investments based on reliability and risk management standards", clarifies ConEdison's Senior Engineer, Griffin Reilly. It is the Storm Hardening and Resiliency Collaborative put in place by the NYSPSC that was interested in using cost-benefit analysis, not as a tool to select projects, but as a way to prioritize projects. "Cost-benefit analysis has highlighted a serious issue: how to monetize the benefits of improved resilience for individual customers; for instance, the value of reduced outages." Customers differ in their evaluation of climate change risks: for instance, the cost of power outages for hospitals or manufacturing is likely much higher than for residential customers or business offices.

ConEdison has faced another interesting challenge related to managing the cost of storm-hardening projects. On some projects, engineering companies submitted initial bids that were much more costly than anticipated, citing the added expense of resilience measures.[10] This has forced ConEdison to re-tender a few projects.

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[i] These projections rely on outputs from 35 Global Climate Models (24 for sea-level rise) used in the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC).
[ii] This is also known as 'FEMA's plus three' standard.
[iii] The 'high-end' sea level rise projections by NPCC2 (31 inches between 2000-2004 and 2050-2059) are based on the 90th percentile of a range of simulations from 24 climate models and 2 greenhouse gas Representative Concentration Pathways.

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[8] ConEdison. Storm hardening and resiliency collaborative report. (ConEdison, 2013).
[9] ConEdison. Amended Storm Hardening and Resiliency Collaborative phase two report. (ConEdison, 2014).
[10] ConEdison. Storm Hardening and Resiliency Collaborative phase three report. (ConEdison, 2015)

AT A GLANCE

KEYTAKEAWAYS

1. **A storm-hardening process can lead to a full-fledged climate resilience plan**

2. **Climate change adaptation does not always require 'net new' investments; often it raises the profile of operational-excellence measures that have already been identified**

3. **Cost-benefit analysis can be a useful tool to prioritize adaptation, but it raises issues about the value of impacts and benefits for different populations**

ORGANIZATION(S)

New York City (United-States), ConEdison (United-States)

POWER SUB-SECTOR(S)

- Natural gas supply
- Electricity transmission and distribution

ADAPTATION TYPE(S)

- Informational – Monitoring equipment and technology
- Management – Design and operation standards, guidelines, tools and maintenance schedules
- Physical – Equipment protection, upgrades and alternative materials

CLIMATE CHANGE IMPACT(S)

- Increased storm and tropical-cyclone intensity
- Sea-level rise and coastal flooding
- Rising temperatures and numbers of hot days

ADAPTATION COSTS

- The cost of strengthening the resilience of New York City to more severe storms is very high.
- The total value of ConEdison's climate resilience investment plans for 2013-2016 is very high.
- The cost of enhanced flood-risk standards for substations is medium.

ADAPTATION BENEFIT(S)

- Increased resilience to climate-driven failures
- Reduced service-restoration times during climate-related disasters

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FULL REPORT

https://ouranos.ca/en/programs/energy-adaptation-case-studies/

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