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Climate Change Resilience Plan

Niagara Mohawk Power Corporation
d/b/a National Grid

Case 22-E-0222

CLIMATE CHANGE RESILIENCE PLAN

Submitted to:

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Acronyms

AIC	Avoided Impact to Critical Facilities
BCJ	Business Case Justification
CCRP	Climate Change Resilience Plan
CCRT	Climate Change Risk Tool
CCVS	Climate Change Vulnerability Study
CHI	Customer Hours Interrupted
CJWG	Climate Justice Working Group
CLCPA	Climate Leadership and Community Protection Act or the Climate Act
CRWG	Climate Resilience Working Group
CAL	Community Avoided Loss
CMIP	Coupled Model Intercomparison Project
CAIDI	Customer Average Interruption Duration Index
DDGs	Deep-Dive Groups
DER	Distributed Energy Resource
EPRI	Electric Power Research Institute
ERP	Emergency Response Plan
FLISR	Fault, Location, Isolation, and Service Restoration
FEMA	Federal Emergency Management Agency
FY	Fiscal Year
GCM	Global Climate Model
MIT	Massachusetts Institute of Technology
NESC	National Electrical Safety Code
NYSERDA	New York State Energy Research and Development Authority
NMPC	Niagara Mohawk Power Corporation
NWA	Non-Wires Alternative
PDS	Project Data Sheet
PSC	Public Service Commission
PSL	Public Service Law
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
T&D	Transmission and Distribution
WPF	Worst Performing Feeder

Executive Summary

Niagara Mohawk Power Corporation (NMPC) d/b/a National Grid (National Grid or the Company) is committed to enhancing the resilience of its assets to provide customers with safe and reliable electric service in the face of climate change. Climate hazards are impacting the electric system and are projected to increase in severity, frequency, and variability. National Grid recognizes the importance of acting now to prepare its assets for these changes; this Climate Change Resilience Plan (CCRP) is one more step in the Company's journey to achieving resilient and reliable service for customers.

In September 2023, National Grid submitted a Climate Change Vulnerability Study (CCVS) to the New York Public Service Commission (PSC). The CCVS assessed the vulnerability of its electric infrastructure, design specifications, and planning and operational procedures to four key climate hazards: 1) high temperature (extreme heat), 2) inland flooding, 3) high wind gusts, and 4) ice. The CCVS was informed by the best available climate science and was prepared with input from a Climate Resilience Working Group (CRWG), composed of a variety of stakeholders from state agencies, municipal and community leaders, and customer and environmental advocacy groups. National Grid reached out to communities across its service territory and engaged diverse stakeholders throughout the process to understand and incorporate their concerns, priorities, and interests, including those of disadvantaged communities. Impacts from climate change may fall disproportionately on disadvantaged communities, who often are the least able to prepare for and recover from them.

This CCRP builds on a foundation of previous resilience efforts, as well as the findings from the CCVS. It outlines identified resilience measures using results from the CCVS of high exposure areas where National Grid should focus its future resilience planning and investment decisions.

As part of the CCRP, a multi-pronged resilience framework was created to evaluate whether identified resilience measures achieved one of four key objectives:

1. Strengthen assets to withstand structural loads that may occur during extreme weather events.
2. Anticipate climate hazards and absorb their impact when exposure cannot be avoided.
3. Respond and recover service to normal levels in the aftermath of a climate hazard event.
4. Advance resilience improvements and adapt to a continuously changing climate hazard landscape.

The objective of this framework was to guide the development of resilience measures across National Grid to achieve resilience at every stage—from implementation of physical projects and programs to planning, design, and operational practices. Ultimately, enhanced resilience to extreme events results in decreased customer outages and restoration costs. The operational and physical resilience measures identified in this CCRP were informed by inputs from utility subject matter experts and include both incremental and new projects. Incremental measures modify the scope of previously planned projects to improve their resilience to climate vulnerabilities (e.g., updating substation transformers ambient temperature standards of previously planned replacements). New resilience projects were identified based on CCVS findings, such as targeted undergrounding or flood walls for distribution and transmission substations.

Identified operational resilience projects and programs are listed in Table 1. Identified physical resilience projects and programs are listed in Table 2, which also includes the estimated 5-year costs[1] for the identified measures.

Table 1. Summary of identified operational resilience projects and programs

Operational Project/Program	Mitigated Climate Hazard(s)	Applicable Asset Type	Description
1. Substation Transformer Specification Changes	Extreme Heat	Substations	Due to increasing ambient average and maximum temperatures, transformer specifications will be updated from 32°C (90°F) to 35°C (95°F) for future builds.
2. Update Transmission Structure Standards	Wind Gusts	Transmission	Update transmission structure design guidelines to withstand wind gust projections of up to 120 mph based on structure locations and wind gust maps derived from Massachusetts Institute of Technology (MIT) wind speed projection data.
3. Electric Load Forecasting	Extreme Heat	Distribution	Evaluate climate scenarios in the load forecasting practice.
4. Transmission Facility Rating Methodology Changes	Extreme Heat	Transmission	Update transmission facility rating methodology ambient temperature from present assumption of 35°C (95°F) to 40°C (104°F). Revised facility ratings will be incorporated into transmission system models and used in planning studies.

Table 2. Summary of identified physical resilience projects and programs

Physical Project	Mitigated Climate Hazard	Description	FY Start	FY End	5-year Capital Cost (FY26-30)
1. Overhead Distribution and Sub-transmission Line Design Upgrades*	Wind Gusts and Ice	Update distribution line standards to move from Class 3 poles to Class 1 for main lines and poles that carry heavy equipment (approximately 8,000 poles/year) and update sub-transmission line standards to use Class 1 poles for single circuit structures, Class H1 for double circuit structures, and Class H2 for double circuit with distribution underbuilds (approximately 900 poles/year).	FY26	FY45	$133M
2. Overhead Transmission Line Design Upgrades*	Wind Gusts and Ice	Build T-Lines to withstand 120 mph wind gusts in high wind areas (46 currently planned) by using more steel and larger foundations. Planned projects include 44–115kV lines and 2–230KV lines (approximately 1,300 circuit miles covered).	FY26	FY45	$33M
3. Distribution Targeted Undergrounding	Wind Gusts and Ice	Targeted undergrounding of 1–2 miles per year of 3-phase main line in highest wind and icing areas.	FY27	FY45	$51M

[1] These cost estimates are for the first five years of the CCRP (i.e., Fiscal Year (FY)26 to FY30). National Grid's FY runs April 1–March 31; e.g., FY26 is April 1, 2025–March 31, 2026.

Physical Project	Mitigated Climate Hazard	Description	FY Start	FY End	5-year Capital Cost (FY26-30)
4. Spare Transmission Line Structures	Wind Gusts and Ice	Purchase 10 T-Line spare structures per division (30 total) designed for 120 mph gusts to speed restoration.	FY26	FY30	$2M
5. Substation Flood Walls	Flooding	Install flood walls at 18 substations in high-risk areas (approximately 17,000 linear feet of flood walls total).	FY27	FY33	$19M
6. Distribution and Transmission Substation Transformer Specification Upgrades*	Extreme Heat	Update transformer spec from 32°C (90°F) to 35°C (95°F). Current plans include 35 distribution projects (81 transformers) and 24 transmission projects (37 transformers) with installs and replacements.	FY26	FY31	$7M[2]
*Added scope to existing projects					

The assets targeted for these measures were scored under a Business Case Justification (BCJ) framework leveraged by National Grid to characterize the potential benefit that a resilience project may have on improving system reliability, criticality, and community resilience. These three considerations are compared across all assets, so the score represents a relative comparison of potential benefits, rather than the prioritization of a project. The estimated cost of implementation informed the number of projects for each resilience measure, as well as the type of measure to be implemented (e.g., building a flood wall around a substation versus rebuilding a substation away from the floodplain).

Overall, the capital investment in resilience programs identified under a 5-year period (from 2026 to 2030) is estimated at $244M. By the 10th year of the CCRP (from 2026 to 2035), the cumulative investment would be approximately $567M. By the 20th year of the CCRP (from 2026 to 2045), the cumulative investment would be approximately $1,390M. The revenue requirements for the identified resilience investments presented in this CCRP result in total bill increases ranging from 0.02% in FY26 to 0.66% in FY30 when compared to current rates across all service classes. Additional information on estimated rate impacts of the measures identified in the CCRP are presented in Section 5.

The adaptation measures presented in this CCRP complement the Company's extensive efforts to achieve the goals of the Climate Leadership and Community Protection Act (CLCPA or the Climate Act) by interconnecting and delivering increasing amounts of renewable generation, advancing transportation electrification, enabling customers to use less energy, and safely, reliably, and affordably decarbonizing the energy system. The Company looks forward to continuing to work with customers, stakeholders, and the Department of Public Service Staff on this journey.

[2] Cost estimates for projects are only included for currently planned projects. Cost for additional years (out to fiscal year 45) are based on yearly averages.

1. Introduction and Background

Niagara Mohawk Power Corporation (NMPC) d/b/a National Grid (National Grid or the Company) serves approximately 1.7 million electric customers throughout New York State. The impacts of climate change pose an increasing risk to National Grid's electric system and the continued ability to provide reliable, high-quality service. National Grid experienced 11 notable storms between February and July of 2022, creating service interruption for more than 237,000 customers.[3] The most recent notable storm, Winter Storm Elliott in December 2022, affected 202,659 customers and required the replacement of over 250 broken poles and 100 damaged transformers.[4] With extreme weather events becoming more frequent, National Grid is committed to implementing resilience measures to enable the continued delivery of safe and reliable energy to customers and their communities.

National Grid has taken various steps to support its climate resilience work. National Grid has joined the Electric Power Research Institute (EPRI) in their Climate READi initiative, conducted numerous studies to identify infrastructure vulnerabilities, and invested in resilience efforts. The Company's Climate Change Vulnerability Study (CCVS) and this Climate Change Resilience Plan (CCRP) build upon these prior efforts to ensure resilient energy delivery.

The recently completed CCVS provided National Grid additional insights on climate change projections and potential impacts to the electric system and enabled the Company to make more informed decisions about resilience investment prioritization. By improving its understanding of the system's vulnerability across the service territory, National Grid is better positioned to effectively strengthen the electric system. This CCRP builds on the CCVS's results and identifies actionable investments and changes to standards and processes to support National Grid's resiliency measures.

1.1 Legislative Context

In February 2022, New York State passed Public Service Law (PSL) §66(29) setting forth a process to enable the state's electric utilities to better understand and prepare for climate hazards. Specifically, this legislation directs electric companies to conduct climate change vulnerability studies and design resilience plans informed by this work. These resilience plans are intended to identify the electricity infrastructure changes needed to protect against the harsher, more frequent weather extremes associated with climate change.

This legislation mandates that each electric utility develop a CCRP that reflects an approach and ultimately an investment strategy to address the risks identified by the CCVS for the next 5-, 10-, and 20-year periods. The CCRP is also required to describe how equity is being considered. Appendix A – Legislative Requirements lists the legislative requirements of PSL §66(29) and identifies where in this CCRP the Company addresses said requirements.

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[3] National Grid, 2022. Climate Change Vulnerability Study & Resilience Plan: Community Leader Webinar. https://www.nationalgridus.com/media/pdfs/our-company/climate-change-vulnerability-study-resilience-plan-community-leader-webinar.pdf

[4] National Grid, 2023. Winter Storm Elliott Storm Report. National Grid. https://www.documentcloud.org/documents/23703289-national-grid-winter-storm-elliott-storm-report-2023

1.2 Climate Change Vulnerability Study

To understand and prepare for potential climate risks, National Grid carried out the CCVS which assessed the vulnerability of its electric assets, design specifications, and planning and operational procedures. The findings from the CCVS guided the development of the CCRP which evaluated and selected a suite of resilience measures.

The CCVS leveraged the latest climate data to evaluate exposure and potential impacts of climate change on National Grid's physical assets within its service territory. Three main climate data sources informed the exposure analysis:

- New statistically downscaled global climate projections developed by Columbia University and New York State Energy Research and Development Authority (NYSERDA) in 2022[5] were used to develop projections for temperature variables tailored to the sensitivities of assets. For example, days above 32°C (90°F) were analyzed due to the relevance of this temperature threshold to substation transformer ratings.
- Massachusetts Institute of Technology (MIT) generated[6] wind speed and ice projections[7] were used to understand the exposure of National Grid's transmission, distribution, and sub-transmission structures to extreme wind gusts and radial icing events.
- National Grid's in-house Climate Change Risk Tool (CCRT), which uses precipitation projections from Coupled Model Intercomparison Project Phase 5[8] (CMIP5) global climate models[9] (GCMs) as a proxy for changes in future inland floodplains. This information was used to complement Federal Emergency Management Agency (FEMA) flood risk designations to understand present-day and future flood risk levels and identify substations located in potentially high flood risk areas across the service territory.

The CCVS evaluated substation, transmission line, and distribution line[10] assets. Four key climate hazards were selected for analysis based on the sensitivity of the assets and consequences to the system if exposed to the climate hazard:

High temperatures: Across the service territory, both daily average and extreme temperatures are expected to rise. The capacity of electrical equipment is influenced by ambient temperatures, and

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[5] Downscaled from the Coupled Model Intercomparison Project Phase 6 (CMIP6) dataset.

[6] The wind speed and radial icing data were developed by the MIT Joint Program on the Science and Policy of Global Change as described in Komurcu and Paltsev, 2021. MIT Joint Program Report 352. National Grid converted the wind speed data to wind gusts as part of its analysis.

[7] Projections for wind gusts and ice were based on two different risk tolerances: 1-in-10-year and 1-in-100-year. While 1-in-10-year represents a 10% annual likelihood of occurrence, 1-in-100-year represents a 1% annual likelihood of occurrence. The 1-in-100-year values represent more of a worst-case scenario and are used for systems with lower risk tolerances, such as transmission and sub-transmission lines. The 1-in-10-year values were used for understanding exposure of distribution line assets. This approach is consistent with National Electrical Safety Code (NESC) standards traditionally used to inform line designs.

[8] A set of 35 climate model experiments designed to assess the mechanisms responsible for model differences associated with the carbon cycle and with clouds, explore the ability of models to predict climate on decadal time scales, and determine why similarly forced models produce a range of responses. https://wcrp-cmip.org/cmip-phase-5-cmip5/

[9] Based on well-documented physical processes to simulate the transfer of energy and materials through the climate system and use mathematical equations to characterize how energy and matter interact in different parts of the ocean, atmosphere, land. https://www.climate.gov/maps-data/climate-data-primer/predicting-climate/climate-models

[10] Sub-transmission assets were examined as part of the distribution line asset group.

mitigating these impacts effectively will be key to minimizing costs and other impacts to customers. Mid- and late-century projections (2050–2080) reveal increased frequency in high-temperature days. For example, projections indicated that substations across National Grid's service territory could experience up to nine days per year with daily average ambient temperatures over 32°C (90°F) by the 2080s. Historically, substations in most regions of the service territory have not exceeded this threshold. Sustained temperatures that exceed 32°C (90°F) can reduce the effective capacity of substation transformers and increase the rate of aging of internal components. Transmission and distribution (T&D) lines are also projected to experience more severe extreme heat throughout the later part of the 21st century.

Inland flooding: As precipitation becomes more variable and heavy precipitation events become more intense and frequent due to climate change, inland flooding is projected to increase particularly along riverbanks. The CCVS found that flooding may pose a significant threat to National Grid's assets, particularly for substations. Substations in high flood risk areas are scattered throughout the National Grid service territory but are predominantly located in the Central and Eastern divisions. The exposure of electrical assets to flooding can result in equipment damage and lead to customer outages. The sensitivity of assets to flooding exposure highlights the importance of taking proactive flood risk mitigation measures.

High winds: Climate change is projected to drive more severe extreme weather events, which could cause higher wind gusts across the service territory. Understanding where higher wind gusts are likely to occur and finding effective ways to withstand those conditions will support maintaining safe and reliable service. Near-term (2025–2041), 1-in-10-year projections show that National Grid's distribution poles could experience wind gusts of 100 mph or greater, depending on location. Similarly, transmission and sub-transmission structures in some areas of the service territory could experience 1-in-100-year wind gusts reaching 120 mph.

Ice: Climate projections show that distribution and transmission line assets across National Grid's service territory may face more severe icing events. Understanding which areas and assets are likely to experience higher impacts from icing and preparing to better withstand those conditions will help enhance resilience and reduce customer outages. For example, in the near term (2025–2041), transmission structures in the western division, near Buffalo, are projected to see 1-in-100-year radial icing impacts at icing levels greater than 0.7 inches. Additionally, around 19% of distribution poles in the service territory are projected to experience 1-in-10-year radial icing totals between 0.4 and 0.6 inches, while 3% could see more than 0.6 inches of radial icing during an event.

The CCVS determined priority vulnerabilities by evaluating sensitive and critical assets located in areas of high exposure to a given climate threat. National Grid assessed the vulnerability of assets to each of the four key climate hazards. Climate projections, evaluation of asset sensitivity and criticality, and inputs from National Grid's subject matter experts served as the cornerstones for the vulnerability assessment.

Priority vulnerabilities represent the asset–hazard combinations with the highest potential for negative outcomes for National Grid customers (Table 3). National Grid's substation assets were identified to be particularly vulnerable to extreme heat and precipitation-driven inland flooding. T&D line assets were identified to be highly vulnerable to extreme heat, wind gusts, and ice. Priority vulnerabilities are a helpful indicator to identify areas where resilience efforts can be beneficial. However, the identification and prioritization of resilience projects and measures in the CCRP also relies on the technical knowledge and experience of National Grid experts in identifying specific vulnerable assets for implementing resilience interventions. The identified resilience measures to reduce the risk to these climate hazards are described in Section 4, with the BCJ, based on benefits to the system and the communities served, described in Section 5.

Table 3. Identified priority climate vulnerabilities

ASSET GROUP	High Temperature	Inland Flooding	Wind Gusts	Ice
Transmission Line	✓		✓	✓
Distribution Line[11]	✓		✓	✓
Substation	✓	✓		

1.3 Resilience Planning Approach

The results from National Grid's CCVS have been used to inform the development of this CCRP. To address the priority risks flagged in the CCVS, National Grid has leveraged a multi-pronged resilience strategy, described in Section 4, that guides the development of resilience measures to mitigate priority climate risks. The strategy addresses four objectives to improve resilience: Strengthen & Withstand, Anticipate & Absorb, Respond & Recover, and Advance & Adapt. This approach addresses resilience in a holistic fashion and allows for the continuous transformation and advancement of the electric system.

After identifying possible resilience measures and projects, National Grid utilized the BCJ framework to identify benefits to customers, local communities, and system infrastructure. The BCJ scores the benefits of the selected resilience projects to implement through three main considerations: system reliability, criticality, and community resilience.

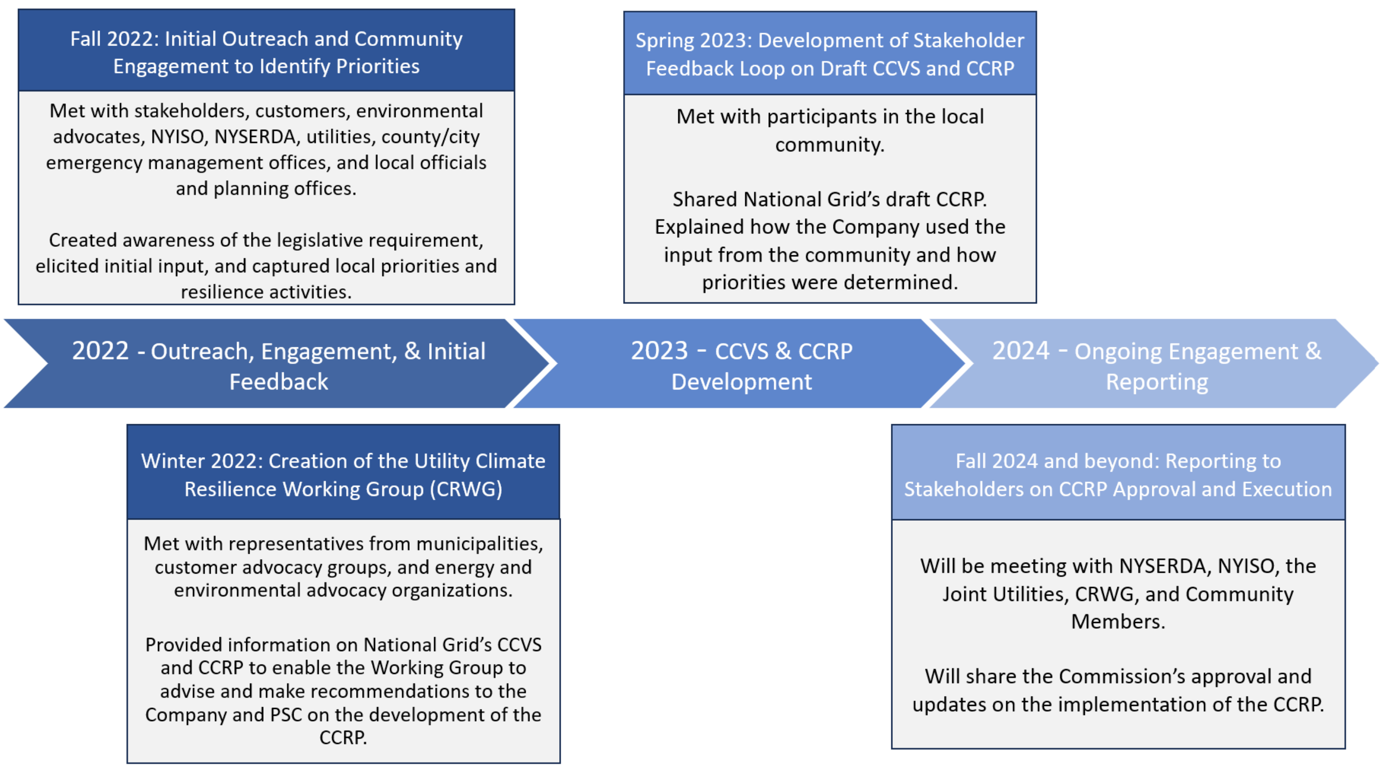
National Grid recognizes the important role of equity in resilience planning and is committed to ensuring that equity is recognized during investment planning. As part of the BCJ framework, National Grid identified whether the proposed project serves a disadvantaged community, understanding that disadvantaged communities are often more vulnerable to the impacts of climate change than other communities. The Company will continue to work toward achieving equitable solutions that mitigate existing vulnerabilities and avoid unduly burdening disadvantaged communities. Equity considerations in National Grid's resilience planning efforts are discussed in Section 3.

[11] Sub-transmission assets were examined as part of the distribution line asset group.

2. Engagement of the Climate Resilience Working Group

National Grid is committed to enlisting input from stakeholders and using that information to inform Company policies and projects by engaging customers, communities, and advocates at the front end of decision making. For this, National Grid created a comprehensive stakeholder engagement roadmap as a pathway for stakeholders to inform National Grid's decision making throughout the process, including development of the CCVS, and ensuring that the CCRP is responsive to customer and community priorities. National Grid continues to meet its obligation to provide safe and reliable electric service equitably and to engage the Climate Resilience Working Group (CRWG) in the process. Figure 1 depicts the timeline of the Company's CCVS and CCRP stakeholder engagement roadmap.

Figure 1. National Grid Climate Change Vulnerability Study & Resilience Plan — Stakeholder engagement roadmap



In the Fall of 2022, National Grid carried out initial outreach to create awareness about the CCVS and CCRP and to seek preliminary input from stakeholders. National Grid held meetings with municipal and community leaders, where they informed stakeholders about plans to develop the CCVS and CCRP, solicited their input via a survey to identify areas of concern, and encouraged participation in the CRWG. A second meeting was held in December 2022 to update and inform this group on the results of the survey and to reemphasize the important role of the CRWG in the development of the CCVS and the CCRP. A third meeting was held in August 2023 to update community and municipal leaders on progress and next steps. At the community meetings, National Grid solicitated interest from community members to join the CRWG.

An informational meeting was also held with environmental and consumer advocates as well as other interested parties in January 2023, where the Company stressed the twin goals of sharing ideas and seeking feedback to ensure that both the CCVS and the CCRP reflect stakeholder concerns. National Grid invited participation by these organizations and other interested parties to be members of the CRWG.

National Grid established the CRWG, composed of members from state agencies, community organizations, and municipal leaders, as well as customer and environmental advocacy groups. The Company recognizes that meaningful collaboration with this diverse group of stakeholders is critical to understanding and incorporating their concerns and priorities, including equity concerns, into the CCRP.

Throughout the CCVS and CCRP development processes, three CRWG meetings were held. The first two meetings (in February 2023 and June 2023) were held during the development of the CCVS. During these meetings, vulnerability assessment methods and preliminary findings were presented to the CRWG members, and their inputs were sought for incorporation into the CCVS. A third meeting was held in October 2023, as part of the CCRP development, where resilience measures were presented to the stakeholder group and input and feedback were solicited. A list of community and municipal organizations that National Grid included in its stakeholder engagement efforts and a list of CRWG member organizations is provided in Appendix B – Stakeholder Engagement during CCVS and CCRP Development.

National Grid has also created a dedicated webpage[12] as a source of information and an email address[13] that stakeholders can use to ask questions or provide feedback. National Grid will continue to work with stakeholders beyond the CCRP to gauge the impact of resilience measures on communities on a biennial basis.

[12] National Grid, 2023. New York Climate Resiliency Plan. https://www.nationalgridus.com/Our-Company/New-York-Climate-Resiliency-Plan
[13] Email address: box.NYClimateresiliency@nationalgrid.com

3. Considerations of Equity

National Grid understands that the impacts of climate change can fall disproportionately on overburdened communities who are the least able to prepare for and recover from them.[14] These communities tend to live in areas that are particularly exposed to extreme weather events like inland flooding or extreme heat.[15] In addition, these populations are also more sensitive to climate change impacts from not having access to adequate heating or cooling services, being likely to experience food spoilage or shortage, and experiencing delayed or disrupted healthcare services.[16] For example, the health-compromised or elderly may have lower tolerance for extreme temperatures or some homes may lack air conditioning units.

Climate hazards are anticipated to worsen existing inequalities across disadvantaged communities.[17] National Grid continues to consider how disadvantaged communities may be disproportionately affected by climate change and what the Company can do to enhance resilient service to those communities.

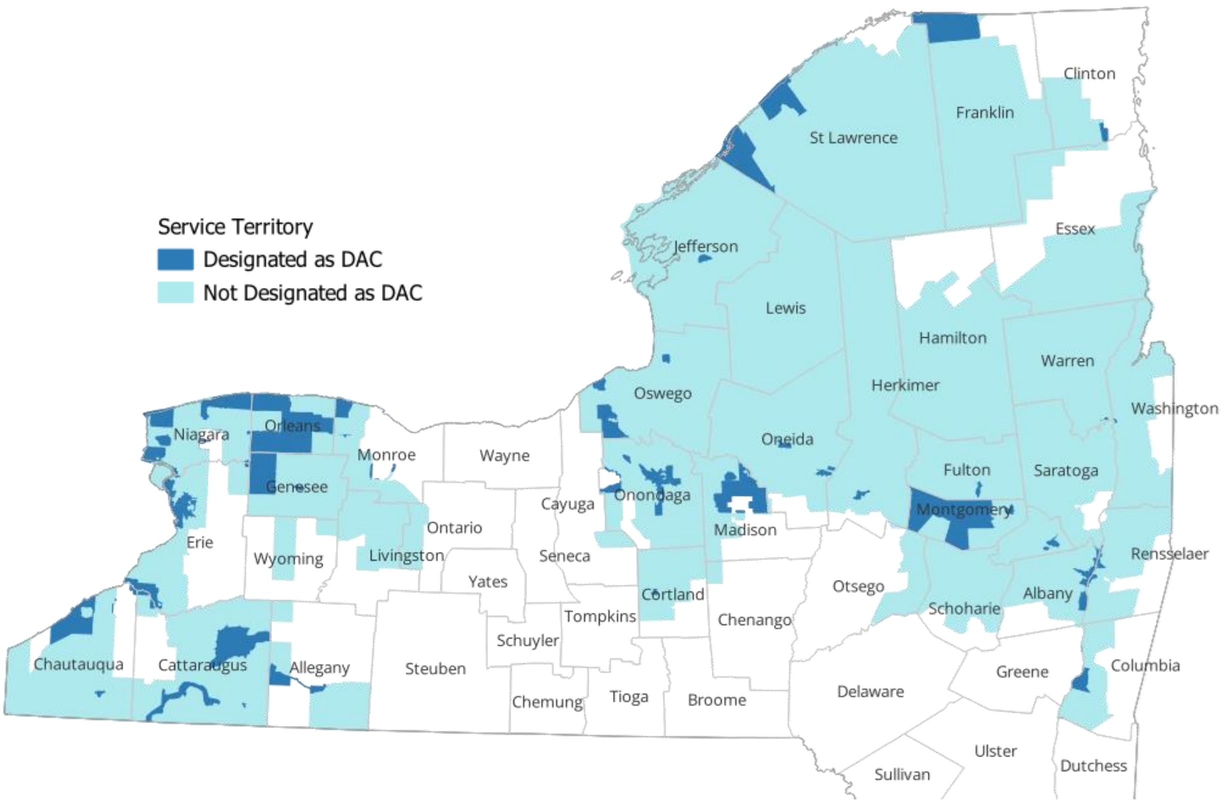
The Climate Act[18] charged the Climate Justice Working Group (CJWG) with leading the development of a set of criteria to identify disadvantaged communities and confirm that they benefit from climate change investments. The CJWG comprises representatives from Environmental Justice communities, members of rural and urban communities, and representatives from the New York State Departments of Environmental Conservation, Health, and Labor, and NYSERDA. The CJWG underwent a robust process with multiple rounds of feedback and iterations, and on March 27, 2023, adopted the final list of criteria to designate disadvantaged communities. The CJWG identified 1,736 or 35% of the New York census tracts as disadvantaged communities based on 45 indicators, including potential pollution exposures, potential climate change risks, income, and race and ethnicity. As defined in the Climate Act (ECL §75-0111), disadvantaged communities are identified based on geographic, public health, environmental hazard, and socioeconomic criteria, which shall include but are not limited to the following:

1. Areas burdened by cumulative environmental pollution and other hazards that can lead to negative public health effects.
2. Areas with high concentrations of people that are of low income, high unemployment, high rent burden, low levels of home ownership, low levels of educational attainment, or members of groups that have historically experienced discrimination based on race or ethnicity.
3. Areas vulnerable to the impacts of climate change such as flooding, storm surges, and urban heat island effects.[19]

[14] EPA, 2021. Climate Change and Social Vulnerability in the United States: A Focus on Six Impacts. https://www.epa.gov/system/files/documents/2021-09/climate-vulnerability_september-2021_508.pdf
[15] Ibid.
[16] Dugan, Jesse, et al., 2023. Social vulnerability to long-duration power outages. Science Direct. https://www.sciencedirect.com/science/article/pii/S2212420922007208
[17] EPA, 2021. Climate Change and Social Vulnerability in the United States: A Focus on Six Impacts. https://www.epa.gov/system/files/documents/2021-09/climate-vulnerability_september-2021_508.pdf
[18] The Climate Leadership and Community Protection Act (Climate Act) was signed into New York State Law on July 18, 2019. The law requires the state to reduce economy-wide greenhouse gas emissions 40% by 2030 and at least 85% by 2050 from 1990 levels. https://www.nysenate.gov/legislation/laws/ENV/75-0111
[19] The New York State Senate, 2020. Climate Act, ECL § 75-0111(1)(c). https://www.nysenate.gov/legislation/laws/ENV/75-0111

As part of developing the CCRP, National Grid leveraged the findings of the CJWG on disadvantaged communities to integrate inclusion and equity considerations into resilience planning. The directives requiring this CCRP also call for equity considerations to be included as part of the evaluation of costs and benefits of recommended resilience measures. Figure 2 shows a map of the CJWG-designated disadvantaged communities overlaid on National Grid's electric service territory.

Figure 2. Disadvantaged communities (DAC) within National Grid's service territory



3.1 Considerations for Resilience Investments

National Grid recognizes the central role of equity in resilience planning and is committed to ensuring equity is appropriately incorporated during investment planning. The Company strives to provide safe and reliable electricity service in a way that is equitable, considers the interests of disadvantaged communities, and avoids unduly burdening any affected communities. National Grid is addressing equity by focusing on both:

- **Procedural Equity:** To ensure that stakeholders and communities impacted by resiliency projects and programs are provided the necessary information and a meaningful opportunity to participate in and inform project development and implementation.
- **Distributional Equity:** To ensure resiliency planning is implemented in a way that drives equitable outcomes, including the equitable realization of the benefits and burdens.

The Company is also working towards developing a methodology that enables it to achieve these objectives more effectively and efficiently and will continue to advance equity considerations into planning. As a New York electricity provider, National Grid is addressing climate justice in a variety of ways,[20] including:

- Providing affordable, clean energy options to all,
- Supporting the restoration of New York public parks by planting trees[21] and other revitalization projects,
- Advocating for New York Environmental Justice policy, and
- Educating the public on climate justice issues.

National Grid will maintain its commitment to equity in resilience projects, recognizing which proposed projects benefit disadvantaged communities in support of climate justice goals. This is described in the BCJ framework in Section 5.

[20] National Grid, 2021. National Grid Project C. Environmental Justice & Social Equity Initiatives in New York. https://www.nationalgridus.com/project-c/Our-Pillars/Environmental-Justice-Social-Equity

[21] National Grid, 2020. National Grid Providing Support to Restore Trees, Parks Affected by October Greater Capital Region Wind Storm. https://www.nationalgridus.com/News/2020/11/National-Grid-Providing-Support-to-Restore-Trees,-Parks-Affected-by-October-Greater-Capital-Region-Wind-Storm-/

4. Multi-Pronged Resilience Strategy

National Grid has leveraged an innovative framework that employs a multi-pronged, forward-looking resilience strategy. The framework emphasizes the need for adaptable, resilient infrastructure and operational practices that anticipate and adjust for changing climate conditions. The objective of the framework is to guide the development of resilience measures across National Grid's service territory and ultimately enhance resilience to extreme events, decrease customer outages, and reduce restoration costs.

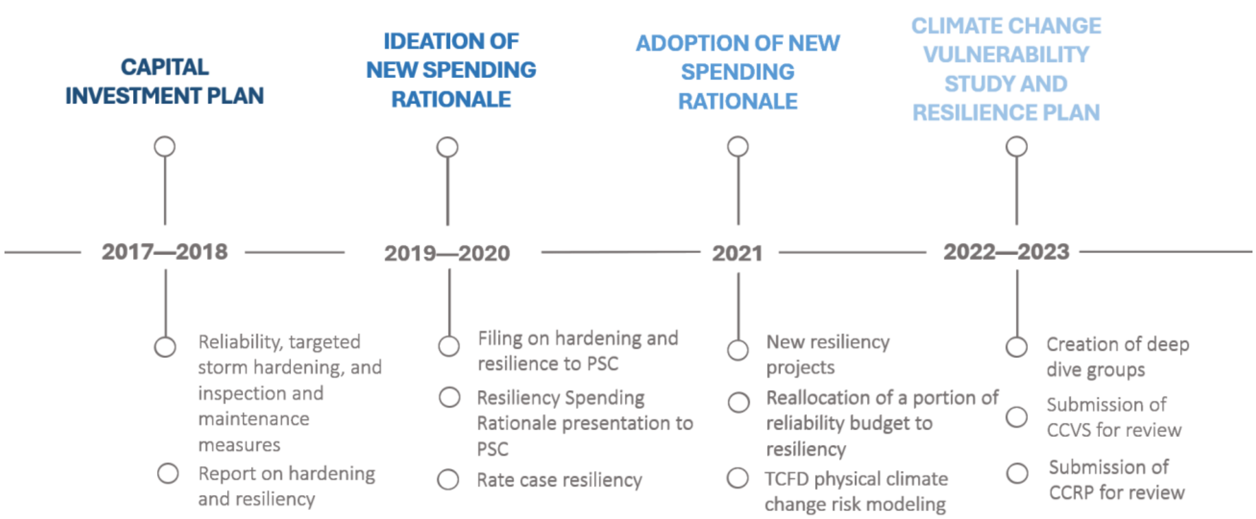
The following is included in this section:

- National Grid's past resilience investments and commitment to ensuring a resilient electric system.
- National Grid's resilience strategy and its four key objectives.
- An overview of how National Grid is incorporating resilience into existing planning, design, and operational practices.
- How National Grid may apply new technologies to create a robust, adaptable system capable of withstanding the impacts of climate change.

4.1 Resilience Journey

National Grid has been continuously improving system resilience for decades (Figure 3). In March 2021, the Company introduced a new Resiliency Spending Rationale which is an investment category for projects that improve the system's ability to withstand and recover from major events. With the new spending rationale in place, the resiliency budget comprises approximately 5% of the total 5-year capital budget.

Figure 3. National Grid's resilience journey



In 2021, National Grid further assessed the physical climate change risk to the Company's assets as part of its report to the Task Force on Climate-related Financial Disclosures[22] titled *Physical Climate Change Risk Modelling.* The general findings from this evaluation were that all asset types may be more vulnerable to risk from at least one climate hazard in future years. National Grid created response recommendations based on the hazard type and risk level, from monitoring low-risk assets during a climate event, to proposing resilience projects for funding and implementation for high-risk assets.

These studies preceded this CCRP and have informed National Grid's investment plan for FY24 to FY28, which includes a total investment in the resiliency category of approximately $887M. The resilience measures include targeted undergrounding, electricity storage, rebuilds, and feeder tie enhancements. Other grid modifications that enhance resilience by reducing restoration time and extent of an outage are also included in the investment plan, such as sub-transmission automation programs ($91M), installation of fault location, isolation, and service restoration devices (FLISR) in distribution and sub-transmission lines ($96M), energy storage ($9M), and microgrids ($140M).

Another way National Grid seeks to improve resilience is to assess the impact of specific severe weather events on its system to develop recommendations for improvements going forward. One recent example was in response to the December 2022 Winter Storm Elliott, an event which brought multi-day blizzard conditions to Buffalo, New York, forcing a number of distribution stations to be de-energized due to blowing snow burying electrical equipment. National Grid implemented a response plan to install barriers to prevent snow build up and mitigate forced customer outages if a similar extreme weather event were to occur in the future.

In 2022, National Grid created internal deep-dive groups (DDGs) to investigate climate hazard vulnerabilities and resilience measures for electrical substations, transmission lines, and distribution lines (which include sub-transmission assets). The DDGs include subject matter experts across various teams, including Forecasting, Engineering, Standards & Work Methods, Planning, Asset Management, Operations, Reliability, and Emergency Planning. Their findings informed the vulnerability assessment in the CCVS and the identified resilience measures for the CCRP.

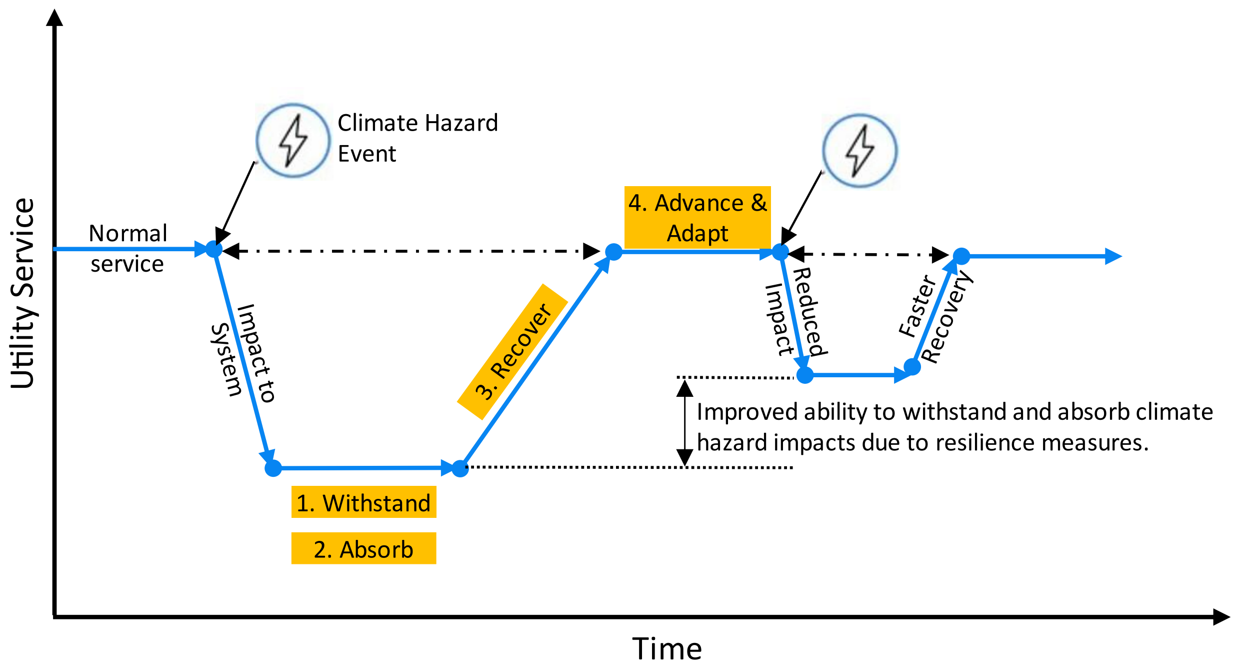
4.2 Proposing Resilience-Related Measures

The resilience measures identified in this CCRP were identified as a result of the subject matter experts' analyses of the available climate data and findings from the CCVS.

To ensure a range of solutions is used to achieve resilience, National Grid reviewed resilience measures under a framework that explores alternatives to target four key objectives: Strengthen & Withstand, Anticipate & Absorb, Respond & Recover, and Advance & Adapt. Figure 4 provides a graphical depiction of the resilience framework.

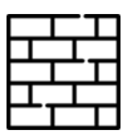
[22] The Task Force on Climate-related Financial Disclosures (TCFD) is an Environment, Social and Governance (ESG) disclosure framework that aims to improve and increase reporting of climate-related financial information by companies. https://www.fsb-tcfd.org/.

Figure 4. Multi-pronged resilience framework



The first two objectives (Strengthen & Withstand and Anticipate & Absorb) focus on reducing the level of disruption in the service level through physical measures. The other two objectives (Respond & Recover and Advance & Adapt) focus on enhancing resilience in planning, design, and operational practices. These objectives are described in the following sub-sections, and the resilience projects, programs, and investment plan are presented in Section 5. The planning and operational resilience measures are discussed in Section 4.3.

4.2.1 Strengthen & Withstand



As discussed in the CCVS, National Grid's assets are projected to be more exposed to climate hazards in the future. This resilience objective explores measures that provide physical strength to assets to withstand structural loads that may occur during extreme weather events (e.g., extreme wind gusts or additional weight from radial icing).

4.2.2 Anticipate & Absorb

This objective explores resilience measures that reduce impacts to electrical service should an asset fail, regardless of physical strengthening. These types of measures limit the level or propagation of the service disruption that may occur.

4.2.3 Respond & Recover

This objective is focused on activities and procedures designed to restore the service to normal levels in the aftermath of a climate hazard event. These are incorporated into planning, design, and operational practices.

4.2.4 Advance & Adapt

This objective addresses a continuously changing climate hazard landscape and the need for perpetual improvement in resilience. This is achieved by learning from previous experiences and sustaining investment in resilience, so that the next time the electric system is exposed to a similar climate hazard event, the level of disruption is reduced. These learnings are incorporated into planning, design, and operational practices. The application of new technologies can also help achieve this objective, which is further detailed in Section 4.4.

4.3 Incorporating Resilience into Planning, Design, and Operational Practices

In addition to physical resilience investments, National Grid is seeking to build on existing standards and processes to reflect the findings of the CCVS. These measures can also be grouped under the multi-pronged resilience framework, with the exception of the "strengthen and withstand" objective, which only applies to physical resilience measures.

Anticipate and Absorb

As part of planning and preparation activities in the event of a forecast of severe weather, National Grid presently alerts its customers to the possibility of service interruptions. This practice is described in the Company's Emergency Response Plan (ERP), and includes the following, among other things:

- Issuing press releases prior to a major climate event.
- Updating the Company's website storm pages and adding notes on the outage central page.
- Communicating with customers through social media channels.
- Directly contacting customers designated as Critical Facilities, Life Support Equipment Customers, and Special Needs Customers.
- Keeping key stakeholders, elected officials, and regulators informed of the plans of action prior to a storm.

Respond and Recover

As outlined in the ERP, National Grid will continue to carry out activities that enable efficient response and recovery after a climate hazard event. This involves performing a minimum of four electric exercises per year. The exercises are conducted to evaluate the capability to execute one or more portions of the Electric Emergency Response Procedures and engage employees to be prepared, respond to, and recover from an emergency. This is beneficial in that it allows the Company to test and evaluate plans and policies, improve coordination and communication, clarify roles, train personnel, and boost individual performance. These exercises include the following:

- Training discipline and function-specific workshops to thoroughly review the roles and responsibilities to be performed as part of the emergency planning, preparation, and response.
- Working collaboratively with emergency management partners, elected officials, regulators, and other utilities in New York and across the United States to plan for emergency response.

Advance and Adapt

National Grid will continue to drive organizational resilience through the following activities and upgrades to design standards:

- Conducting performance reviews after a major event to identify opportunities for improvement in future events.
- Updating transmission structure design standards to withstand higher wind gusts per MIT projections, specific to each structure's location and up to 120 mph wind gusts.
- Updating ambient and maximum temperatures for substation transformer specifications, from the current daily average of 32°C (90°F) to 35°C (95°F).
- Incorporating best-available flood risk data, as they become available, to identify substation flood mitigation projects.

4.4 Applying New Technologies

National Grid will continue to explore the adoption of new and emerging technologies that could contribute to physical and operational resilience. For example:

- Installing FLISR systems: This technology automatically restores power to as many customers as possible and as quickly as possible in the event of a persistent fault. It improves coordination between currently installed switching devices for protection or sectionalization purposes. National Grid's investment plan for FY24 to FY28 includes approximately $96M in FLISR systems for distribution infrastructure.
- Incorporating climate projections into planning: National Grid's Distribution and Transmission explorer software has been enhanced to include wind gusts and ice loading projections, providing greater visibility for the Distribution Planning and Asset Management (DPAM) and Transmission Planning and Asset Management (TPAM) teams.
- Updating current distribution design software modeling tools with the latest wind gust and icing climate data, such that information from climate projections can be applied at the local distribution infrastructure levels.
- Utilizing the newly developed visualization mapping tool to simulate impacts on distribution assets from combined wind gust and icing. As additional climate science data are released, the Company will continue to develop the tool's potential to integrate other climate hazard data.

5. Investment Plan

Six physical and four operational resilience programs are identified in this CCRP to address the key climate hazards addressed in the CCVS (i.e., high heat, inland flooding, high wind, and ice). To maximize efficiency in the implementation of resilience measures, existing capital expenditure projects were reviewed against the climate projections in the CCVS. As a result, the projects identified an incremental scope. For example, some substation transformers that had been identified to be replaced as part of the existing capital investment planning process are now proposed to be upgraded based on extreme temperature projections, as opposed to replacing them based on existing ambient temperature standards. The additional cost to upgrade the transformers is being proposed in this CCRP.

Justifications for each of the programs and projects are described below by asset type. For more details see Appendix C – Project Data Sheets (PDSs). Table 4 and Table 5 summarize the operational and physical resilience projects and programs, respectively, that are identified in this CCRP. The following icons below link the identified resilience projects and programs to the four objectives of the multi-pronged resilience framework.

Icon Key	
Strengthen & Withstand	Respond & Recover
Anticipate & Absorb	Advance & Adapt

Table 4. Operational resilience projects and programs

Operational Project/Program	Mitigated Climate Hazard(s)	Applicable Asset Type	Description
1. Substation Transformer Specification Changes	Extreme Heat	Substations	Due to increasing ambient average and maximum temperatures, transformer specifications will be updated from 32°C (90°F) to 35°C (95°F) for future builds.
2. Update Transmission Structure Standards	Wind Gusts	Transmission	Update transmission structure design guidelines to withstand wind gust projections of up to 120 mph based on structure locations and wind maps produced with MIT data.
3. Electric Load Forecasting	Extreme Heat	Distribution	Evaluate climate scenarios in the load forecasting practice.
4. Transmission Facility Rating Methodology Changes	Extreme Heat	Transmission	Update transmission facility rating methodology ambient temperature from present assumption of 35°C (95°F) to 40°C (104°F). Revised facility ratings will be incorporated into transmission system models and used in planning studies.

Table 5. Physical resilience projects and programs

Physical Project	Mitigated Climate Hazard	Description	FY Start	FY End	Total Cost[23] (Capex)
1. Overhead Distribution and Sub-transmission Line Design Upgrades*	Wind Gusts and Ice	Update distribution line standards to move from Class 3 poles to Class 1 for main lines and poles that carry heavy equipment (approximately 8,000 poles/year) and update sub-transmission line standards to use Class 1 poles for single circuit structures, Class H1 for double circuit structures, and Class H2 for double circuit with distribution underbuilds (approximately 900 poles/year).	2026	2045	$879M
2. Overhead Transmission Line Design Upgrades*	Wind Gusts and Ice	Build T-Lines to withstand 120 mph wind gusts in high wind areas (46 total) by using more steel and larger foundations. Projects include 44–115kV lines and 2–230kV lines (approximately 1,300 circuit miles covered).	2026	2045	$109M
3. Distribution Targeted Undergrounding	Wind Gusts and Ice	Targeted undergrounding of 1–2 miles per year of 3-phase main line in highest wind and icing areas.	2027	2045	$348M
4. Spare Transmission Line Structures	Wind Gusts and Ice	Purchase 10 T-Line spare structures per division (30 total) designed for 120 mph gusts to speed restoration.	2026	2030	$2M
5. Substation Flood Walls	Flooding	Install flood walls at 18 substations in high-risk areas (approximately 17,000 linear feet of flood walls total).	2027	2033	$28M
6. Distribution and Transmission Substation Transformer Specification Upgrades*	Extreme Heat	Update transformer spec from 32°C (90°F) to 35°C (95°F). Current plans include 35 distribution projects (81 transformers) and 24 transmission projects (37 transformers) with installs and replacements.	2026	2031	$25M
*Added scope to existing projects					

Substations

Substation transformers are currently designed to withstand an average ambient temperature of 32°C (90°F). However, by the 2050s, climate projections show that temperatures may rise in some areas to 35°C (95°F). Operating substation transformers at temperatures higher than the design threshold would lower their capacities and potentially result in transformer loss-of-life or damages. Ultimately, this could cause transformer failures and outages. National Grid has developed an operational resilience program and a physical resilience program to address this risk, both of which contribute to the "advance and adapt" objective of the resilience framework.

- Operational: Upgrade substation transformer specifications to withstand projected increases in ambient temperature to 35°C (95°F) for all future builds.

[23] These costs are over the 20 years of the CCRP (FY26 to FY45).

- Physical: Currently, National Grid has existing projects to replace substation transformers as part of the Company's capital investment plans. In this CCRP, the Company identified transformers to be replaced with the updated temperature design standard, including 81 distribution substation transformers and 37 transmission substation transformers, based on current plans. Only the additional cost to upgrade the temperature design standard is included in the investment plan.

Substations are also susceptible to flooding, which can cause damage to critical equipment such as transformers, breakers, and protection and control systems. These impacts may cause lengthy outages for thousands of customers. To address this risk, National Grid developed a new physical measure under the "strengthen and withstand" objective.

- Physical: Based on the results of the CCVS, National Grid will implement flood risk mitigation projects for 18 substations. While relocating or raising substation equipment may protect against flooding, flood wall installations were identified as the most cost-effective solution for these substations.

Transmission Lines

Currently, overhead transmission lines are designed to withstand 95 mph gusts. Some areas, however, may see gusts reaching up to 120 mph based on MIT's wind speed projections used for the analysis in the CCVS. If a line has just one or more structure failures, entire substations without transmission line redundancy may experience outages, resulting in tens of thousands of long duration customer outages. Additionally, transmission facilities are currently rated based on a maximum ambient temperature of 35°C (95°F), a design threshold which is projected to be exceeded. To address these risks, National Grid has developed two operational resilience programs (contributing to "advance and adapt") and two physical resilience programs (contributing to "strengthen and withstand" and "respond and recover" objectives).

- Operational: Upgrade transmission structure design guidelines for all future structures in locations that are projected to experience wind gusts of up to 120 mph.
- Physical: Currently, there are numerous existing transmission line projects that include structure replacements or additions based on existing design standards as part of the Company's capital investment plans. In this CCRP, the Company identified 46 transmission line structures in high wind areas to be upgraded to withstand up to 120 mph wind gusts. Only the additional cost to upgrade the structure design is included.
- Physical: Purchase 10 transmission line spare structures per division (30 total) designed for 120 mph gusts to speed restoration.
- Operational: Update transmission facility rating ambient temperature from present assumption of 35°C (95°F) to 40°C (104°F) and incorporate the revised facility ratings into transmission system models and used in future planning studies.

Distribution Lines

Distribution and sub-transmission lines are currently designed to withstand combined 40 mph wind gusts and 0.5 inches of icing; however, future projections indicate some areas may experience over 100 mph wind gusts or 0.75 inches of icing. To avoid long-term outages for thousands of customers, National

Grid has developed two physical programs to strengthen poles and minimize the impacts of wind and ice events, both of which contribute to the "strengthen and withstand" resilience objectives.

To better forecast load as temperatures increase, National Grid has developed an operational measure to incorporate climate scenarios in load forecasting practices. This measure is anticipated to contribute to the "anticipate and absorb" resilience objective.

- Physical: Upgrade design standards from typical Class 3 poles to Class 1 going forward. Currently, it has been planned to replace approximately 8,000 distribution poles and approximately 900 sub-transmission poles per year, on average. The pole replacements are part of existing projects and only the additional cost to upgrade the pole class is included.
- Physical: Underground 1 to 2 miles of distribution lines per year. This undergrounding would be a new project, incremental to what is currently planned.
- Operational: Include climate scenarios in the load forecasting practice.

The proposed project and programs support National Grid's goal of delivering a more robust and resilient electric system. The development of these programs was guided by National Grid's DDGs, with subject matter expertise and within the context of criticality and historical climate hazard impacts. The BCJ framework, discussed in Section 5.2, characterizes the system reliability, criticality, and community resilience benefits of the selected resilience projects and programs across the electric system.

5.1 Business Case Justification (BCJ) Framework

The BCJ helps National Grid characterize the benefits of the selected resilience projects and programs. The BCJ is scored across three considerations: system reliability, criticality, and community resilience (Figure 5). The three considerations and associated scoring is discussed in detail in Sections 5.1.1, 5.1.2, and 5.1.3. After these scores are calculated, they are used to determine the BCJ Score out of 100%.

Figure 5. Business Case Justification considerations

System Reliability (scored from 1 to 5)

- This score provides insight to whether a resilience measure being proposed is in an area with historically lower reliability relative to others in the service territory.

Criticality (scored from 1 to 5)

- This score is based on the count of critical facilities (Tier 1 and Tier 2) that provide health and safety-related services to the community (e.g., hospitals, police stations, water treatment plants, and shelters) associated to each substation

Community Resilience (scored from 1 to 5)

- This score provides insight on the extent and likelihood of commercial and residential activity loss in the region due to an electrical outage. It is based on the outage duration, the count of critical facilities (Tier 1, 2, and 3) and the population they serve, the number of customers served, and likelihood of exposure to a climate hazard.

As explained above, some of the projects listed in the CCRP are incremental to existing projects with a planned schedule and priority. The BCJ does not dictate the priority of investment. Instead, it characterizes the potential of the project to realize benefits for the system and the community it serves. A score closer to 100% indicates a higher improvement potential regarding system reliability and community resilience relative to other assets. The result of this scoring is presented in Section 5.2.

The BCJ score may inform project prioritization for future projects. National Grid will work to incorporate these top-scoring assets into its Copperleaf tool, which enables capital project optimization that informs project priority based on value models. The value models are project-type specific (e.g., resiliency projects) and include asset health and condition, and number of critical facilities. Although not counted toward the value model, the tool also provides visibility for whether the project serves a disadvantaged community or not. Going forward, National Grid will work to incorporate resilience benefits as part of the value models for resiliency projects.

5.1.1 System Reliability Score

The system reliability score provides insight to whether a resilience measure is being proposed in an area with historically lower reliability relative to others in the service territory. This score is composed of four categories: the number of outage-causing events, number of Customer Hours Interrupted (CHI), System Average Interruption Frequency Index (SAIFI), and Customer Average Interruption Duration Index (CAIDI).[24]

The total number of feeders on the system are individually ranked based on the above four categories. These are then totaled for each feeder, and the feeder with the highest combined score is the Worst Performing Feeder (WPF). The feeder rank score is used to obtain a quintile score, which becomes the reliability score. The WPFs receive a score of 5, and the best performing feeders receive a score of 1. Table 6 shows the cut-off values of each quintile score for feeder rank and Table 7 shows an example of the reliability score calculation.

Table 6. Feeder rank quintile scores

Quintile Score	Feeder Rank[25]
1	0 – 1,832
2	1,833 – 3,673
3	3,674 – 5,201
4	5,202 – 6,557
5	6,558– 8,397

[24] The score also uses the System Average Interruption Duration Index (SAIDI).

[25] Feeder ranks are based on 2022 data.

Table 7. Reliability scoring example

Substation Name	Number of Events	CHI	SAIFI	CAIDI	SAIDI	Feeder Rank	Reliability Score
East Pulaski	38	16,936	2.07	0.59	8.31	8,058	5
Tonawanda Creek	11	4,235	1.10	1.6	1.76	6,515	4
Buffalo Station 41	2	587	1.01	2.13	2.14	5,173	3

5.1.2 Criticality Score

The criticality score identifies the avoided impact of an outage to Tier 1 and Tier 2[26] customers by analyzing the total number of those types of customers that each feeder serves. Tier 1 and 2 customers are facilities deemed critical to the overall health and safety of the community and its members. They include hospitals, emergency responder facilities, water treatment facilities, municipal buildings, and buildings designated as evacuation shelters. When calculating the criticality score for a distribution or transmission substation, the highest quintile of all the associated feeders is rolled up to the substation. If a transmission substation does not have a feeder associated with it, the value of the nearest distribution substation is rolled up to it. When calculating it for transmission lines, the highest quintile of all the associated substations is rolled up to the transmission line.

Criticality scores for each feeder were ranked from 1 to 5 based on the criteria shown in Table 8; an example is shown in Table 9.

Table 8. Feeder rank for criticality

Score	Criteria
1	Tier 1 and Tier 2 facility count is 0
2	Tier 2 facility count is between 1 and 3 and Tier 1 facility count is 0
3	Tier 2 facility count is more than 3 and Tier 1 facility count is 0
4	Tier 1 facility count is between 1 and 4
5	Tier 1 facility count is more than 4 facilities

[26] Tier 1 facilities include hospitals and facilities with life-sustaining equipment, shelter or evacuation centers, fire or police headquarters, mass transit, major airports, and essential government buildings. Tier 2 facilities include essential communications facilities, senior housing complexes and nursing homes, and key municipal facilities like town halls and jails.

Table 9. Criticality scoring example

Substation Name	Tier 1 Critical Facilities Count*	Tier 2 Critical Facilities Count*	Criticality Score
East Pulaski	3	1	4
Tonawanda Creek	1	0	4
Buffalo Station 41	5	1	5
*This is the maximum critical facility count of all feeders associated with the substation, not the aggregate of all feeders associated with the substation. Aggregating the critical facility count of all feeders is not required because the criticality of a single feeder would define the associated substation's criticality.			

5.1.3 Community Resilience Score

The community resilience score provides insight into the extent and likelihood of commercial and residential activity loss in the region, due to an electrical outage caused by a climate hazard. This score is based on the sum of an asset's Community Avoided Loss (CAL) and Avoided Impact to Critical Facilities (AIC), multiplied by the annualized likelihood of exposure. CAL is the product of the outage duration specific to a climate hazard and the number of customers served by the asset. AIC is the product of the estimated outage duration specific to a climate hazard, the regional population potentially served by critical facilities (Tier 1, Tier 2, and Tier 3), and the total number of critical facilities served by the asset. Lastly, the likelihood of exposure (i.e., the annualized likelihood of recurrence of each climate hazard based on the findings from the CCVS) is factored into the score. Each component of the scoring is explained in further detail below.

Estimated outage duration by climate hazard

The outage duration is defined by a threshold of exposure to a climate hazard or survivability of the asset. Outage duration should be understood as the time to restore power, even if it is through temporary measures (e.g., mobile generators). Table 10 describes the assumed outage duration for substations and flooding and the associated justification.

Table 10. Outage duration for substations and flooding

Flood Depth (feet)	Assumed Outage Duration (days)	Justification of Assumption
1 – 2	1	This flood depth may reach transformers, switchgears, and capacitor banks. These components are commonly placed on a 6-inch or thicker concrete slab, and the components within the enclosure may be a foot above the bottom of the enclosure. Damage to this equipment may be limited; only drying and cleanup might be required. In addition, this flood depth would not impede emergency vehicles to access the site to conduct repairs or bring auxiliary equipment.
2 – 4	3	This flood depth may submerge and damage the equipment listed above and reach critical control components. Some equipment may need to be replaced or bypassed. Access to the site may be impeded until flood recedes.

Flood Depth (feet)	Assumed Outage Duration (days)	Justification of Assumption
> 4	7	Flooding causes permanent damage to electrical components and control equipment. Floating debris may cause structural damage to equipment support structures (e.g., elevated platforms). Major equipment replacement and complete bypass of substation is required by means of temporary mobile equipment. Access to site is impeded until flood recedes.

For extreme heat and substation transformers, outage duration is a result of load shedding, or the length of time power is suspended to customers to prevent permanent equipment damage, which would result in the need for equipment repair or replacement. Average ambient temperatures that exceed the 32°C (90°F) threshold, the design standard presently used by National Grid, can reduce the effective capacity of substation transformers and accelerate aging of internal components. In addition to affecting the capacity of the equipment, high ambient temperatures generally result in increased daily peak demand. It is assumed that these effects of extreme temperatures increase the potential for load shedding to avoid damaging equipment by overloading transformers. Therefore, for every 24 hours where the daily average ambient temperature is above 32°C (90°F), it is assumed to result in 8 hours of outage time, due to load shedding. If the daily average is above 32°C (90°F), it is assumed that peak ambient temperatures last around 8 hours (e.g., 10:00 am to 6:00 pm). For consecutive days with daily averages above 32°C (90°F), it is assumed that the outage duration would be aggregated by day (e.g., 48 hours of exposure equates to 16 hours of outage time). The outage times are listed in Table 11.

Table 11. Outage duration for substation transformers and extreme heat

Number of Consecutive Days Exposed to Extreme Heat	Assumed Outage Duration (hours)
1	8
2	16
3	24

For wind or ice, the T&D line outage duration is based on an analysis of the time it took to restore service after historical major events that affected National Grid infrastructure. The analysis was carried out at a regional level with records from 2011 to 2023. The results are presented in Table 12.

Table 12. Outage duration for transmission and distribution lines and wind or ice

Region	Outage Duration (days)
Capital	2.3
Central	1.9
Frontier	2.3
Genesee	2.0
Mohawk	1.9

Region	Outage Duration (days)
Northeast	2.4
Northern	2.5
Southwest	1.7

Commercial and residential activity loss

CAL is the estimated impact of loss of electric power for residential and commercial customers. The values are based on the outage duration and number of customers served by the asset being scored. A CAL score example, at the feeder level, is presented in Table 13.

Table 13. CAL scoring example at the feeder level

Substation Name	Feeder	Outage Duration (days)	Customers Served (by feeder)	CAL
East Pulaski	16-32452	0.10*	1354	135.39
Tonawanda Creek	01-20653	1.00**	1856	1,856.00
Buffalo Station 41	01-4161	0.17*	13	2.17
*Based on exposure to extreme heat **Based on exposure to flooding				

AIC is the estimated impact of a critical facility losing electric power per capita (i.e., population in the region). The population for each region within the service territory was retrieved from the latest census data[27] and is shown in Table 14.

Table 14. Population in National Grid's service territory by region

Region	Population
Capital	962,603
Central	1,603,242
Frontier	580,596
Genesee	735,846
Mohawk	273,038
Northeast	383,692
Northern	411,212
Southwest	724,316

A critical facility (Tier 1, Tier 2, and Tier 3)[28] is understood to provide essential services to the community, such as hospitals, nursing homes, college or school complexes, and utility facilities. Each essential facility was assumed to have the potential for a region-wide impact. For example, even though a hospital

[27] The United States Census Bureau, 2022. New York: QuickFacts. https://www.census.gov/quickfacts/fact/table/NY
[28] Tier 3 includes customers providing key products and services, public safety facilities, colleges and university complexes, and urgent care facilities.

represents one customer, it has the potential of serving the entire region in which it is located. An AIC score example, at the feeder level, is presented in Table 15.

Table 15. AIC scoring example at the feeder level

Substation Name	Feeder	Outage Duration (days)	Regional Population	Number Critical Facilities Served	AIC
East Pulaski	16-32452	0.10*	1,603,242	6	961,849
Tonawanda Creek	01-20653	1.00**	580,596	1	580,596
Buffalo Station 41	01-4161	0.17*	580,596	7	677,294
*Based on exposure to extreme heat **Based on exposure to flooding					

Likelihood of exposure

As part of the CCRP, National Grid evaluated the exposure of various currently planned projects to climate hazards. The planned projects that presented exposure to climate hazards were selected to add climate risk mitigation to the scope of work. The annual recurrence probability associated with these climate hazards is the last component of the community resilience score. The annual recurrence probabilities used for the exposure analysis are shown in Table 16.

Table 16. Likelihood of exposure to climate hazard

Climate Hazard	Exposure Likelihood
Wind	1%*
Ice	1%*
Extreme Heat	2%**
Flood	1%***
* Average number of storms per year, from 2011-2023 ** Ambient temperature to determine outage duration was based on a 1-in-50-year heat event *** Flood depth to determine outage duration was based on a 1-in-100-year storm event	

The final community resilience score of an asset is expressed in quintiles. Quintiles were calculated based on the sum of an asset's CAL and AIC, multiplied by the likelihood of exposure. Table 17 shows the cut-off values of each quintile score, which characterizes the potential level of disruption to commercial and residential activity, and essential services.

Table 17. Values associated with the community resilience score at a feeder level

Quintile Score	(CAL+AIC) * Exposure Likelihood
1	0 – 10
2	10 – 100
3	100 – 10,000
4	10,000 – 100,000
5	> 100,000

For substations, the quintile score thresholds increase as the feeder values are aggregated to the associated substation. These are shown in Table 18.

Table 18. Values associated with the community resilience score at a substation level

Quintile Score	(CAL+AIC) * Exposure Likelihood
1	0 – 100
2	100 – 10,000
3	10,000 – 100,000
4	100,000 – 1,000,000
5	> 1,000,000

A community resilience score example, at the feeder level, is presented in Table 19.

Table 19. Community resilience scoring example at the feeder level

Substation Name	Feeder	Outage Duration (days)	Likelihood	CAL+AIC	CAL+AIC* Likelihood	Community Resilience Score
East Pulaski	16-32452	0.10	2%*	961,984	19,239	4
Tonawanda Creek	01-20653	1.00	1%**	582,452	5,824	3
Buffalo Station 41	01-4161	0.17	2%*	677,296	13,546	4
*Based on exposure to extreme heat **Based on exposure to flooding						

5.2 Business Case Justification Results

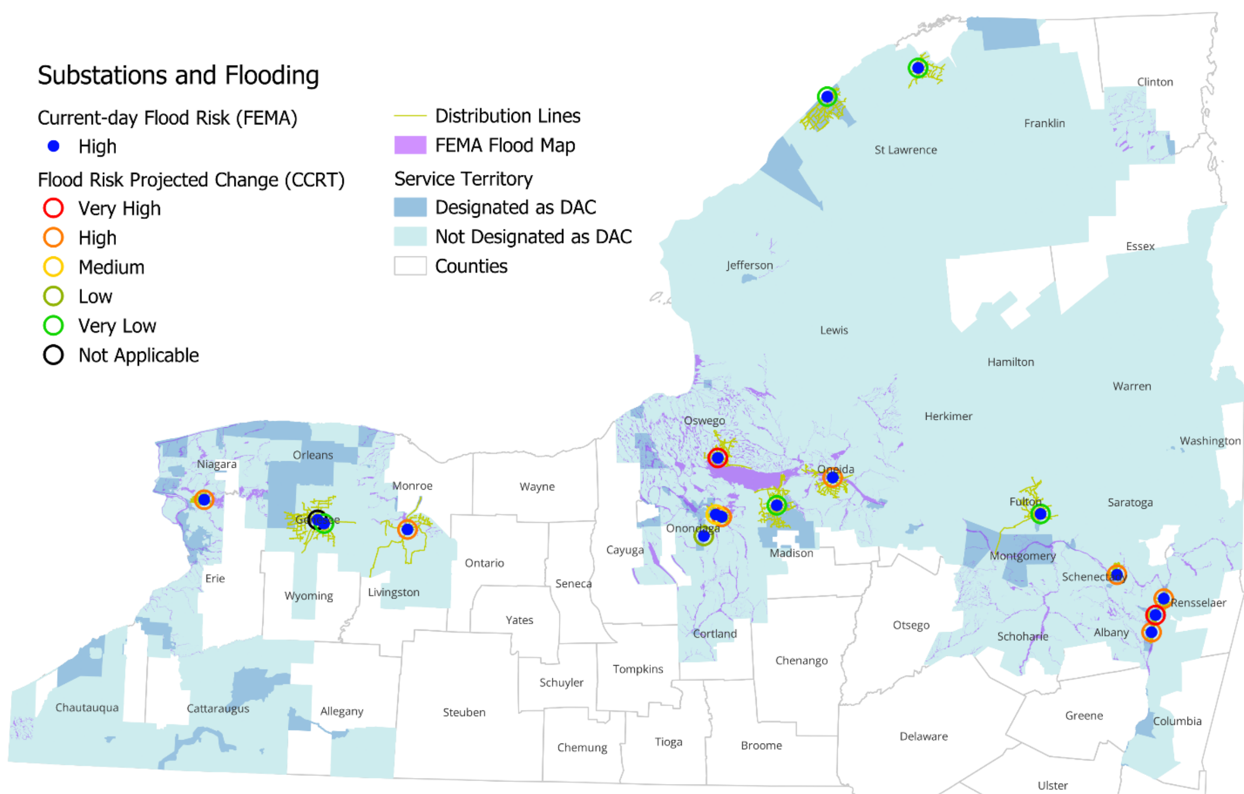
As discussed in Section 4.1, National Grid assembled DDGs composed of subject matter experts across various teams, including Forecasting, Engineering, Standards & Work Methods, Planning, Asset Management, Operations, Reliability, and Emergency Planning. These groups were involved in the identification of vulnerabilities and potential resilience measures. Based on the findings of the CCVS, and institutional knowledge of the DDGs, a preliminary list of assets was selected to be further analyzed through the BCJ process. The resulting scores, which justify the investment of resilience measures for these assets, are presented in the following sections.

5.2.1 Substations

The priority climate hazards identified for substations are flooding and extreme heat, as discussed in the CCVS. National Grid proposes to enhance the resilience of substations to flooding by constructing a flood wall around the selected substations. A flood wall protects the substation and its critical infrastructure from floodwaters and reduces the likelihood of associated outages. While other measures, like elevating assets or rebuilding substations outside the floodplain, are alternatives for flood risk mitigation, it was determined that building floodwalls was a more cost-effective option.

Distribution substations identified for flood mitigation projects, 8 in total, had BCJ scores ranging from 67% to 100%, and 75% of the substations selected serve disadvantaged communities. Transmission substations identified for flood mitigation projects, 10 in total, had BCJ scores ranging from 53% to 93%, and 80% of the substations selected serve a disadvantaged community. See Appendix D – Selected Mitigation Projects for the list of substations identified to receive resilience measures for flooding, and their BCJ scores. Figure 6 shows the location of the distribution and transmission substations selected for flood mitigation, which are all in a current-day FEMA floodplain. Additionally, National Grid's CCRT utilizes rainfall projection data to inform the future change in flood risk, ranging from very low to very high.

Figure 6. Substations selected for flood mitigation and associated distribution feeders



Upgrading transformer specifications from the current daily ambient temperature threshold of 32°C (90°F) to 35°C (95°F) will reduce the likelihood of the load capacity of transformers being reduced during extreme heat events and enhance the ability to serve customers while experiencing high temperatures.

Without investment to enhance design standards, substation transformers can experience accelerated degradation and result in more frequent customer outages due to load shedding.

Appendix D – Selected Mitigation Projects lists the distribution and transmission substations identified for transformer upgrades, with their respective BCJ scores. Distribution and transmission substations identified for transformer upgrade projects, 58 in total, have BCJ scores ranging from 20% to 100%, and 67% of the substations serve disadvantaged communities. All projects listed are substation upgrades, refurbishments, or rebuilds included as part of the Company's latest Capital Investment Plan. Figure 7 shows the location of substations selected for transformer design standards upgrades.

Figure 7. Substations selected for transformer design standards upgrades for extreme heat adaptation

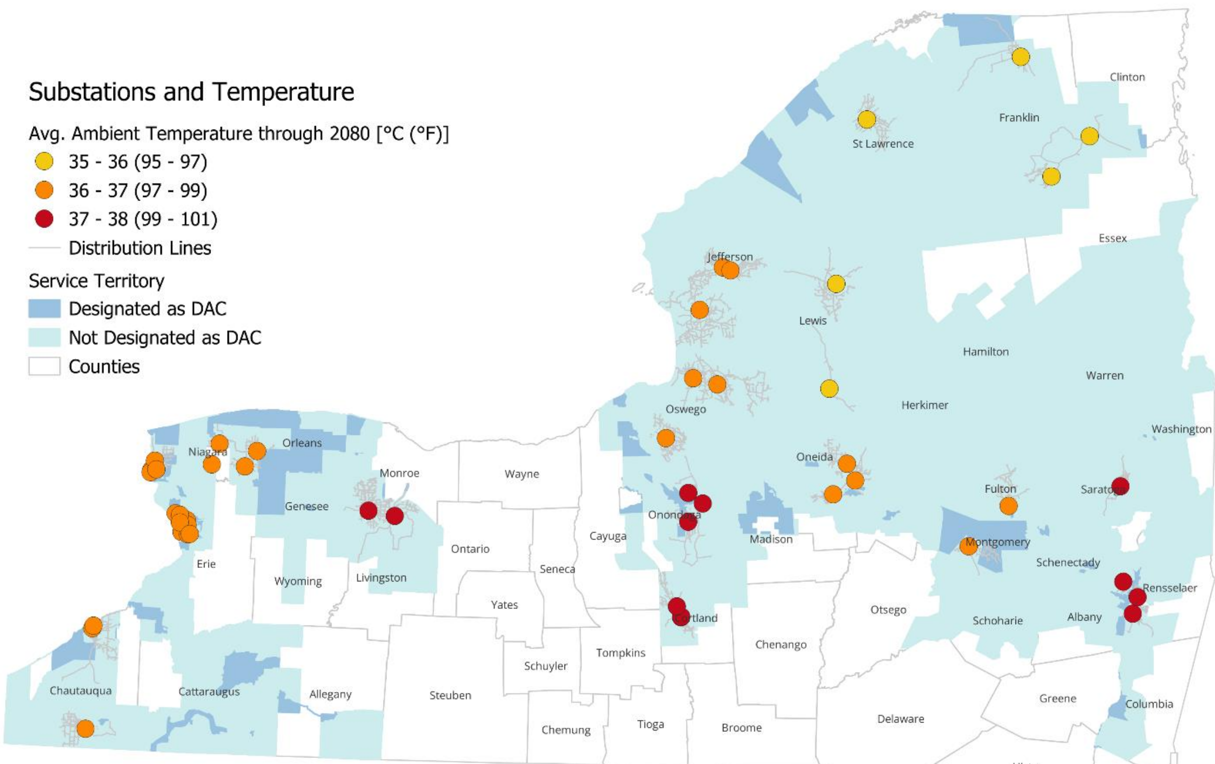


Table 20 summarizes the scope, cost, and start date for the two resilience programs for substations, including flood walls and upgrading transformer heat specifications.

Table 20. Substation resilience plan

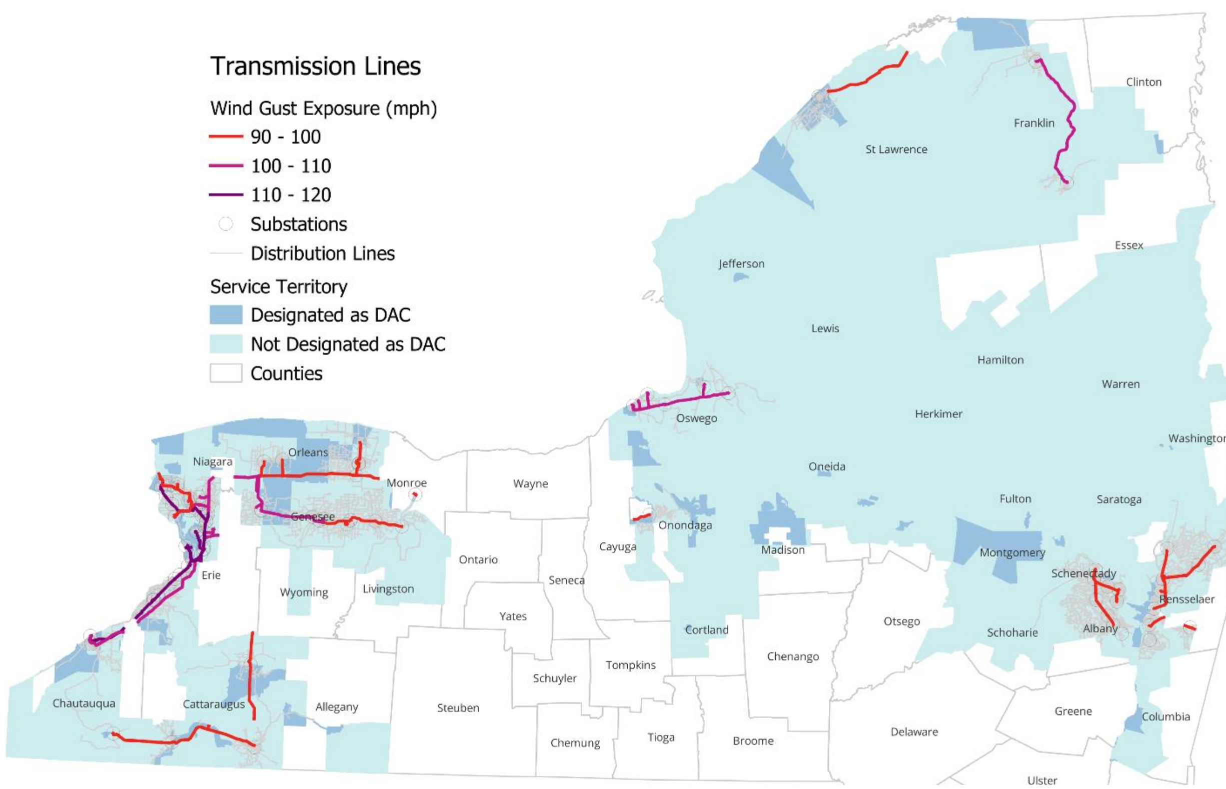
Substations Resilience Plan	Substation Mitigation	Incremental Cost Annually (FY26 – FY30)	Program Start Date
Substation Flood Walls	Approximately 17,000 linear feet of total flood wall	$19M	FY27
Distribution and Transmission Substation Transformer Specification Upgrades	Upgrade transformer specifications from 32°C (90°F) to 35°C (95°F)	$7M	FY26

5.2.2 Transmission Line

A review of transmission line projects within the long-term portfolio was conducted to determine which projects include assets that are projected to be exposed to extreme wind gusts (per CCVS wind projection maps derived from MIT's wind speed data). By designing the transmission structures to withstand up to 120 mph wind gusts in areas that are projected to be exposed to higher wind gusts, transmission structures will be less likely to be damaged during wind events, making the electric system more resilient.

The Company identified 46 transmission lines to undergo support structure design upgrades to withstand higher wind speeds. These lines had BCJ scores ranging from 20% to 100%. In addition, 83% of the transmission lines supported by the structures identified for design upgrade serve disadvantaged communities. Transmission lines selected for structure design upgrades are mapped in Figure 8 and listed in Appendix D – Selected Mitigation Projects, along with their respective BCJ scores.

Figure 8. Transmission lines selected for structure class upgrade



In addition, National Grid is seeking to increase the number of spare structures within each division that will be able to withstand 120 mph wind gusts. This will allow for more timely service recovery, should a transmission structure fail due to high wind gusts or ice accumulation. It will also ensure that the structure installed during service recovery is designed to withstand higher wind speeds to reduce the likelihood of repeat failure at the same location. These measures will enhance National Grid's ability to withstand more extreme wind gusts and ice events and bolster the ability to efficiently restore service when needed. Table 21 provides estimates of the incremental costs to upgrade the transmission structure design standards and to acquire spare structures.

Table 21. Transmission line upgrades plan

Structures Resilience Plan	Structure Mitigation	Incremental Cost Annually (FY26 – FY30)	Program Start Date
Overhead Transmission Line Design Upgrades	Upgraded construction class	$33M	FY26*
Spare Transmission Line Structures	Upgraded construction class	$2M	FY26
* Program will begin in FY26 and ramp up, meaning that the annual spending will vary.			

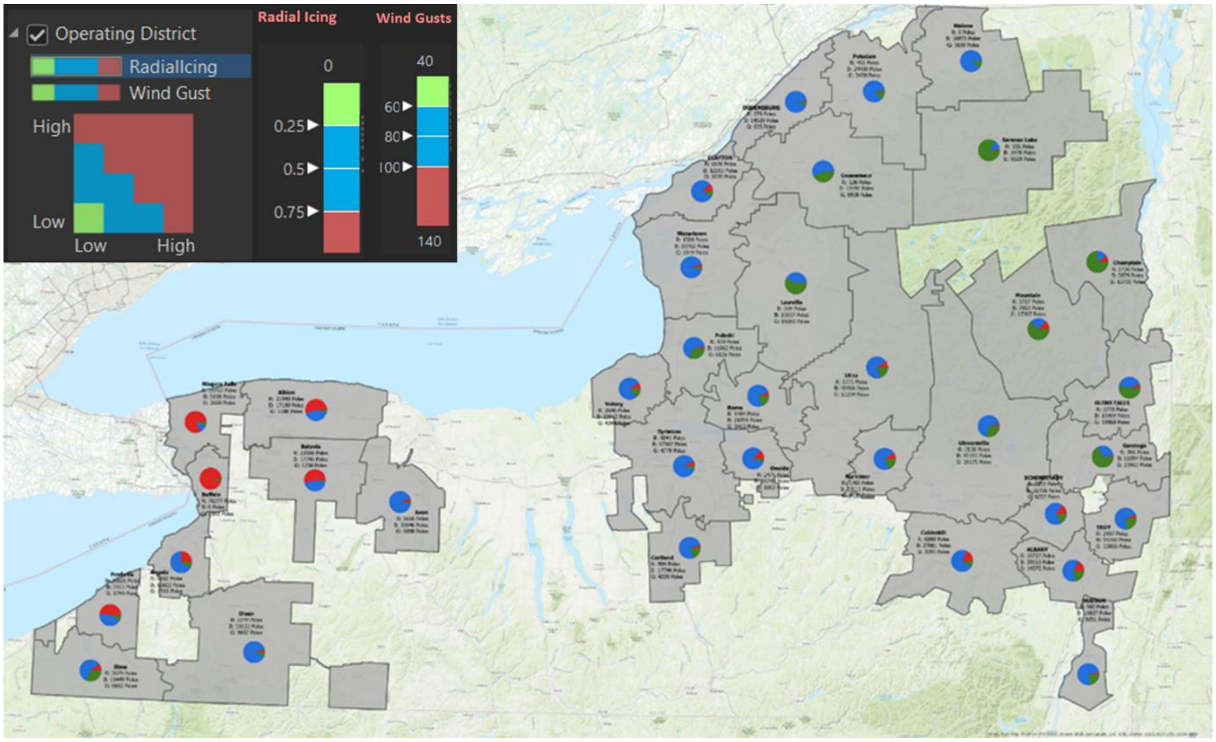
5.2.3 Distribution Line

National Grid has developed projects to upgrade distribution line design standards to withstand more than the currently required National Electrical Safety Code (NESC) loading of 0.5 inches of icing and 40 mph wind gusts. These projects will harden the system and increase resiliency to extreme weather events. Similar to the storm hardening measures that were incorporated into distribution line design standards in 2018 after Superstorm Sandy, National Grid seeks to invest in stronger distribution poles that support significant equipment (e.g., regulators, capacitor banks, and ratio transformers) and 3-phase mainline. This is expected to reduce toppled and damaged infrastructure (such as poles and conductors) due to high wind gusts and ice events.

Figure 9 shows, in green, the number of distribution poles for which Class 3[29] poles are sufficient to withstand the projected climate-driven increase in ice and wind loading, which represents 16% of National Grid's distribution system. Poles in this "green" category are expected to be able to withstand changing climate conditions. Eighty-four percent of National Grid's system is in the "blue" or "red" categories and would be vulnerable if built to National Grid's current standards (Class 3 pole). Therefore, they are candidates for storm hardening. Red category poles specifically, comprising 17% of the system, could be vulnerable even if built to the largest available wood pole class and are candidates for targeted undergrounding, which is described in Section 5.2.4.

[29] Pole Class indicates the thickness of a pole. Typical classes, listed in order of strength, include Class 2, Class 1, Class H1, and Class H2.

Figure 9. Current pole count by operating district according to combination of wind/icing values



Due to the inherent uncertainty as to which areas will ultimately encounter harsh conditions, hardening the system requires a balance of breadth and depth. Investing only in one area leaves much of the system vulnerable even if it minimizes hazards in one area. It would be cost prohibitive to underground the 17% of the system that falls into the red category, and focusing only on undergrounding would leave the remaining system as vulnerable as before. Since no measure fully eliminates risk, hardening the system also requires a balance between being reliable and withstanding the exposure to climate hazards. Class H2 poles require specialized equipment for distribution applications and have longer supply chains, making it expensive and logistically difficult to install them even during blue sky days and extending outage times if they do fail. Although underground lines have a lower frequency of failure, the duration to repair is typically much longer compared to overhead lines.

To balance these factors, National Grid proposes a hardening approach that provides benefits across the system for the assets that need it most. Across its system, National Grid will upgrade Class 3 poles to Class 1 wood poles or cost-effective equivalent fiberglass, steel, or pre-stressed concrete poles if they are on a 3-phase mainline to ensure the backbone of the system is strong. After the mainline, 3-phase poles that carry significant equipment (e.g., regulators, capacitor banks, and ratio transformers) are the next priority for upgrades. At the same time, National Grid will target the poles in the red category, in the areas that most need it, for undergrounding.

The decision to go with Class 1 wood or equivalent poles for the significant equipment and 3-phase mainline structures was a combination of maximizing the resilience of these structures while minimizing the economic impact to customers. Supply chain considerations were also included in the decision making. As utilities across the United States upgrade their pole plants, the availability of the higher-class poles continues to be the pinch point within the supply chain. As a result, National Grid is responding to the wood pole supply chain issues by sourcing alternative material wood pole equivalent structures. Table 22 provides estimates of the incremental costs to upgrade distribution pole design standards.

Table 22. Distribution line structure upgrades plan

Structures Resilience Plan	Structure Mitigation	Incremental Cost Annually (FY26 – FY30)	Material Impacts	Program Start Date
3-Phase Mainline Structures	Install Class 1 Wood Poles or equivalent	$12M – $27M	700% Additional Class 1 Poles Annually	Program will begin in FY26 and ramp up
Significant Equipment Structures (Regulators, Cap Banks, Ratio Transformer)	Install Class 1 Wood Poles or equivalent	$1M – $2M	30% Additional Class 1 Poles Annually	

5.2.4 Distribution Line Targeted Undergrounding

National Grid is proposing investment in a targeted undergrounding program as a solution to harden the system and be more resilient to extreme weather events. The Company plans to target 3-phase mainline sections of distribution feeders and will be utilizing the following criteria: 1) feeder has been identified as a WPF in the past five calendar years, 2) SAIFI impact of tree and wind gust events on those feeders in the last five calendar years, 3) located in an area with projected wind gusts in excess of 50 mph, and 4) located in an area with projected 0.75 inches of ice accumulation. This approach considers the economic costs to underground sections of the system and the benefits from hardening the system against extreme tree, wind, and icing weather impacts. Table 23 provides estimated costs of the proposed distribution line targeted undergrounding plan.

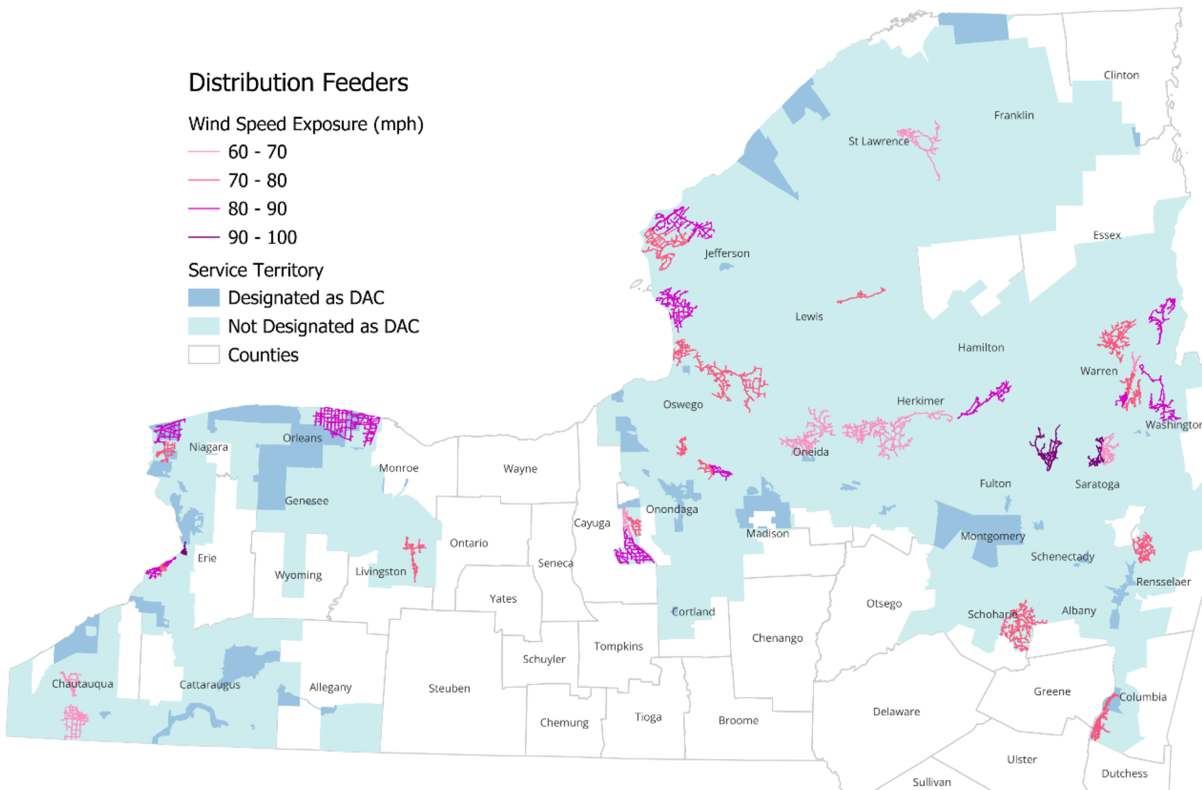
Table 23. Distribution line targeted undergrounding plan

Structures Resilience Plan	Structure Mitigation	Incremental Cost Annually (FY27 – FY30)	Program Start Date
Distribution Targeted Undergrounding	Underground 3-phase Mainline Sections	$5.5M – $15M	FY27*
* Program will begin in FY27 and ramp up.			

The Company is prioritizing 50 distribution feeders[30] for targeted undergrounding, with BCJ scores ranging from 40% to 100%, and 4% of the distribution feeders serving disadvantaged communities. For a full list of feeders and associated BCJ scores, see Appendix D – Selected Mitigation Projects. Figure 10 maps the selected distribution feeders along with projected wind exposure ranges in miles per hour.

[30] National Gid plans to underground at a rate of 1-2 miles per year.

Figure 10. Distribution feeders and wind speed exposure (mph)



5.2.5 Sub Transmission

National Grid is proposing to upgrade sub-transmission line design standards to withstand more than what is currently required by the NESC loading standards to harden the system and be more resilient to extreme weather events. The Company is proposing to invest in stronger sub-transmission structures to account for additional ice accumulations and stronger wind gusts. The plan is to go with wood or equivalent (e.g., steel or laminate wood) pole as follows: Class 1 for single circuit structures, Class H1 for double circuit structures, and Class H2 for double circuit structures with distribution underbuilt (or with multiple third-party attachments). This approach considers the economic costs and the additional benefit of a hardened system, reducing pole failures and restoration times. Table 24 provides estimated incremental costs to upgrade the sub-transmission pole design standards.

Table 24. Resilience measure alternatives for sub transmission projects

Structures Resilience Plan	Structure Mitigation	Incremental Cost Annually	Material Impacts	Program Start
Single Circuit	Install Class 1 Wood Poles or Equivalent	$1.2M – $2.5M	80% Additional Class 1	FY26
Double Circuit	Install Class H1 Wood Poles or Equivalent	$290K – $600K	19% Additional Class H1	FY26
Double Circuit with Distribution Underbuilt	Install Class H2 Wood Poles or Equivalent	$15K – $31K	1% Additional Class H2	FY26

The larger pole classes will be applied to all planned sub-transmission projects. The Copperleaf tool will be used as part of the capital investment planning process to prioritize and manage these capital investments.

5.2.6 Resilience Projects Benefits Summary

Resilience to climate hazards is ultimately achieved by either addressing an asset's likely exposure to a hazard or its sensitivity to a hazard in the event of exposure. The proposed resilience projects either have an exposure or a sensitivity benefit.

- **Exposure Benefit:** A project that lowers exposure is anticipated to reduce the potential for an asset to experience physical climate hazards. For example, by undergrounding a distribution line, the project lowers the potential for assets to experience wind and ice events, therefore, benefiting the system.
- **Sensitivity Benefit:** A project that lowers sensitivity is anticipated to reduce the degree to which an asset is negatively affected in the event of exposure to a climate hazard. For example, by upgrading the design standards of overhead distribution lines, the project increases wind and ice tolerance thresholds and enables assets to withstand higher wind speeds or ice accumulations. This reduces the sensitivity of overhead lines to exposure to wind gusts and ice events.

The resilience benefit of each resilience project or program is summarized in Table 25.

Table 25. Resulting benefit of identified resilience projects

Resilience Project/Program	Hazard	Exposure Benefit	Sensitivity Benefit
1. Overhead Distribution and Sub-transmission Line Design Upgrades	Wind Gusts and Ice	Unchanged	Lower sensitivity
2. Overhead Transmission Line Design Upgrades	Wind Gusts and Ice	Unchanged	Lower sensitivity
3. Distribution Targeted Undergrounding	Wind Gusts and Ice	Lower exposure	Unchanged
4. Spare Transmission Line Structures	Wind Gusts and Ice	Unchanged	Lower sensitivity
5. Substation Flood Wall	Flooding	Lower exposure	Unchanged
6. Distribution and Transmission Substation Transformer Specification Upgrades	Extreme Heat	Unchanged	Lower sensitivity

5.3 Project Timelines and Costs

National Grid has identified costs associated with each identified project and program. Table 26 provides cumulative capex costs for a 5-year, 10-year, and 20-year period from FY26 to FY45 (see Appendix E – Project Costs for cost breakdowns for each project).

Table 26. Resilience project and program costs per 5-, 10-, and 20-year periods

Physical Project/Program	5 Year FY26-30 Capex (millions)	10 Year FY26-35 Capex (millions)	20 Year FY26-45 Capex (millions)
1. Overhead Distribution and Sub-transmission Line Design Upgrades	$133	$328	$879
2. Overhead Transmission Line Design Upgrades	$33	$59	$109
3. Distribution Targeted Undergrounding	$51	$138	$348
4. Spare Transmission Line Structures	$2	$2	$2
5. Substation Flood Wall	$19	$28	$28
6. Distribution and Transmission Substation Transformer Specification Upgrades	$7	$14	$25
TOTAL	**$244**	**$567**	**$1,390**

5.3.1 Rate Impacts

Estimated bill impacts of the resilience measures presented in this CCRP are shown in Table 27, for the period FY26 to FY30, on a total and delivery-only bill basis across all service classes. Levelizing the increases over the five-year period would result in an estimated increase of 0.30% on a total-bill basis and 0.36% on a delivery-only bill basis compared to current rates. The year-by-year and levelized estimates each assume the same supply costs each year to isolate the impacts of resilience project costs on customers' bills and is a marginal percentage when compared to other bill factors.[31]

Table 27. Estimated bill impacts of CCRP measures on total bill and delivery-only basis, FY26 – FY30

	FY26	FY27	FY28	FY29	FY30
Revenue Requirements (thousands)	$782	$3,078	$11,697	$17,432	$22,967
Delivery Bill % Increase from Present	0.03%	0.11%	0.41%	0.61%	0.81%
Total Bill % Increase from Present	0.02%	0.09%	0.34%	0.50%	0.66%

[31] At this time, the Company does not intend to request surcharge recovery treatment for the resilience initiatives proposed in the CCRP. Rather, given the expected timing of the Company's next base rate case filing (projected to occur in the second quarter of calendar year 2024), the Company anticipates that it would include the resilience initiatives in the CCRP as part of its proposed capital plan presented in the rate case and request cost recovery for those initiatives in that proceeding.

6. Governance

National Grid's governance of climate risk and resilience will expand upon previous frameworks and policies with the goal of maintaining accountability, and providing consistent, transparent communications concerning its work on climate resilience and adaptation.

As part of the legislative requirements of PSL §66(29), National Grid was required to include certain information in the CCVS and the CCRP, and to create a CRWG.[32] The Company has formed both an Advisory Committee and Project Team that was engaged in the development of the CCVS and the CCRP. The Committee and the Project Team included subject matter experts and leadership from several areas within the Company, such as electric asset management & engineering, legal, data science, sustainability, regulatory, and corporate affairs. To organize the Project Team, National Grid created a set of DDGs, which comprised of experts from various teams such as, Forecasting, Engineering, Standards & Work Methods, Planning, Asset Management, Operations, Reliability, and Emergency Planning. The DDGs were critical to identifying climate vulnerabilities and potential resilience measures.

Following the filing and approval of the CCRP, National Grid will maintain its Advisory Committee which will meet at least twice annually. The Committee will include an executive sponsor, overall climate resilience lead, technical lead, stakeholder lead, and other participants needed to oversee the approval or modification, and execution of the CCRP and associated requirements, including biennial updates and ongoing working group meetings. The Project Team structure, including the DDGs, will also be maintained to manage and provide updates on the execution of the CCRP and prepare for its future updates.

The Company will also explore the utility of new climate science data sets, as they may become available, to continually update and inform its adaptation and resilience plans. National Grid is already using its in-house CCRT, which covers the entire service territory and evaluates the exposure and vulnerability of its assets to nine climate hazards[33] over two climate scenarios (2°C [3.6°F] and 4°C [7.2°F] of warming based on CMIP5 data) and across timeframes (baseline, 2030s, 2040s, 2050s, and 2070s). Additionally, MIT-generated climate projections for wind gusts and ice loading for 2025–2041 will be used, in addition to the NESC, to inform updates to related standards and designs.

National Grid will continue to collaborate with external stakeholders to regularly reevaluate its resilience priorities. To support the development and implementation of the CCRP, National Grid created the CRWG, which will continue to meet at least twice annually. The CRWG includes members from government and municipal agencies, utility companies, customer advocacy groups, environmental advocates, and other stakeholders. Input and feedback from the CRWG will contribute to National Grid's plan to be responsive to customer and community priorities, while continuing to meet its obligation to provide safe and reliable service and fulfil the requirements of the legislation. National Grid will also continue to work with the Joint Utilities (JUs), as well as industry organizations, such as EPRI, to collaborate and share best practices with the common goal of enhancing climate resilience.

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[32] See New York Public Service Law §66(29) and CCRP Section 1.1, Legislative Context, for more details.

[33] The CCRT analyzes nine climate hazards: high temperatures, low temperatures, freeze-thaw cycles, heat waves, high winds, coastal flooding, river flooding, compound events, and lightning.

To effectively plan and implement resilience measures, National Grid will continue to have consistent and transparent communications with stakeholders. This involves both regular, public updates on plan implementation as well as individual outreach to address specific areas of concern. National Grid must file an updated CCRP with the Commission for approval at least once every five years to ensure continual evaluation and improvement. These governance measures will provide National Grid with the strong collaboration and oversight necessary for the effective monitoring, evaluation, and implementation of resilience measures.

7. Performance Measures

The CCRP cycle provides for biennial update meetings with the CRWG. After the second full year of plan implementation, and biennially thereafter, PSL §66(29) requires utilities to file a report with the Commission detailing activities to comply with the utility's current plan.

The updates are expected to include project status and a discussion around resilience performance after project implementation. As of the date of developing this CCRP, there are no industry standards for resilience performance measures. National Grid is committed to working with industry groups, such as IEEE, EPRI and NYSERDA, to develop such measures and to adopt them as they become available for use throughout utilities in New York. The sections below provide examples of what can be expected for project status and performance updates based on National Grid's current understanding of performance measures.

7.1 Project Status Tracking Example

The project status tracking is expected to include metrics like estimated and actual completion date and planned cost and cost to date. Additional details, like projects completed in time and cost at close-out, will be available for discussion as applicable. Table 28 provides an example assuming the reporting date is at the end of Q3 of 2027. Values in green show hypothetical early completion dates and underbudget costs; values in red show hypothetical late completion dates and overbudget costs.

Table 28. Project status tracking example showing hypothetical dates and costs

Project Name	Completion Date (Estimated)	Completion Date (Actual)	Planned Cost[34] ($K)	Cost to Date ($K)
Targeted Undergrounding	03/31/2045	In progress	$50,500	$30,000
Spare Transmission Structures	12/21/2026	11/21/2026	$1,500	$1,350
Sugar Hill Station – Transformer upgrade	3/31/2030	Planned	$1,467 ($186)[35]	$800
Transmission Substations Flood Mitigation Program	3/31/2045	In Progress	$16,100	$300
South Oswego to Lighthouse Hill – Transmission line upgrade	11/21/2027	12/21/2027	$960 ($30)	$990

[34] Planned costs will be based on the most recently filed Capital Investment Plan.
[35] The value in parenthesis represents the incremental cost to adapt to climate hazards per the findings of this CCRP. Actual cost to date will be reported on the total project cost.

7.2 Performance Metrics

As part of the biennial update, National Grid proposes the following metrics be provided to help understand the effectiveness of each project category. Additional commentary will be included to provide further context and information on the performance of CCRP projects as available.

Distribution Line Design Upgrades

Report on outage frequency,[36] aggregated for all feeders, for 3 years before and 3 years after implementing updated high wind/ice design changes.

Sub-Transmission Line Design Upgrades

Report on the number of line outages, aggregated for all lines, for 3 years before and 3 years after implementing updated high wind/ice design changes.

Transmission Line Design Upgrades & Spares

Report on the number of line outages due to structure failures, aggregated for all lines, for 3 years before and 3 years after implementing updated high wind design changes. Report on use of any spare structures.

Distribution Targeted Undergrounding

Report on outage frequency by feeder for 3 years before and 3 years after implementing targeted undergrounding projects.

Substation Floodwalls

Report on any flood damage since project completion or since the last biennial update.

Substation Transformer Upgrades

Report on number of transformers updated to new 35°C (95°F) average ambient temperature standard. This will include transformers that have been placed in service as well as on-property spares.

Table 29 provides an example performance measure report for distribution line design upgrades.

Table 29. Performance measures hypothetical example for distribution line design upgrades

Performance Metric	Outage Frequency – Post 3 Years	% Change	Comments
Distribution Line Design Upgrades	1.214	-6.5%	No events caused by failure of pole recently upgraded to Class 1

[36] Outage frequency as listed here is defined as the total number of customer interruptions divided by the total number of customers served, including major storm events, and excluding substation and supply outages.

8. Conclusion and Next Steps

The CCRP proposes resilience measures to address key climate hazards and priority climate vulnerabilities for National Grid's assets and operations identified in the CCVS. National Grid's prior investments in resilience projects and programs helped shape the CCRP, along with contributions from valued stakeholders and subject matter experts who formed the CRWG.

The measures identified in this CCRP are intended to make National Grid's electric assets more resilient to four key climate hazards that were identified in the CCVS: high temperature (extreme heat), inland flooding associated with heavy precipitation events, high wind gusts, and icing events. Using a multi-pronged resilience framework, the Company identified resilience measures that address four key objectives for improving resilience: Strengthen & Withstand, Anticipate & Absorb, Respond & Recover, and Advance & Adapt. Each of the resilience measures identified in the CCRP targets one of these objectives and is presented along with a business case justification.

Identified physical projects include overhead distribution and sub-transmission line design upgrades, overhead transmission line design upgrades, distribution targeted undergrounding, spare transmission line structures, substation flood walls, and distribution and transmission substation transformer specification upgrades. As part of the multi-pronged resilience framework, system-wide enhancements to strengthen the Company's operations were also identified. Overall, this holistic approach will prepare the Company's operations and assets to address the projected increase in exposure to climate hazards.

The BCJ framework aids National Grid in characterizing the benefits of identified resilience projects. The BCJ was performed for the priority assets identified for projects and presented in this CCRP. The BCJ evaluates and scores an asset on three considerations – system reliability, criticality, and community resilience. Additionally, it considers whether a given asset serves a disadvantaged community.

Distribution substations identified for flood mitigation projects, 8 in total, had BCJ scores of 67%–100%, and 75% serve disadvantaged communities. Transmission substations identified for flood mitigation projects, 10 in total, had BCJ scores of 53%–93%, and 80% serve disadvantaged communities. Distribution and transmission substations identified for transformer upgrade projects, 58 in total, had BCJ scores of 20%–100%, and 67% serve disadvantaged communities. Transmission lines identified for structural upgrade projects, 46 in total, had BCJ scores of 20%–100%, and 83% serve disadvantaged communities. Targeted distribution feeders that will be considered for undergrounding, 50 in total, had BCJ scores of 40%–100%, and 4% serve disadvantaged communities. The revenue requirements for the identified resilience investments presented in this CCRP result in total bill increases ranging from 0.02% in FY26 to 0.66% in FY30 when compared to current rates across all service classes.

National Grid is acting to prepare its infrastructure, monitor investments and practices, and continuously report on performance in addressing climate hazards. The Company will continue to work towards achieving equitable solutions that mitigate existing vulnerabilities by continuing to collaborate, educate, inform, and include a diverse group of stakeholders in its resilience planning. National Grid appreciates the efforts of the Department of Public Service Staff, the CRWG, other stakeholders, and the dedication of its own employees in contributing to this CCRP, with the aim of continuing to provide safe, reliable, and resilient service to its customers, and looks forward to the Public Service Commission's consideration of this CCRP.

9. Appendices

Appendix A – Legislative Requirements

Table A 1. Legislative requirements and corresponding CCRP sections addressing them

Requirement	CCRP Section
Describe how the utility will mitigate the impacts of climate change on utility infrastructure, reduce restoration costs and outage times associated with extreme weather events, and enhance electric system reliability.	Section 4.2 describes National Grid's framework to mitigate the impacts of climate change on utility infrastructure and achieve these goals.
Propose storm hardening and resiliency measures for the next ten and twenty years.	Section 4 proposes storm hardening and resiliency measures.
Describe how climate change considerations will be incorporated into planning, design, operations, and emergency response.	Section 4.3 describes the incorporation of resilience in these processes.
Incorporate climate change into existing processes and practices, manage climate change risks, and build resilience.	Section 4.3 outlines the incorporation of climate change considerations into existing practices.
Consider the extent to which storm protection and hardening of transmission and distribution infrastructure is feasible, reasonable, or practical.	Section 4.3 describes the feasibility of storm protection and hardening measures.
Propose adjustments to how the corporation plans and designs infrastructure for the increasing impacts from climate change.	Sections 4.3 and 4.4 propose adjustments to how the corporation plans and designs infrastructure.
Provide an estimate of the costs and benefits to the corporation and its customers of making the improvements in the plan, with particular attention paid to the costs and benefits in undergrounding transmission and distribution lines.	Section 5.3 provides a summary of proposed projects and programs, including the estimated costs. Section 5.2 describes the benefits of proposed projects, including targeted undergrounding for specified sections of distribution lines.
Describe how equity is considered in the plan.	Section 3 outlines National Grid's commitment to equity and how it has been considered in the CCRP.
Provide an implementation schedule of proposed measures.	Section 5.3 lists the projects to be implemented in 5-, 10-, and 20-year timeframes.
Provide performance benchmarks.	Section 7 lists potential performance measures.

Requirement	CCRP Section
Describe the rate impact from the first five years of investments.	Section 5.3.1 provides the rate impacts for the first five years.
Consider the extent to which the plan considers a multi-pronged strategy appropriately tailored to addressing the impacts of climate change, reducing restoration costs and outage times, and enhancing infrastructure reliability.	Section 4 describes the multi-pronged resilience strategy.
Describe any third-party coordination opportunities.	Section 2 describes the stakeholder coordination process informing third-party coordination opportunities.
Address the recommendations from the utility Climate Resilience Working Group established through this law.	Section 2 describes National Grid's engagement with the Climate Resilience Working Group.
Contemporaneously serve the climate resilience plan on the parties from its last rate case filed pursuant to subdivision twelve of this section.	Will be completed subsequent to CCRP filing.

Appendix B – Stakeholder Engagement during CCVS and CCRP Development

Table B 1. List of community and municipal organizations included in stakeholder engagement

Adirondack North Country Association	Essex County Emergency Management	Saratoga County
Albany County Emergency Management	Franklin County	Saratoga County Emergency Management
Albany County Executive Office	Fulton County Emergency Management	Schenectady County Emergency Management
City of Albany	Great Lakes Consortium	Shenendehowa CSD
City of Batavia	Hamilton County Emergency Management	St Lawrence County
City of Buffalo	Herkimer County (East)	Syracuse-Onondaga County Planning Agency
City of Dunkirk	Jefferson County	Town of Amherst
City of Glens Falls	Lewis County	Town of Bethlehem
City of Hudson	Madison County	Town of Clifton Park
City of Niagara Falls	Mohawk Valley Economic Development District	Town of Day
City of North Tonawanda	Montgomery County Emergency Management	Town of Dewitt/Onondaga Environmental Institute
City of Olean	Municipality	Town of East Greenbush
City of Rensselaer	National Weather Service-Burlington	Town of Guilderland
City of Saratoga Springs	NYS DOT Region 2	Town of Malta
City of Schenectady	NYS DOT Region 3	Town of Moreau
City of Troy	NYS DOT Region 7	Town of Northumberland
City of Watervliet	NYS Homeland Security & Emer. Mgt.	Town of Stillwater
Clean Communities of Central NY	Oneida County	Town of Tonawanda
Clinton County	Onondaga County	Town of Waterford
CNY Regional Planning Development Board	Oswego County	Village of Greenwich
Columbia County Emergency Management	Otsego County Emergency Management	Warren County Emergency Management
Cortland County	Rensselaer County Emergency Management	Washington County Emergency Management

Table B 2. List of Climate Resilience Working Group (CRWG) member organizations

AARP	Herkimer-Oneida Counties Comprehensive Planning Program (HOCCPP)	Public Utility Law Project of New York, Inc.
AARP New York	MARATHON POWER LLC	Schenectady County
Alliance for a Green Economy (AGREE)	Mission: Data Coalition, Inc.	Schenectady Fire Department
Bob Wyman	Multiple Intervenors	Sierra Club
Central NY Regional Planning & Development Board	National Grid	St Lawrence County Emergency Services
ChargePoint, Inc.	Natural Resources Defense Council	Stop NY Fracked Gas Pipeline
Citizen Action of New York, Inc.	New York Geothermal Energy Organization	Town of Amherst
City of Albany	New York Power Authority	Town of DeWitt
City of Glens Falls	New York State Department of Public Service	Utility Intervention Unit, Division of Consumer Protection, Department of State
City of Niagara Falls	New York State Office of General Services	Walmart
City of Syracuse	New York State Office of General Services	Wyoming County Office of Emergency Services
Columbia County	Niagara County	Wyoming County Planning Department
Columbia Economic Development Corporation	NYSDOT	
Direct Energy Business Marketing, LLC, Direct Energy Business, LLC, Direct Energy Services LLC, Gateway Energy Services Corporation	NYSERDA	
Environmental Defense Fund	Office of Environment, Onondaga County	
Erie County DHSES	Onondaga County DOT	
Family Energy, Inc.	Onondaga County	
Franklin County Government	Oswego County	
Genesee County NY	Pace Energy and Climate Center	
Greenlots	People United for Sustainable Housing (PUSH) Buffalo	

Appendix C – Project Data Sheets (PDSs)

Project Data Sheet: Overhead Transmission Line Design Upgrades

Type:

T	SubT	D
X		

Spending rationale: Incremental spend added to existing projects with existing needs and drivers

Asset Condition	Communications/Control Systems	Customer Requests/Public Requirements	DER (Distributed Energy Resource) Electric System Access	Damage/Failure

Non-Infrastructure	Reliability	Resiliency	System Capacity	Multi-Value Transmission (MVT)
		X		

Program Name: Overhead Transmission Line Design Upgrades

Associated Funding Numbers:

C094262 E. Incremental $$ Xtreme Wind CCVS
C094263 C. Incremental $$ Xtreme Wind CCVS
C094264 W. Incremental $$ Xtreme Wind CCVS

Description: Upgrade transmission line design standard to withstand up to 120 mph wind gusts in areas of projected high winds, up from 95 mph specified by the current NESC standard. This means that future transmission line upgrades and rebuilds in high wind areas will use thicker steel, base plates, foundations, cross bracing, etc. as needed to withstand higher wind gusts. Overhead transmission line projects are shown in Figure C 1.

Project Justification: As directed by PSL §66(29) and the enabling PSC Order in Case 22-E-0222, the Company conducted a Climate Change Vulnerability Study and developed a Climate Change Resilience Plan. High winds were identified as one of the most impactful vulnerabilities to transmission lines. The Company used wind gust projections developed by MIT and correlated this data with transmission lines to identify the areas where wind levels are expected to exceed current design standards (Figure C 2). Increasing structure strength in these areas will improve the ability of these lines to withstand more extreme climate conditions to better maintain the resilience of the electric system. Radial icing was also evaluated, but existing designs were found to be adequate based on MIT projections.

Figure C 1. Map of identified transmission line structure upgrades

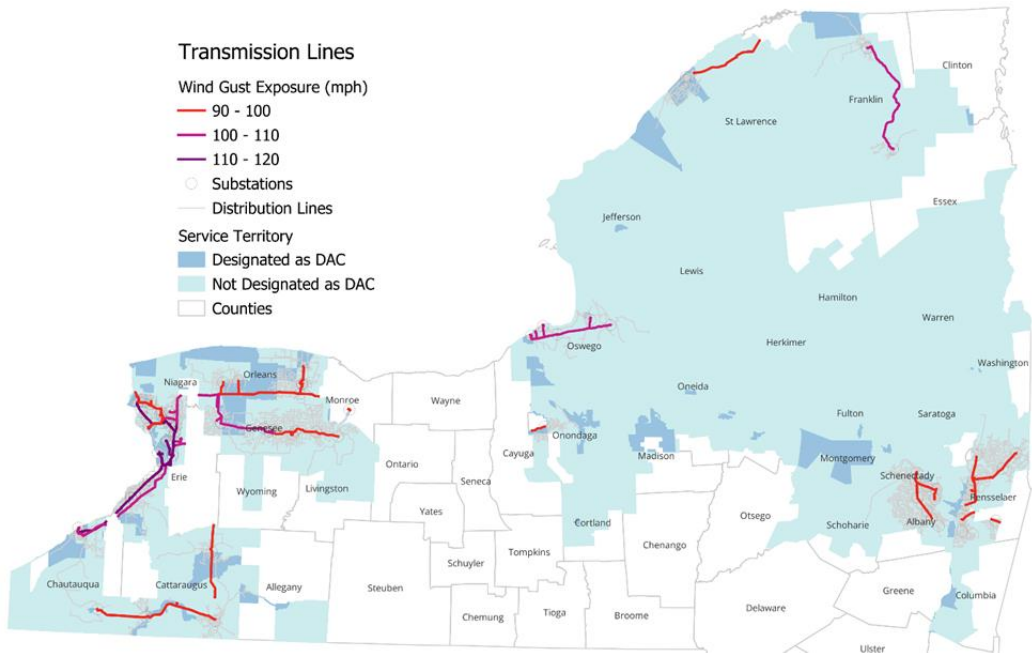
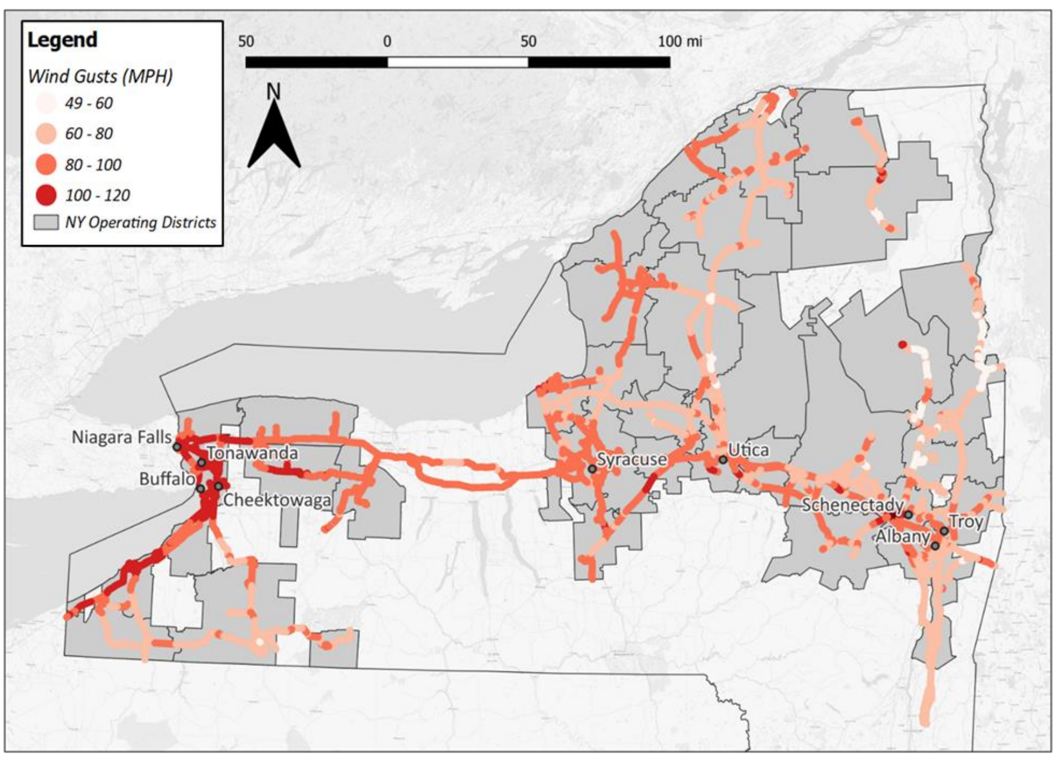


Figure C 2. Map of wind gust projections for transmission lines



Customer Benefit: Increasing the strength of transmission line structures in high wind areas will reduce the chances of structural failures and resulting outages. This is expected to result in improved resilience and to better maintain existing levels of reliability as climate conditions change over time.

Alternatives: Additional transmission line rebuilds in high wind areas were considered but were dismissed in favor of the proposed option which is more cost-effective.

DER Alternative/NWA (Non-wires Alternative): As the project need is for CCRP drivers, it does not meet the NWA suitability criteria thresholds.

Climate Leadership and Community Protection Act (CLCPA): N/A

Studies/References: MIT Joint Program on the Science and Policy of Global Change, Report 352, June 2021 by Muge Komurcu and Sergey Paltsev

Study Report Name(s): Climate Change Vulnerability Study & Resilience Plan
Sanction Paper No: None
Strategy No: None

Total Project Cost Breakdown: ($ Thousands)

Project Number	Spend	Prior Years	F26	F27	F28	F29	F30	Total
C094262 C094263 C094264	CapEx	0	5,792	8,285	7,192	6,379	5,743	33,391
	OpEx	0	0	0	0	0	0	0
	Removal	0	0	0	0	0	0	0
	Total	0	5,792	8,285	7,192	6,379	5,743	33,391

Estimate Grade: Investment Grade

Begin Preliminary Engineering: Various
Final Design Complete: Various
Construction Start: Various
In-Service Date: Various

Project Data Sheet: Distribution and Transmission Substation Transformer Specification Upgrades

Type:

T	SubT	D
X		X

Spending Rationale:

Asset Condition	Communications/Control Systems	Customer Requests/Public Requirements	DER Electric System Access	Damage/Failure

Non-Infrastructure	Reliability	Resiliency	System Capacity	Multi-Value Transmission (MVT)
		X		

Program Name: Transformer Incremental Spend

Associated Funding Numbers:

C094208 CCVS Dist Sub Temp Upgrade – NYC
C094216 CCVS Dist Sub Temp Upgrade – NYE
C094217 CCVS Dist Sub Temp Upgrade – NYW
C094224 Transmission Sub CCRP XFR NY East
C094225 Transmission Sub CCRP XFR NY Central
C094226 Transmission Sub CCRP XFR NY West

Description: Upgrade transformer design specifications for peak average ambient temperature of 35°C (95°F), up from the present 32°C (90°F). The increase in design temperature will allow transformers to operate at the higher temperatures projected for 2050 and beyond while they maintain their capacity ratings and reduce damage or loss of life due to high temperatures. These changes will impact currently planned and all future projects. Upgrading transformer specifications will reduce the potential that the load capacity of transformers will be reduced during extreme heat events and allow National Grid to continue to serve customers while experiencing high temperatures. Without investment, substation transformers can experience accelerated degradation or risk customer outages due to failures or load shedding to avoid equipment damage.

Figure C 3 Transformer incremental spending projects are shown in Figure C 3.

Project Justification: As directed by PSL §66(29) and the enabling PSC Order in Case 22-E-0222, the Company conducted a Climate Change Vulnerability Study and developed a Climate Change Resilience Plan. High temperatures were identified as one of the greatest vulnerabilities for distribution and transmission substations. Figure C 4 maps substations with ambient temperature projections above 32°C (90°F). Given the long service life of substation transformers, it is beneficial to install transformers that are designed to withstand the higher temperatures projected for 2050 and beyond.

Upgrading transformer specifications will reduce the potential that the load capacity of transformers will be reduced during extreme heat events and allow National Grid to continue to serve customers while experiencing high temperatures. Without investment, substation transformers can experience accelerated degradation or risk customer outages due to failures or load shedding to avoid equipment damage.

Figure C 3. Map of substations identified for transformer upgrades

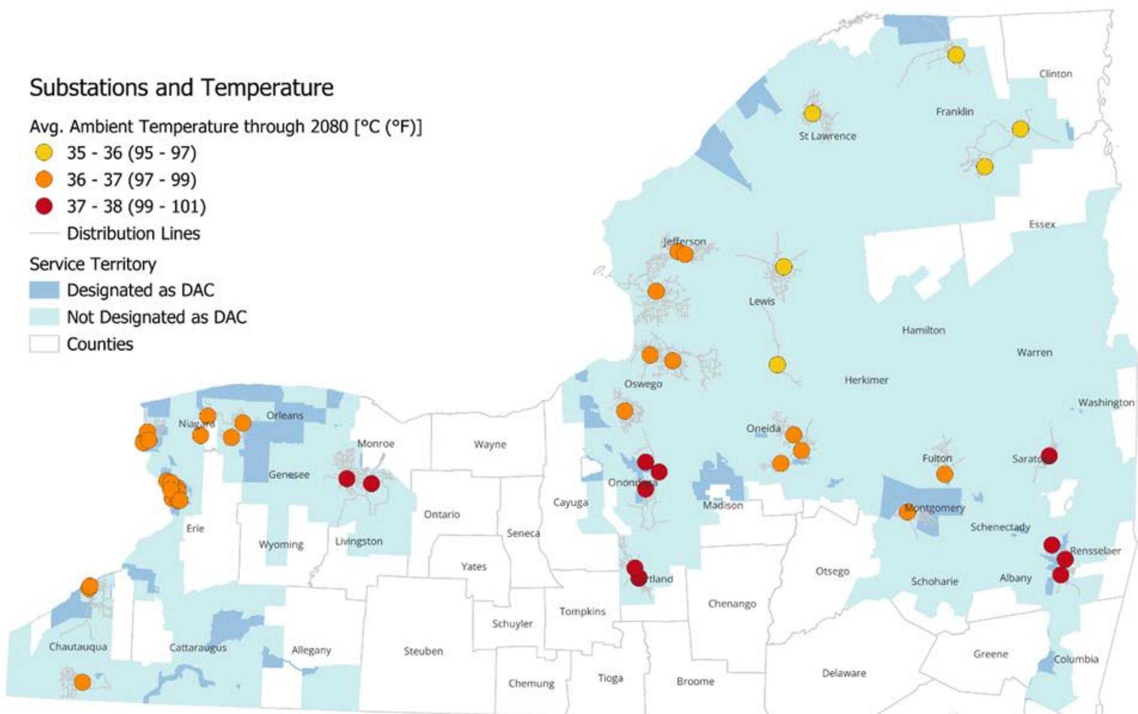
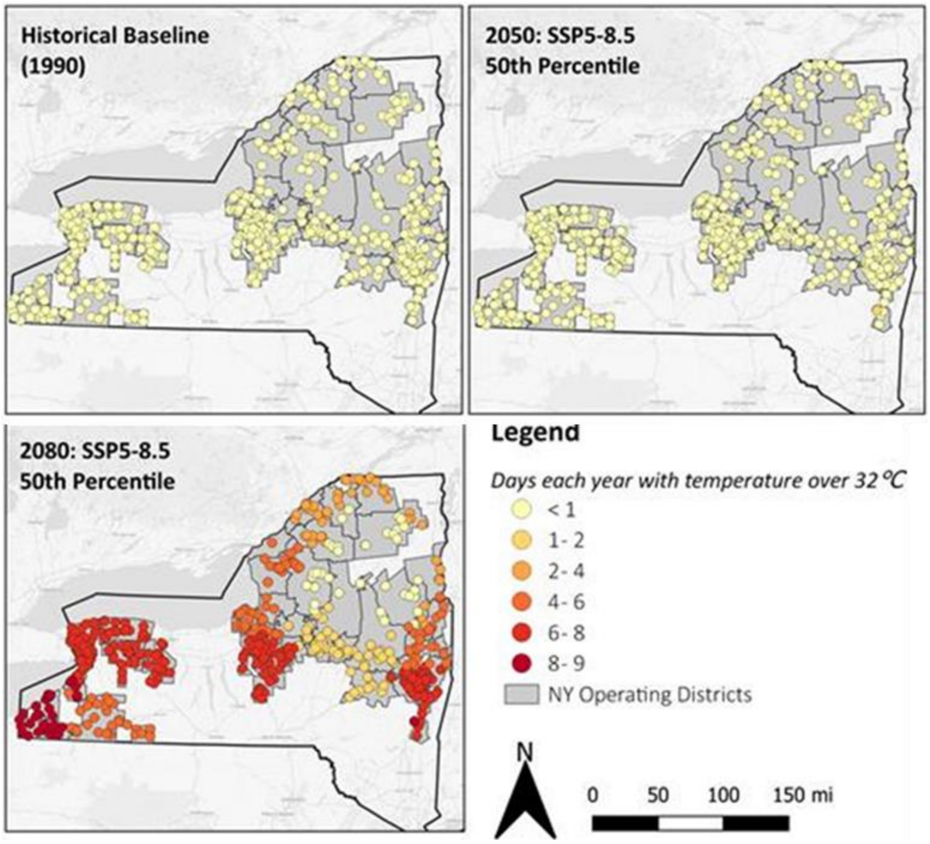


Figure C 4. Map of substations with ambient temperature projections above 32°C (90°F)



Customer Benefit: The proactive procurement of transformers that can withstand projected higher temperatures will limit the likelihood of degrading the capability of substation transformers, which will better maintain the reliability of the electrical system.

Alternatives: Installing larger capacity transformers at existing temperature specifications was considered but was found to be less cost-effective than increasing the temperature specification.

DER/NWA Alternative: As the project need is for CCRP drivers, it does not meet the NWA suitability criteria thresholds.

Climate Leadership and Community Protection Act (CLCPA): N/A

Studies/References:

Study Report Name (s): Climate Change Vulnerability Study & Resilience Plan
Sanction Paper No: None
Strategy No: None

Total Project Cost Breakdown: ($ Thousands)

Transmission Substation Transformer Specification Upgrade

Project Number	Spend	Prior Years	F26	F27	F28	F29	F30	Total
C094224 C094225 C094226	CapEx	0	428	1,037	238	0	281	1,983
	OpEx	0	0	0	0	0	0	0
	Removal	0	0	0	0	0	0	0
	Total	0	428	1,037	238	0	281	1,983

Distribution Substation Transformer Specification Upgrade

Project Number	Spend	Prior Years	F26	F27	F28	F29	F30	Total
C094208 C094216 C094217	CapEx	0	688	941	1,405	1,378	902	5,315
	OpEx	0	0	0	0	0	0	0
	Removal	0	0	0	0	0	0	0
	Total	0	688	941	1,405	1,378	902	5,315

Estimate Grade: Investment

Begin Preliminary Engineering: Various
Final Design Complete: Various
Construction Start: Various
In-Service Date: Various

Project Data Sheet: Distribution Targeted Undergrounding

Type:

T	SubT	D
		X

Spending Rationale:

Asset Condition	Communications/Control Systems	Customer Requests/Public Requirements	DER Electric System Access	Damage/Failure

Non-Infrastructure	Reliability	Resiliency	System Capacity	Multi-Value Transmission (MVT)
		X		

Program Name: Distribution Targeted Undergrounding

Associated Funding Numbers:

C094138 Targeted UG CCRP Projects – NYC
C094140 Targeted UG CCRP Projects – NYE
C094141 Targeted UG CCRP Projects – NYW

Description: This is a program to underground portions of the overhead distribution system in areas with projected wind gusts over 50 miles per hour and icing events resulting in over 0.75 inches of radial icing. The Company plans to target 3-phase mainline sections of distribution feeders and will give priority to feeders that have been identified as a Worst Performing Feeder (WPF) in the past five calendar years and feeders with higher SAIFI impacts from tree and wind events in the last five calendar years. Approximately 1–2 miles of overhead distribution feeders will be replaced with underground construction each year.

Project Justification: As directed by PSL §66(29) and the enabling PSC Order in Case 22-E-0222, the Company conducted a Climate Change Vulnerability Study and developed a Climate Change Resilience Plan. High winds and icing were identified as two of the greatest vulnerabilities to distribution and sub-transmission lines. The Company used wind gust and radial icing projections developed by MIT and correlated them to its distribution and sub-transmission lines to identify areas where wind and/or icing levels are expected to exceed current design standards. Undergrounding will be used to improve reliability and reliance to extreme weather events in targeted areas where upgrading overhead structures is insufficient to withstand projected wind and icing levels.

Customer Benefit: Undergrounding overhead lines in areas of projected high wind and icing will reduce the chances of widespread facilities damage and resulting outages. This is expected to result in improved resilience and to better maintain existing levels of reliability as climate conditions change over time.

Alternatives: A separate program for increasing pole strength/class will be used for areas of high wind and icing but will not be as effective in areas of highest wind/icing.

DER/NWA Alternative: None

Climate Leadership and Community Protection Act (CLCPA): N/A

Studies/References: MIT Joint Program on the Science and Policy of Global Change, Report 352, June 2021 by Muge Komurcu and Sergey Paltsev

Study Report Name(s): Climate Change Vulnerability Study & Resilience Plan
Sanction Paper No: None
Strategy No: None

Total Project Cost Breakdown: ($ Thousands)

Project Number	Spend	Prior Years	F26	F27	F28	F29	F30	Total
C094138 C094140 C094141	CapEx	0	0	5,500	15,000	15,000	15,000	50500
	OpEx	0	0	0	4,286	4,286	4,286	12,857
	Removal	0	0	0	2,143	2,143	2,143	6,429
	Total	0	0	5,500	21,429	21,429	21,429	69,786

Estimate Grade: Investment

Begin Preliminary Engineering: Various
Final Design Complete: Various
Construction Start: Various
In-Service Date: Various

Project Data Sheet: Spare Transmission Line Structures

Type:

T	SubT	D
X		

Spending Rationale:

Asset Condition	Communications/Control Systems	Customer Requests/Public Requirements	DER Electric System Access	Damage/Failure

Non-Infrastructure	Reliability	Resiliency	System Capacity	Multi-Value Transmission (MVT)
		X		

Program Name: Spare Transmission Line Structures

Associated Funding Numbers:

C093520 W. Spares for Climate Change
C093521 C. Spares for Climate Change
C093522 E. Spares for Climate Change

Description: Purchase 10 spare 115kV transmission structures for each division (east, west, and central) that are designed to withstand 120 mph wind gusts.

Project Justification: As directed by PSL §66(29) and the enabling PSC Order in Case 22-E-0222, the Company conducted a Climate Change Vulnerability Study and developed a Climate Change Resilience Plan. High wind gusts were identified as among the greatest vulnerabilities to transmission structures. Upgrading structures with new design standards to withstand up to 120 mph wind gusts for areas with high projected wind speeds will occur gradually over time. Having spare structures will speed restoration for structure failures that may occur prior to upgrades and will then allow those replaced structures to withstand the higher wind gusts.

Customer Benefit: Single pole structures are the most vulnerable structure type during an extreme wind weather event, and by having these spares on-hand, lines will be able to be restored with robust structures in a short period of time, reducing the number and impacts of customer outages.

Alternatives: The option of adding anti-cascading (terminal dead end) structures was evaluated in projected high wind areas. This option was ruled out due to limited benefits and the greater flexibility and cost effectiveness of maintaining additional spares.

DER/NWA Alternative: As the project need is for CCRP drivers, it does not meet the NWA suitability criteria thresholds.

Climate Leadership and Community Protection Act (CLCPA): N/A

Studies/References:

Study Report Name(s): Climate Change Vulnerability Study & Resilience Plan
Sanction Paper No: None
Strategy No: None

Total Project Cost Breakdown: ($ Thousands)

Project Number	Spend	Prior Years	F26	F27	F28	F29	F30	Total
C093520 C093521 C093522	CapEx	0	1,500	0	0	0	0	1,500
	OpEx	0	0	0	0	0	0	0
	Removal	0	0	0	0	0	0	0
	Total	0	1,500	0	0	0	0	1,500

Estimate Grade: Project Grade

Begin Preliminary Engineering: N/A
Final Design Complete: N/A
Construction Start: N/A
In-Service Date: N/A (Spares to be available by 3/31/2026)

Project Data Sheet: Substation Flood Walls

Type:

T	SubT	D
X		X

Spending Rationale:

Asset Condition	Communications/Control Systems	Customer Requests/Public Requirements	DER Electric System Access	Damage/Failure

Non-Infrastructure	Reliability	Resiliency	System Capacity	Multi-Value Transmission (MVT)
		X		

Program Name: Substation Flood Walls

Associated Funding Numbers:

C093527 Tran Sub Flood Mitigation – East
C093528 Tran Sub Flood Mitigation – West
C093529 Tran Sub Flood Mitigation – Central
C094040 CCVS (Flood) Front St Station
C093814 CCVS(Flood) Gloversville Station 72
C093553 CCVS (Flood) Riverside Station 288
C093834 CCVS (Flood) West Monroe Sta 274
C093813 CCVS(Flood) Peterboro 514-Flood Wall
C093821 CCVS(Flood) Tonawanda Creek 206
C093554 CCVS (Flood) Liberty St Sta. 94
C093835 CCVS (Flood) Butternut Station 255

Description: The Climate Change Vulnerability Study has identified substation locations that may be impacted and require additional measures to prevent substation flooding. The Company aims to install flood walls around the perimeter of substations that were identified as being at increased risk of flooding based on their FEMA flood risk designation as well as considering an area's future flood risk based on the Company's CCRT. Flood walls are designed to prevent damage to critical assets and allow substations to stay in service during flooding events. A total of approximately 17,000 linear feet of flood walls will be installed or supplemented at 8 distribution and 10 transmission substations. Substations flood wall project locations are shown in Figure C 5.

Project Justification: As directed by PSL §66(29) and the enabling PSC Order in Case 22-E-0222, the Company conducted a Climate Change Vulnerability Study and developed a Climate Change Resilience Plan. Flooding was identified as one of the greatest vulnerabilities to distribution and transmission substations. The Company used FEMA flood risk information along with risks for future flooding based on its CCRT. Installing flood walls around electric substations in these areas will provide protection from projected flood levels and will better maintain the resilience of the electric system during periods of high rainfall. Figure C 6 maps flood risk for substations.

Figure C 5. Map of substations identified for flood wall projects

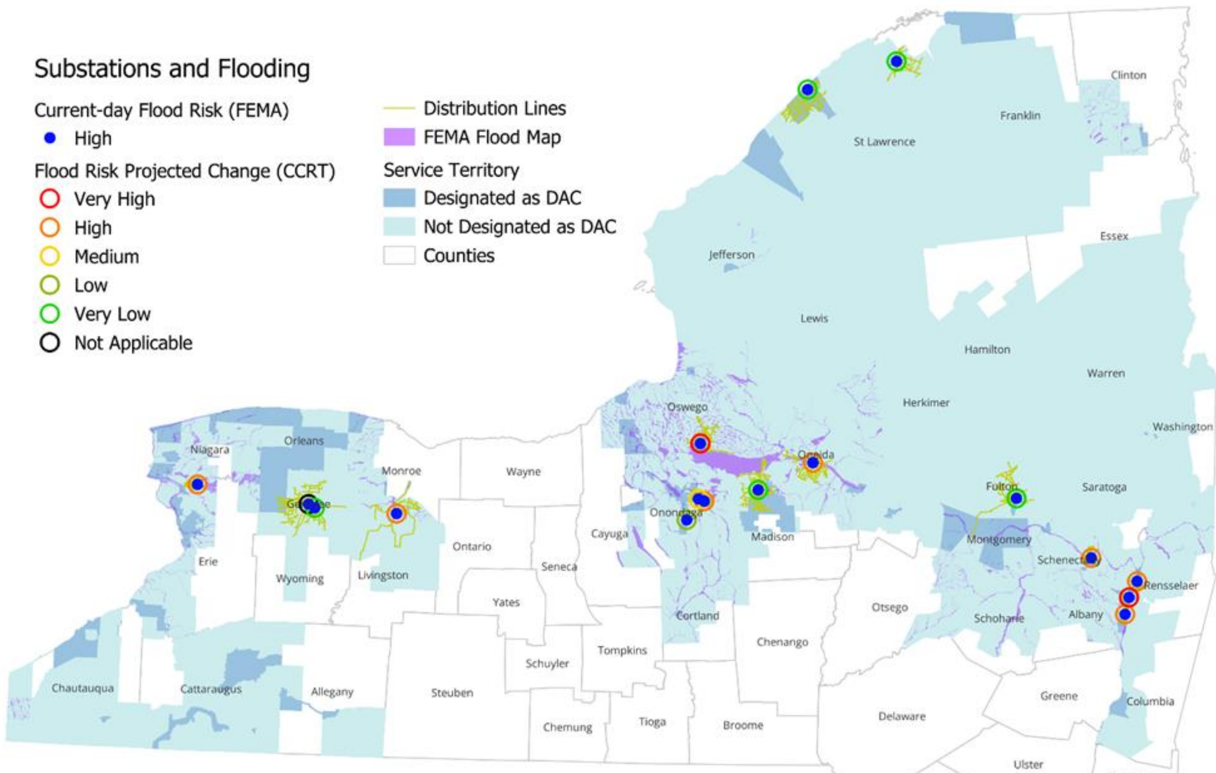
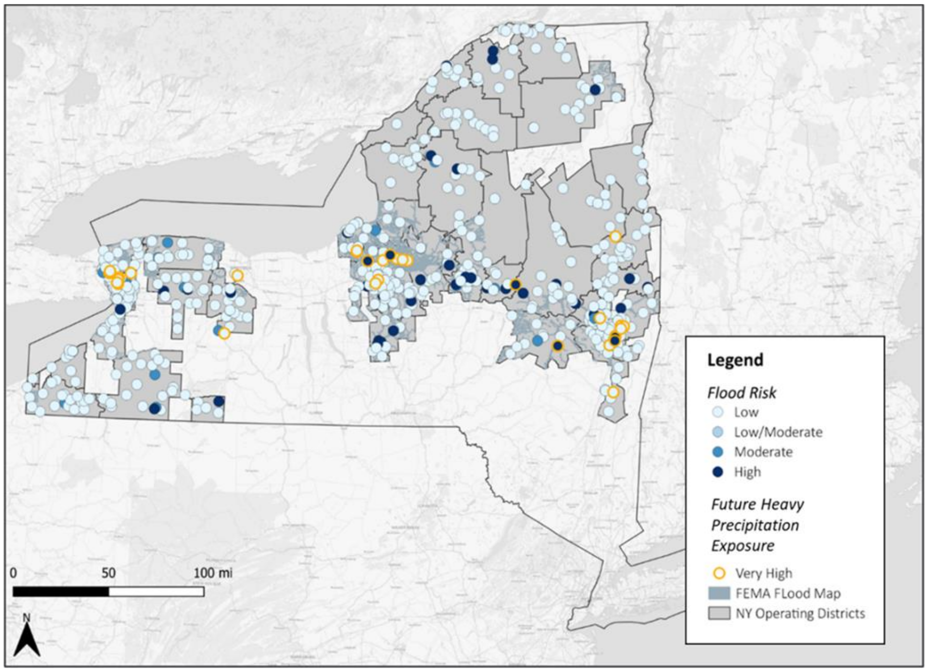


Figure C 6. Map of substation area flood risk



Customer Benefit: The proactive installation of substation flood walls will limit the likelihood of in-service equipment failures, which could cause long-term outages to customers.

Alternatives: Relocating or raising substation equipment was considered, but the installation of flood walls was found to be the most cost-effective solution.

DER/NWA Alternative: As the project need is for CCRP drivers, it does not meet the NWA suitability criteria thresholds.

Climate Leadership and Community Protection Act (CLCPA): N/A

Studies/References:

Study Report Name(s): Climate Change Vulnerability Study & Resilience Plan
Sanction Paper No: None
Strategy No: None

Total Project Cost Breakdown: ($ Thousands)

Transmission Substation Flood Mitigation

Project Number	Spend	Prior Years	F26	F27	F28	F29	F30	Total
C093527 C093528 C093529	CapEx	0	0	300	5,600	3,700	2,800	12,400
	OpEx	0	0	0	0	0	0	0
	Removal	0	0	0	0	0	0	0
	Total	0	0	300	5,600	3,700	2,800	12,400

Distribution Substation Flood Mitigation

Project Number	Spend	Prior Years	F26	F27	F28	F29	F30	Total
C094040 C093814 C093553 C093834 C093813 C093821 C093554 C093835	CapEx	0	0	500	2,000	2,000	2,000	6,500
	OpEx	0	0	0	0	0	0	0
	Removal	0	0	0	0	0	0	0
	Total	0	0	500	2,000	2,000	2,000	6,500

Estimate Grade: Investment

Begin Preliminary Engineering: Various
Final Design Complete: Various
Construction Start: Various
In-Service Date: Various

Project Data Sheet: Overhead Distribution and Sub-transmission Line Design Upgrades

Type:

T	SubT	D
	X	X

Spending Rationale:

Asset Condition	Communications/Control Systems	Customer Requests/Public Requirements	DER Electric System Access	Damage/Failure

Non-Infrastructure	Reliability	Resiliency	System Capacity	Multi-Value Transmission (MVT)
		X		

Program Name: Overhead Distribution and Sub-transmission Line Design Upgrades

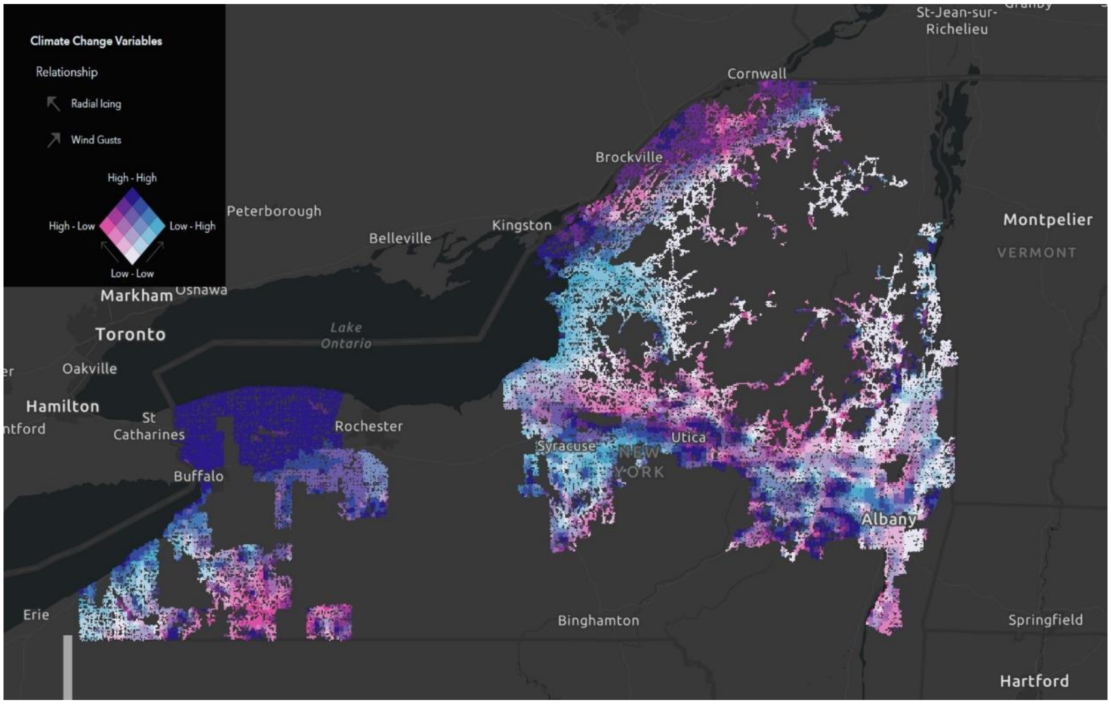
Associated Funding Numbers:

C094130 Dist Line CCRP Projects – NYC
C094132 Dist Line CCRP Projects – NYE
C094133 Dist Line CCRP Projects – NYW
C094134 Sub-T Line CCRP Projects – NYW
C094135 Sub-T Line CCRP Projects – NYE
C094136 Sub-T Line CCRP Projects – NYC

Description: Upgrade distribution and sub-transmission line design standard to withstand more than the required NESC weather loading of 0.5 inches of icing and 40 mph wind gusts. For distribution lines, this means that future pole additions or replacements will utilize larger Class 1 poles (rather than Class 3 poles typically used today) for 3-phase mainline areas as well as for poles carrying significant equipment such as regulators, capacitor banks, and ratio transformers. For sub-transmission lines, future pole additions or replacements will use larger Class 1 poles for single circuit structures, Class H1 for double circuit structures, and Class H2 for double circuit structures with distribution underbuilt or with multiple third-party attachments. It is anticipated that approximately 8,000 distribution poles, and 900 sub-transmission poles per year will be impacted by design standard upgrades.

Project Justification: As directed by PSL §66(29) and the enabling PSC Order in Case 22-E-0222, the Company conducted a Climate Change Vulnerability Study and developed a Climate Change Resilience Plan. High winds and icing were identified as two of the most impactful vulnerabilities to distribution and sub-transmission lines. The Company used wind gust and radial icing projections developed by MIT and correlated these data with distribution and sub-transmission lines to identify the areas where wind and/or icing levels are expected to exceed current design standards (Figure C 7). Increasing pole class/strength in these areas will improve the ability of lines to withstand more extreme climate conditions to better maintain the resilience of the electric system.

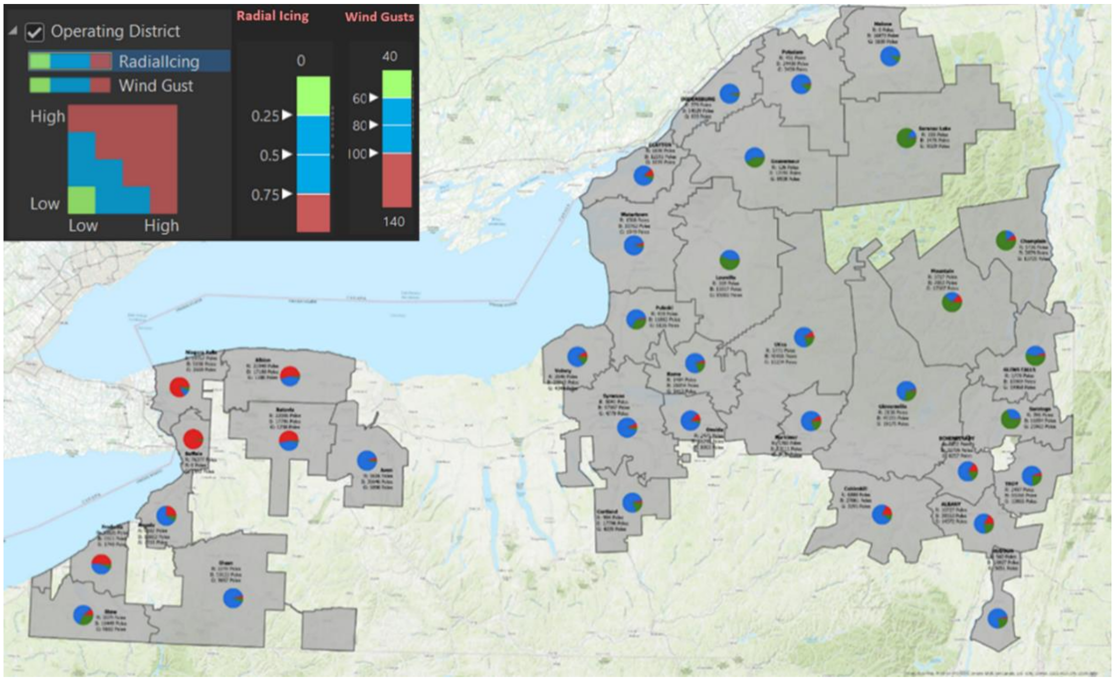
Figure C 7. Map of projected wind speeds and ice loading overlaying distribution feeders



Upgrading design standards to incorporate stronger poles in projects going forward balances the need to maintain resilience to wind and icing climate hazards with the objective of minimizing cost and associated customer bill impacts. Upgrades will take place over time in a manner consistent with how updates to the NESC are incorporated into design standards. This means that the scope of this upgrade will result in incremental material costs for larger class poles that will be added or replaced due to other spending rationales, such as customer requests/public requirements, asset condition, system capacity, or damage/failure. Although the upgrades to larger pole classes will be more gradual with this approach, it will avoid the replacement of otherwise "healthy" poles which would be much more costly.

Figure C 8 depicts the number of distribution poles exposed to icing and wind gusts. Green zones represent the poles where current standards (Class 3 poles) are sufficient. Blue zones and red zones represent where pole upgrades are proposed to harden the system based on projected climate hazards, with red zones anticipated to experience more severe climate conditions.

Figure C 8. Map of current pole count exposed to a combination of wind/icing values



<u>Customer Benefit</u>: Increasing pole class/strength in areas of projected high wind and icing will reduce the chances of widespread pole failures and resulting outages. This is expected to result in improved resilience and to better maintain existing levels of reliability as climate conditions change over time.

<u>Alternatives</u>: Consideration was given to upgrading to larger pole classes than Class 1 (such as H1 and H2) for distribution lines, but the additional cost and difficulty in sourcing large numbers or larger class poles and the need for specialized equipment to install such poles would have resulted in a smaller number of upgraded poles for the same yearly cost as the preferred option of limiting distribution pole sizes to Class 1.

Due to supply chain challenges for procuring high quantities of larger class poles, the Company will investigate alternatives to wood poles, such as fiberglass. Additionally, a separate program for targeted undergrounding will be used for areas impacted by projected winds over 50 mph and icing over 0.75 inches.

<u>DER/NWA Alternative</u>: None

<u>Climate Leadership and Community Protection Act (CLCPA)</u>: N/A

<u>Studies/References</u>: MIT Joint Program on the Science and Policy of Global Change, Report 352, June 2021 by Muge Komurcu and Sergey Paltsev

Study Report Name(s): Climate Change Vulnerability Study & Resilience Plan
Sanction Paper No: None
Strategy No: None

Total Project Cost Breakdown: ($ Thousands)

Distribution Line:

Project Number	Spend	Prior Years	F26	F27	F28	F29	F30	Total
C094130 C094132 C094133	CapEx	0	12,862	20,059	28,595	28,522	28,998	119,036
	OpEx	0	0	0	0	0	0	0
	Removal	0	0	0	0	0	0	0
	Total	0	12,862	20,059	28,595	28,522	28,998	119,036

Sub-Transmission Line

Project Number	Spend	Prior Years	F26	F27	F28	F29	F30	Total
C094134 C094135 C094136	CapEx	0	1,450	3,000	3,000	3,100	3,100	13,650
	OpEx	0	0	0	0	0	0	0
	Removal	0	0	0	0	0	0	0
	Total	0	1,450	3,000	3,000	3,100	3,100	13,650

Estimate Grade: Investment

Begin Preliminary Engineering: Various
Final Design Complete: Various
Construction Start: Various
In-Service Date: Various

Appendix D – Selected Mitigation Projects

Table D 1. Distribution substations identified for flood risk mitigation

Substation Name	Reliability Score	Criticality Score	Community Resilience Score	BCJ Score	Serves a Disadvantaged Community?
Butternut 255	4	2	5	73%	Yes
Front Street 360	5	5	5	100%	Yes
Gloversville 72	5	5	5	100%	Yes
Liberty Street 94	1	4	5	67%	Yes
Peterboro 514	5	4	5	93%	Yes
Riverside 288	5	5	5	100%	Yes
Tonawanda Creek 206	5	4	3	80%	No
West Monroe 274	5	4	4	87%	No

Table D 2. Transmission substations identified for flood risk mitigation

Substation Name	Reliability Score	Criticality Score	Community Resilience Score	BCJ Score	Serves a Disadvantaged Community?
Albany Steam Plant	4	1	5	67%	Yes
Batavia 01	5	4	4	87%	Yes
Dewitt 241	4	2	5	73%	Yes
East Conklin Terminal 314	5	4	4	87%	Yes
Golah	5	4	4	87%	No
Headson 146	3	1	4	53%	Yes
Norfolk 934	5	4	4	87%	No
Ogdensburg 938	5	4	4	87%	Yes
Rome 762	5	4	4	87%	Yes
South-East Batavia	4	5	5	93%	Yes

Table D 3. Distribution (D) and transmission (T) substations identified for transformer upgrades

Substation Name	T or D Station	Reliability Score	Criticality Score	Comm. Resilience Score	BCJ Score	Serves a Disadvantaged Community?
Baker Street	D	5	1	3	60%	No
Beech St 81	D	4	1	3	53%	Yes
Boonville	T	5	4	4	87%	No
Buffalo 25	D	4	2	4	67%	Yes
Buffalo 30	D	3	4	4	73%	Yes
Buffalo 31	D	4	2	3	60%	Yes
Buffalo 34	D	3	4	3	67%	Yes
Buffalo 35	D	3	1	1	33%	Yes
Buffalo 41	D	4	4	4	80%	Yes
Buffalo 45	D	2	1	4	47%	Yes
Buffalo 51	D	3	4	4	73%	Yes
Buffalo 68	D	5	2	3	67%	Yes
Buffalo 98	D	5	4	3	80%	No
Buffalo 99	D	5	4	4	87%	Yes
Cicero	D	5	5	5	100%	No
Clinton	D	5	5	5	100%	No
Coffeen	T	4	4	5	87%	Yes
Cortland Area	D	5	1	1	47%	Yes
Deerfield	T	5	4	4	87%	Yes
Dewitt Station	T	4	2	5	73%	Yes
East Pulaski	D	5	4	4	87%	Yes
Eleventh St 82	D	4	1	1	40%	Yes
Gilbert Mills	D	5	4	4	87%	No
Golah	T	5	4	4	87%	Yes
Greenbush	T	5	5	5	100%	Yes
Homer Hill	T	1	1	4	40%	Yes
Lake Colby	T	4	4	4	80%	No
Lewiston Heights 086	D	3	4	3	67%	Yes
Lighthouse Hill	T	5	4	5	93%	No
Little River	D	4	4	3	73%	No

Substation Name	T or D Station	Reliability Score	Criticality Score	Comm. Resilience Score	BCJ Score	Serves a Disadvantaged Community?
Lockport	T	4	1	3	53%	Yes
Lockport Road 216	D	4	1	3	53%	Yes
Malone	T	5	4	4	87%	Yes
Marshville 115Kv Rebuild	T	5	5	5	100%	Yes
Marshville New Substation	T	5	5	5	100%	Yes
Meco	T	5	5	5	100%	Yes
Mill Street	T	3	4	3	67%	Yes
Mumford #50	D	5	1	3	60%	No
New Manheim Greenfield	T	5	5	5	100%	Yes
New Middleport	D	2	4	3	60%	Yes
New Royalton	D	5	4	4	87%	No
Newtonville Area	D	4	4	4	80%	No
North Shore	D	5	4	4	87%	No
Reynolds Rd	T	5	5	5	100%	Yes
Roberts Rd	D	4	5	4	87%	Yes
Seneca #5	T	1	1	1	20%	Yes
Smith Bridge	D	5	4	5	93%	No
South Newfane	D	4	1	1	40%	No
Stittville	D	5	4	3	80%	No
Sugar Hill Station	T	5	5	5	100%	Yes
Taylorville	T	5	4	4	87%	No
Teall Ave	T	4	4	5	87%	Yes
Tilden	T	4	1	4	60%	Yes
Union Fall	T	4	1	1	40%	No

Substation Name	T or D Station	Reliability Score	Criticality Score	Comm. Resilience Score	BCJ Score	Serves a Disadvantaged Community?
West Adams	D	5	4	4	87%	No
West Utica Area	D	4	4	4	80%	No
Whitman	T	4	2	4	67%	Yes
Yahnundasis	T	4	4	4	80%	No

Table D 4. Transmission lines identified for design upgrades

Transmission Lines	kV[37]	Reliability Score	Criticality Score	Comm. Resilience Score	BCJ Score	Serves a Disadvantaged Community?
Falconer - Homer Hill #153	115	5	4	4	87%	Yes
Falconer - Homer Hill #154	115	5	4	4	87%	Yes
Five Mile - Homer Hill #169	115	1	4	4	60%	Yes
Five Mile - Homer Hill #170	115	1	4	4	60%	Yes
Fues Rd – Rotterdam	115	4	5	5	93%	No
Gardenville - Arcade #151	115	1	1	1	20%	No
Gardenville - Big Tree #165	115	1	1	1	20%	Yes
Gardenville - Dunkirk #141	115	5	5	4	93%	Yes
Gardenville - Dunkirk #142	115	5	5	4	93%	Yes
Gardenville - Dunkirk #73	230	1	4	3	53%	Yes
Gardenville - Dunkirk #74	230	1	4	3	53%	Yes
Gardenville - Erie St #54-921	115	1	1	1	20%	Yes
Gardenville - Five Mile #152	115	1	2	3	40%	Yes
Gardenville - Ohio St #145	115	1	4	3	53%	Yes
Gardenville - Ohio St #146	115	1	4	3	53%	Yes

[37] Transmission line voltage rating in kilovolts (kV)

Transmission Lines	kV[37]	Reliability Score	Criticality Score	Comm. Resilience Score	BCJ Score	Serves a Disadvantaged Community?
Greenbush - Feura Bush #17	115	5	5	5	100%	No
Greenbush - Schodack #13	115	5	5	5	100%	No
Greenbush - Stephentown 993	115	1	5	5	73%	No
Huntley - Gardenville #38	115	4	4	3	73%	Yes
Huntley - Gardenville #39	115	4	4	3	73%	Yes
Huntley - Lockport #36	115	4	4	4	80%	Yes
Huntley - Lockport #37	115	4	4	4	80%	Yes
Indeck Oswego - Lighthouse Hill #2	115	1	5	5	73%	Yes
Kensington - Gardenville #44	115	3	4	3	67%	Yes
Kensington - Gardenville #45	115	3	4	3	67%	Yes
Lockport - Batavia #107	115	4	5	4	87%	Yes
Lockport - Batavia #108	115	2	4	4	67%	Yes
Lockport - Mortimer #111	115	5	4	3	80%	Yes
Lockport - Mortimer #113	115	5	4	4	87%	Yes
Lockport - Mortimer #114	115	5	1	1	47%	Yes
Malone - Lake Colby #5	115	3	4	4	73%	Yes
Mortimer - Elbridge #2	115	4	1	1	40%	Yes
Mortimer - Sta 122 (Pannell) #24	115	5	1	1	47%	Yes
Mortimer - Sta 122 (Pannell) #25	115	5	1	1	47%	Yes
Niagara - Gardenville #180	115	1	1	3	33%	Yes
North Troy - Hoosick #5	115	1	5	5	73%	No
North Troy - Reynolds Road #16	115	1	5	5	73%	No

Transmission Lines	kV[37]	Reliability Score	Criticality Score	Comm. Resilience Score	BCJ Score	Serves a Disadvantaged Community?
Packard - Erie St #181-922	115	1	1	1	20%	Yes
Packard - Gardenville 182	115	5	2	3	67%	Yes
Packard - Huntley #130	115	4	4	3	73%	Yes
Reynolds Road - Greenbush #9	115	1	5	5	73%	Yes
Rotterdam - New Scotland #19	115	4	5	5	93%	Yes
Rotterdam - Woodlawn #35	115	3	5	5	87%	Yes
Schaghticoke - Eastover #10	115	1	4	4	60%	No
Southeast Batavia - Golah #119	115	4	5	4	87%	Yes
Walck Road - Huntley #133	115	4	4	3	73%	Yes

Table D 5. Priority distribution feeders for targeted undergrounding

Feeder Number	Substation	Tree/Wind SAIFI	Customer Count	Number of WPF Occurrences	Max. Wind Gust (mph)	>.0.75' Icing
10558	105 SWANN RD	2.951	1,711	2	80	Yes
10557	105 SWANN RD	1.15	1,711	1	80	Yes
10558	105 SWANN RD	0.001	1,711	1	90	Yes
21253	212 HARBOR FRONT	0.003	1,554	1	100	Yes
06055	60 HAUSAUER RD	0.84	875	2	90	Yes
33151	ASHLEY	0.076	1,191	3	90	Yes
15056	BAKER STREET	0.135	2,227	1	70	Yes
32554	BARTELL	0.367	2,806	2	80	Yes
32252	BIRCH AVENUE	0.666	1,781	3	90	Yes
30352	BLUE STORES	2.21	1,128	2	80	Yes
28451	BOLTON	1.624	1,498	2	80	Yes
28453	BOLTON	1.106	812	2	70	Yes
16852	BRIDGEPORT	1.042	1,911	2	80	Yes
16854	BRIDGEPORT	0.35	1354	3	90	Yes
04252	CHESTERTOWN	0.297	2,398	4	80	Yes
6652	CLINTON ERCC	0.259	1,689	2	80	Yes
28551	CORINTH	0.797	1,667	2	100	Yes

Feeder Number	Substation	Tree/Wind SAIFI	Customer Count	Number of WPF Occurrences	Max. Wind Gust (mph)	>.0.75' Icing
28552	CORINTH	0.487	2,184	2	70	Yes
9351	DELAMETER RD	0.332	1,588	1	90	Yes
31954	FORT GAGE	0.72	1,912	3	80	Yes
8964	FT. COVINGTON	0.023	651	1	90	Yes
15451	GILMANTOWN	0.771	2,061	3	90	Yes
41853	HAGUE	2.74	2,229	3	90	Yes
7955	HARTFIELD	1.783	1,537	1	70	Yes
3851	HEMLOCK	0.001	927	1	80	Yes
32852	HEMSTREET	0.817	426	3	80	Yes
92451	HIGLEY	0.929	1,094	2	70	Yes
08753	HUDSON	1.61	2,100	2	80	Yes
29154	JEWETT	1.004	1,034	3	70	Yes
29155	JEWETT	0.102	808	1	80	Yes
18251	LAKEVIEW	0.51	1,581	1	80	Yes
18254	LAKEVIEW	0.002	1,808	1	90	Yes
6144	LIGHTHOUSE HILL	3.58	2,333	4	80	Yes
73351	LYME E.S.	0.122	2,335	1	90	Yes
73352	LYME E.S.	0.052	2,877	1	80	Yes
39052	MIDDLEBURG	0.533	2,177	2	80	Yes
29451	NILES	0.819	1,321	3	90	Yes
12351	NORTH TROY	0.145	1,345	2	80	Yes
33252	NORTHVILLE	0.444	2,459	2	100	Yes
62258	POLAND CRCC	3.23	1,618	3	70	Yes
33352	SHERMAN CRCC	0.098	1,511	1	60	Yes
87651	SUNDAY CREEK	2.253	269	4	80	Yes
65357	TURIN RD	1.221	1,460	2	70	Yes
65358	TURIN RD	1.017	2,260	2	70	Yes
65355	TURIN RD	0.001	1,428	1	60	Yes
8254	W HAMLIN	0.969	2,124	2	90	Yes
8253	W HAMLIN	0.432	2,322	1	90	Yes
8252	W HAMLIN	0.147	2,322	1	90	Yes
8254	W HAMLIN	0.002	2,124	1	90	Yes
87551	WEST ADAMS	0.283	2,105	2	90	Yes

Table D 6. Distribution feeders prioritized for targeted undergrounding BCJ results

Feeder Number	Substation	Reliability Score	Criticality Score	Comm. Resilience Score	BCJ Score	Serves a Disadvantaged Community
03-10558	105 SWANN RD	5	4	4	87%	Yes
03-10558	105 SWANN RD	5	4	4	87%	No
03-10557	105 SWANN RD	3	1	4	53%	No
01-21253	212 HARBOR FRONT	3	4	4	73%	No
01-6055	60 HAUSAUER RD	5	1	2	53%	No
38-33151	ASHLEY	5	2	5	80%	No
09-15056	BAKER STREET	5	1	3	60%	No
11-32554	BARTELL	5	4	5	93%	No
40-32252	BIRCH AVENUE	5	4	5	93%	No
33-30352	BLUE STORES	5	4	5	93%	No
40-28453	BOLTON	4	5	5	93%	No
40-28451	BOLTON	4	1	4	60%	No
11-16852	BRIDGEPORT	4	4	5	87%	No
11-16854	BRIDGEPORT	3	4	4	73%	No
40-04252	CHESTERTOWN	5	4	5	93%	No
16-6652	CLINTON ERCC	5	1	2	53%	No
39-28551	CORINTH	4	5	5	93%	No
39-28552	CORINTH	5	2	5	80%	No
07-9351	DELAMETER RD	5	5	4	90%	No
40-31954	FORT GAGE	5	4	4	87%	No
03-8964	FT. COVINGTON	3	1	2	40%	No
35-15451	GILMANTOWN	5	5	5	100%	No
41-41853	HAGUE	5	5	5	100%	No
09-7955	HARTFIELD	5	1	2	53%	No
05-3851	HEMLOCK	5	4	5	93%	No
31-32852	HEMSTREET	4	1	2	47%	No
25-92451	HIGLEY	5	1	2	53%	No
33-08753	HUDSON	5	5	5	100%	No
11-29154	JEWETT	4	1	2	47%	No
11-29155	JEWETT	5	1	2	53%	No
07-18254	LAKEVIEW	3	4	4	73%	No
07-18251	LAKEVIEW	3	1	2	40%	No
16-6144	LIGHTHOUSE HILL	5	4	5	93%	Yes
13-73351	LYME E.S.	5	4	4	87%	No
13-73352	LYME E.S.	5	4	4	87%	No
37-39052	MIDDLEBURG	4	4	4	80%	No

Feeder Number	Substation	Reliability Score	Criticality Score	Comm. Resilience Score	BCJ Score	Serves a Disadvantaged Community
11-29451	NILES	5	4	4	87%	No
31-12351	NORTH TROY	5	4	5	93%	No
35-33252	NORTHVILLE	5	4	5	93%	No
17-62258	POLAND CRCC	5	4	4	87%	No
17-33352	SHERMAN CRCC	5	4	4	87%	No
23-87651	SUNDAY CREEK	5	1	1	47%	No
18-65358	TURIN RD	5	4	4	87%	No
18-65357	TURIN RD	5	2	4	73%	No
18-65355	TURIN RD	4	1	3	53%	No
06-8254	W HAMLIN	5	4	4	87%	No
06-8254	W HAMLIN	5	4	4	87%	No
06-8253	W HAMLIN	5	1	2	53%	No
06-8252	W HAMLIN	3	1	2	40%	No
13-87551	WEST ADAMS	5	4	3	80%	No

Appendix E – Project Costs

Table E 1. Breakdown of total costs (in millions of dollars) of the six project categories identified in the CCRP

CCRP Project Categories	Project Type	Climate Hazard	FY26	FY27	FY28	FY29	FY30	FY31-35	FY36-40	FY41-45	TOTAL
Overhead Distribution and Sub-transmission Line Design Upgrades*	D Line and Sub-T Line	Wind/Ice	$14.3	$23.1	$31.6	$31.6	$32.1	$195.0	$260.7	$291.2	$879.5
Overhead Transmission Line Design Upgrades*	T Line	Wind/Ice	$5.8	$8.3	$7.2	$6.4	$5.7	$25.4	$20.3	$29.8	$108.9
Distribution Targeted Undergrounding[38]	D Line	Wind/Ice	-	$5.5	$21.4	$21.4	$21.4	$124.3	$150.0	$150.0	$494.1
Spare Transmission Line Structures	T Line	Wind	$1.5	-	-	-	-	-	-	-	$1.5
Substation Flood Walls	D Sub and T Sub	Flooding	-	$0.8	$7.6	$5.7	$4.8	$9.2	-	-	$28.1
Distribution and Transmission Substation Transformer Specification Upgrades *	D Sub and T Sub	Extreme Temperature	$1.1	$2.0	$1.6	$1.4	$1.2	$6.3	$5.5	$5.5	$24.6
*Added incremental spending to existing projects and program		CCRP TOTAL	**$22.7**	**$39.6**	**$69.5**	**$66.5**	**$65.3**	**$360.1**	**$436.5**	**$476.4**	**$1,536.6**

[38] Total costs for targeted undergrounding include capital costs (70%), operating expenses (20%), and cost of removal (10%). Costs for all other projects listed in the table are 100% capital.