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Climate Change Resilience Plan

Rochester Gas and Electric Corporation

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List of Acronyms

CCRP	Climate Change Resilience Plan
CCVS	Climate Change Vulnerability Study
CMIP6	Coupled Model Intercomparison Project Phase 6
CRWG	Climate Resilience Working Group
DAC	Disadvantaged Communities
EOP	Emergency Operations Procedures
ETR	Estimated Time of Restoration
FEMA	Federal Emergency Management Agency
FSF	First Street Foundation
GCM	Global Climate Model
GHG	Greenhouse Gas
GIS	Geographic Information System
HILL	High Impact and Low Likelihood
IEEE	Institute of Electrical and Electronics Engineers
IPCC	[United Nations] Intergovernmental Panel on Climate Change
JU	New York State Joint Utilities group
MPH	Miles Per Hour
NASA	National Aeronautics and Space Administration
NESC	National Electric Safety Code
NEX-GDDP	NASA Earth Exchange Global Daily Downscaled Projections
NOAA	National Oceanic and Atmospheric Administration
NYSERDA	New York State Energy Research and Development Authority
PSL	Public Service Law
RG&E	Rochester Gas and Electric Corporation
SME	Subject Matter Expert
SSPs	Shared Socioeconomic Pathways

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Executive Summary

RG&E is committed to enhancing resilience to climate change in the face of escalating environmental challenges. As our world confronts increasingly frequent and severe climate events, our electric utility recognizes the importance of safeguarding our infrastructure and ensuring uninterrupted service for our customers. This Climate Change Resilience Plan (CCRP) outlines the efforts that have been and will continue to be undertaken by RG&E to continue making our electric assets more resilient to climate change.

Building on the outcome of the Climate Change Vulnerability Study (CCVS), the CCRP identifies a number of ongoing activities that RG&E is performing in the current rate plan to build resilience to the effects of climate change and then identifies new activities that are designed to continue building resilience to climate change both now and in the 10- and 20-year time horizons.

Priority Vulnerabilities

Identification of priority vulnerabilities was the focus of the CCVS. An asset's vulnerability is determined by sensitivity and exposure to a particular climate hazard, as well as the consequence of its malfunction or failure. The identified priority vulnerabilities listed in Table 1 are based on the study findings as well as input from stakeholders and subject matter experts. Asset-hazard combinations not included in the table (e.g., transmission + flooding) were not identified as priority vulnerabilities.

Table 1. Summary of Priority Vulnerabilities by Asset Family Type

Hazard	Transmission	Distribution	Substation
High Temperature			✓
Flooding			✓
Wind	✓	✓	
Wind & Ice	✓	✓	✓

RG&E's current substation, transmission and distribution construction standards meet or exceed the 2023 version of the National Electric Safety Code (NESC). The results of this CCRP are based on an evaluation against these current standards, observations, and projections of future conditions due to climate change. As standards change, or new data and projections become available, the results will be incorporated into future CCRPs.

Using the results of the CCVS, RG&E identified one new resilience measure in the CCRP to adapt to projected changes in the climate between now and 2050, based on the SSP5-8.5 50th[1] percentile planning scenario: update internal standards to reflect substation transformer ambient design specifications to account for future temperatures.

For the other priority climate hazards identified in the CCVS, RG&E will be leveraging existing projects, programs, or practices that are specifically, or in part, designed to mitigate against those impacts.

[1] Shared Socioeconomic Pathway 5, "Fossil Fueled Development"

Ongoing Climate Change Resilience Activities

The following is a summary of some major activities RG&E is currently undertaking to increase the resilience to climate change in its transmission, distribution, and substation assets.

Distribution and Wind, Wind-and-Ice Priority Vulnerabilities

Grid Modernization: For the expected impact of extreme weather due to climate change on the distribution systems, RG&E has existing programs designed to harden and automate its systems to reduce the number of customers interrupted, restoration time and interruption costs from weather events. RG&E has invested substantially in grid modernization, incorporating advanced technologies such as smart meters, automated devices, and real-time monitoring systems. These additions will continue to improve the system's ability to respond swiftly to outages caused by climate-related disruptions. This modernization can reduce the scope of outages, their duration, and the cost to restore customers.

Resilient Infrastructure: For the expected impact of extreme weather due to climate change on the distribution system, RG&E has existing programs designed to harden key distribution infrastructure components, such as poles, lines, transformers, and substations, to better withstand extreme weather events. This proactive approach minimizes infrastructure damage, ensuring more reliable service during extreme weather events.

Transmission and Wind, Wind-and-Ice Priority Vulnerabilities

Transmission Line Upgrades: For the expected impact of extreme weather due to climate change on the transmission system, RG&E routinely inspects and assesses the need to upgrade existing lines with more modern and resilient designs. RG&E is actively engaged in upgrading and strengthening our transmission lines to better withstand extreme climate events. Replacing this infrastructure with modern facilities designed to current requirements helps boost its resilience to the challenges posed by extreme climate events and identified in the CCVS in the Transmission and Wind and Transmission and Wind-and-Ice priority vulnerabilities.

Newly Identified Resilience Measures

In addition to the ongoing initiatives, RG&E has identified the following incremental resilience measures specifically from analysis performed in the CCVS and CCRP:

Substation Flood Mitigation: Based on the analysis included in the CCVS, substation flooding exposure at RG&E substation assets is not significantly different between now and 2050. Flooding exposure is regularly included in the review and development of substation projects, as demonstrated by multiple ongoing substation flooding projects. The CCRP used a risk-based analysis to identify a subset of important substations for flood mitigation.

Substation Transformers with Increased Temperature Capability: RG&E will update substation transformer specifications to begin installing substation transformers with higher ambient temperature capability. This update addresses the substation and heat priority vulnerability from the CCVS and will allow newly installed substation transformers to better withstand future extreme temperatures.

RG&E's Commitment to Resilience

RG&E is committed to building resilience to climate change throughout its electric system as demonstrated by the multiple ongoing projects and initiatives in the current rate plan that have direct ties to climate resiliency. In addition to this pre-existing work, the CCRP identifies ways in which climate data can be incorporated into existing processes, or adjustments that can be made to account for future conditions.

Introduction

1. Introduction and Background

The Climate Change Resilience Plan (CCRP) builds upon the ongoing resilience work performed by Rochester Gas and Electric Corporation (RG&E). The recently published Climate Change Vulnerability Study (CCVS)[2] presents the findings of the Company's electrical transmission, distribution, and substation assets across a set of priority hazards: high temperature, flooding, wind, and wind & ice. The CCRP identifies how RG&E is planning to address the results of the CCVS with the intent of building resiliency to the identified climate change vulnerabilities and enhancing the resiliency of the Company's assets and operations to the impacts from climate change.

To complete this CCRP, RG&E continued its engagement of internal subject matter experts and ICF[3], a climate resilience consultant. In addition to the Study Team, external stakeholders were invited to participate in Climate Resilience Working Group (CRWG) meetings[4]. In these meetings, the CRWG discussed key elements of the CCRP, including the Multi-pronged Resilience Strategy and Approach and the Business Cost Justification Frameworks.

1.1 Background

In response to worsening climate hazards and in support of climate resilience planning, the Governor of New York State signed into law on February 24, 2022, the addition of subdivision 29 to Public Service Law (PSL) §66. Under the law, electric utilities in the state are required to conduct a Climate Change Vulnerability Study (CCVS) and develop a Climate Change Resilience Plan (CCRP) (New York State Public Service Commission, 2022). The CCVS was structured to evaluate the utility's assets, design specifications, and procedures to better understand the electric system's vulnerability to climate-driven risks[5]. The CCRP, due 60 days after the filing of the CCVS, will detail how utilities are, or plan to increase the resilience of their electrical system to the vulnerabilities identified in the CCVS.

1.2 Overview of the RG&E Electrical System

RG&E (Figure 1) was established in 1848 and operates more than 8,900 miles of electric distribution lines and nearly 1,100 miles of electric transmission lines. It serves more than 380,000 electricity customers in a nine-county region of New York State (Rochester Gas and Electric, 2023).

[2] https://www.rge.com/documents/40137/2122498/NYSEG+RG%26E+Climate+Change+Vulnerability+Study_10.03.23.pdf/368c6b3e-96ec-95b3-0b8e-2e02fb5bcf7b?t=1696357182533
[3] https://www.icf.com/company/about
[4] RG&E's CCRP was performed in conjunction with New York State Electric & Gas' CCRP. Accordingly, some references in this report may include both companies though the results in this document apply only to RG&E.
[5] NYS PSC Case 22-E-0222 Order Initiating Procedure: https://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7bCA027C18-8246-47E7-A1A1-B2C096AC42C0%7d

Figure 1. Map of Rochester Gas & Electric Service Area

1.3 Climate Change Vulnerability Study

RG&E's CCVS assessed the risks climate change poses to the Company's electric system and generated results that guide the CCRP. The CCVS identified the projected impacts of climate change on the Company's service area and contemplated potential resilience measures that have been evaluated for the CCRP. The CCVS used several resources to establish climate and risk projections, including climate projections developed by Columbia University and NYSERDA[6], baseline and projected flooding depths from First Street Foundation[7], baseline historical average wind speeds and wind gusts from the National Oceanic and Atmospheric Administration, and daily average wind speed projections from NASA's NEX-GDDP downscaled global climate models (GCMs).[8]

Assets

For the CCVS, RG&E electrical assets were grouped into three asset families: transmission, distribution, and substations.

Transmission assets carry electricity over long distances and at high voltage; for RG&E, these voltages range from 34.5 to 345 kilovolts (kV). These assets allow for power to efficiently flow from interconnected generation facilities to substations where it is transformed to feed the distribution system. Transmission line structures, conductors, and other related components were included.

Distribution assets originate at substations and deliver electricity to homes and businesses at voltages that typically range from 4.8 to 12.5 kV. The distribution conductors, structures,

[6] Columbia University and NYSERDA are currently updating the 2014 ClimAID report using these same newly produced CMIP6 station data.
[7] First Street Foundation. https://firststreet.org/
[8] NASA. "NASA Earth Exchange Global Daily Downscaled Projections (NEX-GDDP-CMIP6)." https://www.nccs.nasa.gov/services/data-collections/land-based-products/nex-gddp-cmip6

transformers, regulators, capacitors, surge arrestors, and other current-carrying components were included in this assessment.

Substations are facilities where one or more generation, transmission, or distribution systems interconnect to supply electricity to other parts of the grid. Substations often include complex pieces of interconnected electrical assets, like transformers and circuit breakers, which are crucial to the operation of the grid. Transformers, circuit breakers, regulators, reactors, protection and control equipment, and substation structures were included in this assessment

Priority Vulnerabilities

An asset's vulnerability was determined by sensitivity and exposure to a particular climate hazard, as well as the consequence of its reduced performance or failure. The identified priority vulnerabilities listed in Table 2 are based on the results of the CCVS. Asset-hazard combinations identified as priority vulnerabilities are indicated with a checkmark in the table below; asset-hazard combinations without a checkmark (e.g., transmission + flooding) are not considered priority vulnerabilities.

Table 2. Summary of Priority Vulnerabilities by Asset Family Type

Hazard	Transmission	Distribution	Substation
High Temperature			✓
Flooding			✓
Wind	✓	✓	
Wind & Ice	✓	✓	✓

Key Results from CCVS

To complete its CCVS RG&E worked with New York State Electric & Gas (NYSEG). The following summary information comes directly from the Companies' shared CCVS.

Temperature Projections: Climate projections reveal the potential for significant temperature increases across the NYSEG and RG&E service areas. For example, the number of days with daily maximum temperatures exceeding 95°F in Rochester is projected to increase from the historical average occurrence of approximately 1 day per year to over 11 days per year by 2050.

Temperature Vulnerabilities: Transformers, a critical component in substations, are highly sensitive when exposed to maximum ambient temperatures above 104°F or prolonged exposure to average temperatures[9] above 86°F; these temperatures have rarely occurred throughout the Companies' service area. The projected higher ambient temperatures could lead to accelerated transformer degradation, damage, or sudden failure.

Under the study planning scenario (SSP5-8.5 50th percentile 2050[10]), RG&E is projected to have all substations, transmission lines, and distribution circuits experience between 2 and 5 days with average temperatures above 86°F.

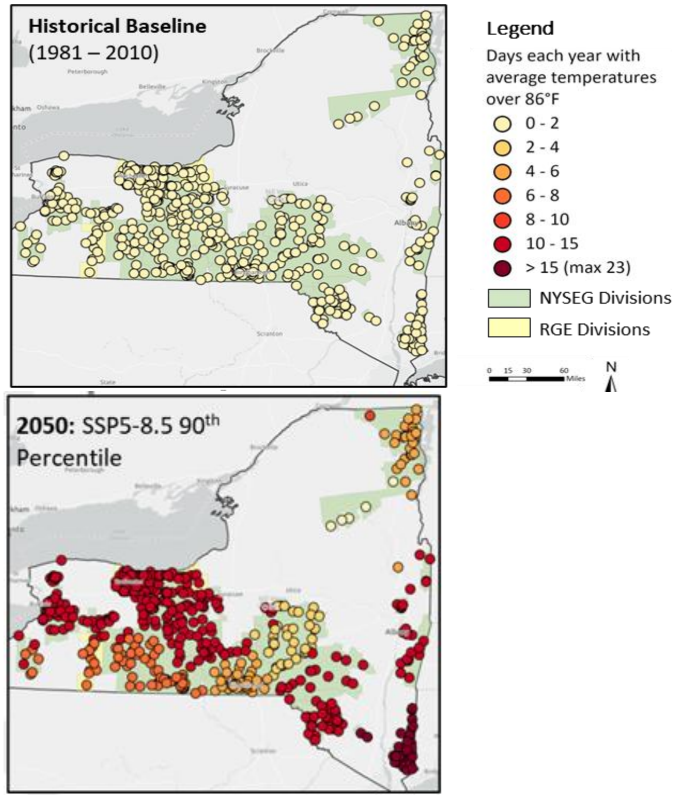

Figure 2. Historical and Projected Number of Days with Temperatures over 86°F

Flooding Projections: RG&E's service area is not coastal; therefore, the CCVS focused on inland flooding. In general, floods throughout the RG&E service area are expected to increase in depth and extent for both 100- and 500-year storm scenarios due to increased precipitation. By 2050, substations that already experience some levels of flooding are projected to see, on average, an approximate 2-inch increase in flood depth under the 100-year storm scenario and a nearly 2.4-inch increase under the 500-year storm scenario.

[9] Average temperature across a 24-hour period including the nighttime low and daytime high.

[10] The SSP5-8.5 50th percentile of results was selected as the climate resilience planning level. This was selected and discussed with the Study Team and external stakeholders with the aim of establishing a conservative planning level for analysis of future conditions. This selection aligns with work performed by industry peers.

Flooding Vulnerabilities: Components in substations are highly vulnerable to flooding due to their sensitivity to water exposure. If flood waters reach critical components (such as control cabinets, fans, pumps, external wiring connections, or other accessories), the damage can range from minor to significant, causing prolonged outage exposure to customers.

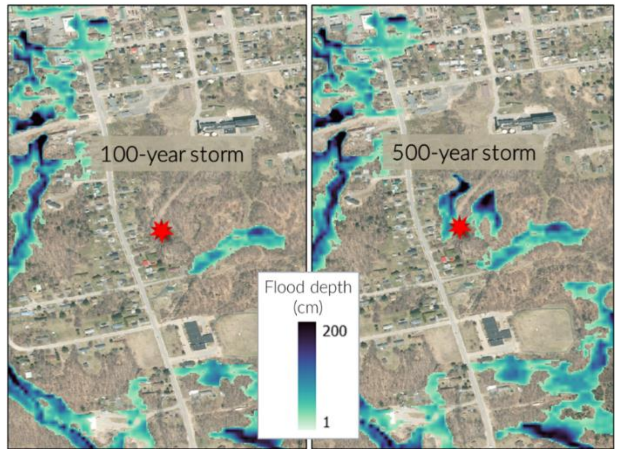

Figure 3. Sample Flooding

The takeaways from the exposure analysis are summarized below:

- Under the 100-year flood, 143 substations are projected to be exposed to more than 12 inches of water in all or a portion of the substation yard at present day and in 2050.
- Under the 500-year flood, 192 substations are projected to be exposed to more than 12 inches of water in all or a portion of the substation yard at present day. In 2050, five additional stations are projected to be exposed to more than 12 inches of water.

Wind Projections: Qualitative analysis showed that extreme wind speeds and gusts are projected to increase in both frequency and intensity by mid- through late century based on available peer-reviewed research on these infrequent but highly impactful events (Thrasher, 2022). The quantitative analysis performed in the CCVS showed an increase of less than 1 mile per hour in 2050. These findings were localized to regional airports and do not preclude higher wind speeds from occurring elsewhere in New York.

Wind Vulnerabilities: Extreme wind speeds that occur in low likelihood events, such as tornadoes and hurricanes, can directly affect utility assets and frequently cause fallen vegetation to impact the transmission or distribution system. While these assets are designed to be resilient, such additional and sudden impacts may cause assets to be damaged or to fail.

Wind & Ice Projections: Quantitative projections for the influence of climate change on ice and simultaneous windstorms remain uncertain due to the specific atmospheric conditions required for ice storms to occur (Intergovernmental Panel on Climate Change (IPCC), 2021). However, there has been qualitative analysis that shows that the overall frequency of ice storms is projected to decrease in the service areas as temperatures warm but that the intensity of these events could increase (Zarzycki, 2018).

Wind & Ice Vulnerabilities: Concurrent wind-and-ice events can damage transmission and distribution structures and conductors. Significant accumulation of ice, followed by strong wind gusts, can exceed the design capabilities causing assets to be damaged or fail.

1.4 Resilience Planning Approach

In the CCRP, RG&E used a risk-based resilience strategy that considers multiple approaches to advancing resiliency, but it is important to recognize that it is not feasible to harden the electrical system against all future event types and severity. The CCRP utilizes a multi-value framework to review potential resilience measures.

Summary of the Multi-Pronged Resilience Strategy

The multi-pronged resilience framework, initially discussed in the CCVS, establishes four key ways to enhance resilience for operational processes and assets:

1. **Strengthen** assets and processes to **withstand** the adverse impacts of a climate hazard event.
2. Increase the ability to **anticipate** when a climate hazard event may occur and increase the electric system's ability to **absorb** the effects.
3. Bolster the ability to quickly **respond and recover** in the aftermath of a climate hazard event.
4. **Advance and adapt** the electric system to address continuous changes from climate change and to perpetually improve resilience.

A risk-based approach was used to identify the most at-risk assets based on the potential magnitude of customer interruption and severity of the climate event the asset could be exposed to. The resulting top scoring assets were identified as key locations to evaluate implementing resilience measures as identified in each section of the CCRP.

Summary of the Business Cost Justification Framework

Once locations were identified, the Study Team developed a Business Case Justification (BCJ) Framework that captures the benefits of implementing a resilience measure at the identified location. The BCJ established several criteria to arrive at a score by asset. The dimensions included in the criteria are as follows:

1. **Community Resilience:** Provides insight into the extent of the impact on the region due to an electrical outage. It is based on the types of critical facilities and the population they serve and the number of customers served.
2. **System Reliability:** Provides insight on whether a resilience measure being proposed is in an area with historically lower reliability, including during storms, relative to others in the service territory.
3. **Community Safety:** Based on the count of critical facilities that provide health- and safety-related services to the community (e.g., hospitals, police stations, water treatment plants, and shelters) associated to each circuit.

Additionally, the priority locations for resilience measures were mapped to understand if the asset serves disadvantaged communities (DACs), which are discussed further in Section 3.

Engagement of the Climate Resilience Working Group

2. Engagement of the Climate Resilience Working Group

To gather information from community and public sources, stakeholders were engaged to form a Climate Resilience Working Group (CRWG); involvement in the CRWG was open to the public for anyone to participate. The CRWG met periodically to receive updates on the development progress of the CCVS. In these engagements, stakeholders were given the opportunity to provide feedback via meeting participation or through e-mail. In addition, CRWG members were given an opportunity to review and comment on the CCVS and CCRP before they were filed.

There were five stakeholder meetings held throughout the development of the CCVS and CCRP that occurred regularly between September 2022 and September 2023. Again, participation in these meetings was open to the public, such that anyone could participate and be considered a stakeholder. For each of these meetings, the Study Team prepared presentation materials that were shared with all registered participants regardless of attendance at meetings. These materials were designed to communicate project progress and next steps and to invite stakeholder participation and feedback. These meetings covered the following topics:

- **Stakeholder Meeting (September 22, 2022):** Initial kickoff meeting that included introduction to Study Team, broad overview of the legislation, project scope, and expected timeline for future engagement of the Climate Resilience Working Group.
- **Climate Resilience Working Group Session #1 (December 14, 2022):** In the first meeting of the CRWG, the initial climate projection results were shared, as well as an overview of the next steps that would be used to assess vulnerability.
- **Climate Resilience Working Group Session #2 (April 17, 2023):** The second meeting of the CRWG expanded upon the previous climate projection data by including asset locations to demonstrate the exposure of assets to climate hazards. In addition, asset sensitivity, consequence, and vulnerability ratings for each of the assets and asset families were shared.
- **Climate Resilience Working Group Session #3 (July 12, 2023):** In the third and last meeting before the publication of the CCVS, a summary of the key findings from the study were shared, as well as potential mitigation solutions, prioritization frameworks, and resilience measure benefit scoring.
- **Climate Resilience Working Group Session #4 (September 28, 2023):** This meeting was focused on discussing the next steps for the Climate Change Resilience Plan and discussion of how resilience measures were identified.

Key inputs from Working Group participants included discussion of the most concerning climate hazards in their community and how these hazards may impact their communities. This stakeholder input was used to help tailor the CCVS and future CRWG meetings to focus on concerns raised by the CRWG.

Future CRWG Meetings

In 2024 and beyond, RG&E will continue to meet at least twice annually with the CRWG to discuss the Climate Change Resilience Plan and any updates from the Company or stakeholders.

Consideration of Equity

3. Consideration of Equity

RG&E acknowledges its role in contributing to the equitable development of the communities it serves. The Company's investments to aid the transition to clean energy, for example, will generate jobs and access to clean, renewable, and affordable energy. Additionally, RG&E's Supplier Diversity program has the goal of increasing spending on businesses owned by ethnic minorities, women, people with disabilities, veterans, and members of the LGBTQI+ community (Avangrid, 2022).

RG&E is looking to continue pursuing equity in the prioritization of climate resilience projects by leveraging the work done by the New York State Climate Justice Working Group (CJWG) and the New York State Department of Environmental Conservation, who identified disadvantaged communities (DAC) across New York State. Pursuant to the Climate Leadership and Community Protection Act (CLCPA) that was signed into law in July of 2019[11], 35% of census tracts in New York State were identified as DACs (New York State Climate Justice Working Group, 2023). A map of the DACs is available to the public and is depicted in Figure 4.

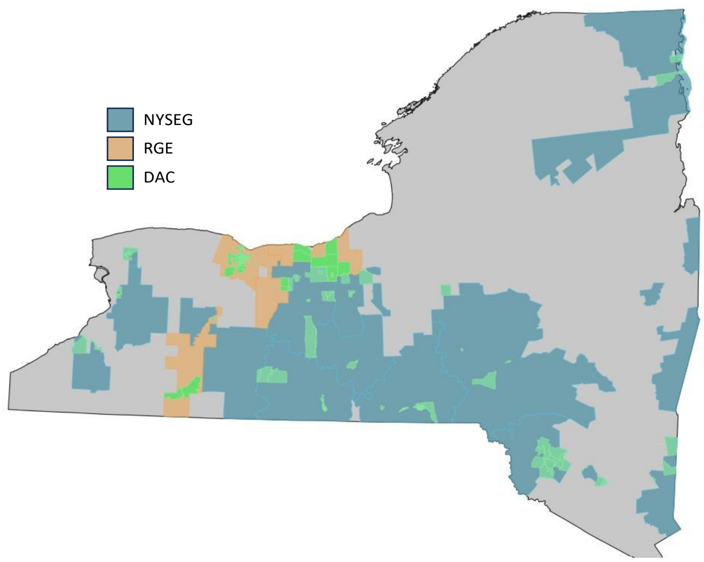

Figure 4. Map of Disadvantaged Communities in NYSEG and RG&E's Service Territory.

In the CJWG context, DACs are communities that "have historically been overburdened by environmental pollution"[12] and are now also exposed to climate hazards, like flooding and extreme heat. The CLCPA mandates that no less than 35% (with a goal of 40%) of the State's climate action benefits (e.g., reducing emissions and investing in clean energy) must go toward DACs (New York State, 2023). While this mandate is not specifically applicable to the CCRP, RG&E is actively identifying which of the resilience measures discussed in Section 5 are in, adjacent to, or directly benefit DACs.

[11] https://www.dec.ny.gov/press/127364.html
[12] https://climate.ny.gov/Our-Impact/Ensuring-Equity-Inclusion

Multi-pronged Resilience Strategy and Approach

4. Multi-pronged Resilience Strategy and Approach

Public Service Law §66 includes consideration that resilience measures could include a multi-pronged approach with a range of solutions used to achieve resilience. In the CCRP RG&E implemented a resilience framework that explores alternatives within four key objectives: 1) strengthen assets and operations to withstand the adverse impacts of a climate hazard event; 2) increase capacity to anticipate when a climate hazard event may occur and absorb its effects; 3) bolster the system's ability to quickly respond and recover in the aftermath of a hazard event; and 4) advance and adapt the system such that it may evolve with the continuously changing climate threat landscape and perpetually prioritize resilience.

4.1 Proposing Resilience-Related Measures

Strengthen and Withstand

As shown in the results of the CCVS, RG&E's assets are projected to be exposed to different climate hazards. This resilience objective explores measures that provide physical strength to assets to withstand impacts that may occur during extreme weather events (e.g., extreme wind gusts and extreme temperatures).

Anticipate and Absorb

In some cases, reinforcing assets with a resilience measure designed to strengthen and withstand may be insufficient or impractical. The anticipating and absorb resilience measure explores ways to reduce the impacts to electrical service should an asset fail regardless of physical strengthening. These types of measures limit the level or propagation of service disruption that may occur.

Respond and Recover

The previous two objectives (strengthen and withstand, anticipate and absorb) focus on reducing the level of disruption in the service level through physical measures. This objective is focused on activities and procedures to restore the service to normal levels in the aftermath of a climate hazard event. Respond and recover measures are often incorporated into planning, design, and operation practices but may also include identification of additional spare equipment needs.

Advance & Adapt

The last objective addresses a continuously changing climate threat landscape and perpetually improve resilience. This is achieved by learning from previous experiences and continued investment in resilience, so that the next time the system is exposed to a similar climate hazard event, the level of disruption is reduced. These learnings are incorporated into planning, design, and operation practices. Relocating assets to avoid the exposure to climate hazards, when feasible, is an example of an adaptive resilience measure.

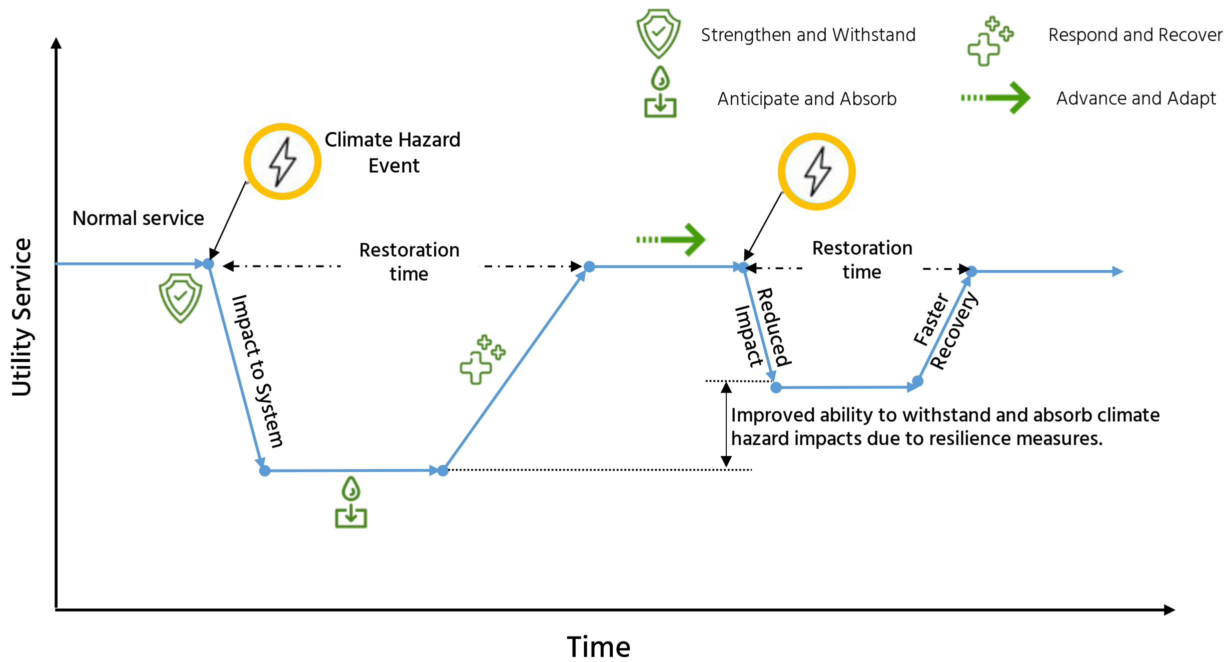

Figure 5. RG&E's Multi-Pronged Resilience Strategy

4.2 Incorporating Resilience into Existing Planning, Design, and Operations

RG&E used the findings of the CCVS's Operational Process Vulnerability Summary to identify ways in which resilience to climate hazards could be built gradually over-time, or through updates to existing processes. These identified measures can also be considered under the multi-pronged resilience framework.

Substations & High Temperature – Strengthen and Withstand

In the CCVS, temperature was identified as a priority vulnerability for the following substation equipment: transformers, regulators, circuit breakers, and reactors. For each of these types of equipment, the 24-hour average ambient temperature and the daily maximum temperature are important design considerations. If these assets are subjected to high loading coincident with ambient temperatures beyond their design parameters their internal components will degrade at an increased rate leading to a shortened service-life, and potentially resulting in a higher risk of failure.

A significant number of transformers operating today are expected to remain in service into and beyond 2050. RG&E SMEs have reviewed the climate projections generated in the CCVS and determined that in order to adapt to the coincident effects of high-loading and increased ambient temperatures, future substation transformers should be specified so that they are suitable to operate in an environment where the average temperature of the cooling air for any 24-hour period is 35°C, rather than the current 30°C. This will allow for future equipment to withstand the projected effects of climate change and operate at full rated capacity in future climate conditions, which are discussed further in Section 5.

Substations and Flooding – Advance and Adapt

A comprehensive set of flood depth data, obtained from the First Street Foundation, identified additional substation locations throughout the RG&E service territory that are at risk of flooding. This new, comprehensive list will be shared with the Emergency Preparedness, Energy Control Center, Asset Management, and Operations groups to inform their response during anticipated flooding events or during routine project development.

Reliability Analysis – Advance and Adapt

GeoMesh

This project maps RG&E's service area to identify the strengths and weaknesses of its electric networks to help forecast its performance during both blue-sky and storm scenarios. The goal is to improve understanding about how the electric grid is performing under various weather conditions so that RG&E can better plan upgrades, storm response, and more.

To accomplish this, GeoMesh breaks the service area into small sections to allow the Company to focus on one specific region at a time. For the chosen selection, GeoMesh makes predictions by analyzing millions of data points, such as temperature, average wind speed, precipitation type and amount, outage history and reason, population and density of tree limbs and other vegetation. All of this lets the Company make informed, data-based decisions on things like where and what upgrades are most needed or which customers are most likely to be impacted by a storm.

HealthAI

This project will analyze millions of high-resolution photos of the Company's street-level distribution system—poles, wires, and grid equipment—to identify the assets in the photos and, eventually, catalogue their health. This increases the Company's awareness of the condition of its grid equipment and helps to identify areas of concern. HealthAI is anticipated to save RG&E time and money by targeting at-risk locations for inspections and maintenance. It is also expected to reduce outage exposure and improve safety for line workers by giving them more information before they arrive on scene.

Currently, RG&E is training the AI system to correctly identify grid equipment in photos, such as cross arms, transformers, or wire. Next, the AI system will learn to analyze and determine the health of that equipment. For instance, it will identify if the cross arm is broken or if the wire is sagging. Currently RG&E learns of these equipment damages or failures from customer reports, manual inspections, or customer outages. HealthAI aims to be a proactive process that automatically identifies system needs prior to customer interruptions occurring. In the long term, RG&E aims to also use HealthAI to identify threats to its distribution network, such as hanging tree limbs or dead trees that may fall onto Company electric lines.

Facility Ratings – Advance and Adapt

As noted in the CCVS, RG&E SMEs are currently working with the other New York Transmission Owners to review and revise the 2019 New York Transmission Owner's Tie-Line Ratings Report[13]. One

[13] https://www.nyiso.com/documents/20142/1402024/NYTO-2019-Tie-Line-Report-V01-2020-January-9.pdf/7029e9e9-3f76-5355-5646-8b1f18699750

of the topics for discussion is if the normal and emergency ambient temperature assumptions used to calculate the static season transmission line ratings in NY should be revised.

Climate Vulnerability & Resilience – Advance and Adapt

As required in PSL §66 (29), RG&E will be submitting an updated resilience plan to the commission at least once every five years. RG&E anticipates that these updates can provide an opportunity to include the latest and most appropriate data on the effects of climate change that may be developed as the scientific communities' understanding of the complex climatological process continues to improve, new research is completed, and/or computational capabilities unlock the ability to develop even more robust projections for climate hazards affecting RG&E's service areas.

4.3 Business Case Justification Framework

The Business Case Justification framework (BCJ) helps RG&E estimate the benefits of the resilience projects and programs. The BCJ is scored by three main dimensions: System Reliability, Community Safety, and Community Resilience. After System Reliability, Community Safety, and Community Resilience scores are calculated, the three scores are then used to determine the BCJ score out of 100%. A score closer to 100% indicates that an investment may have a larger impact on communities. Figure 6 provides example summaries for each of these dimensions. The BCJ was only performed for substations with regards to flooding and for circuits with regards to wind and combined wind-and-ice; in both cases, the BCJ score is intended to be used as an estimate of potential project prioritization.

BCJ scores should be understood as a relative comparison among all assets, not only the assets selected for mitigation projects, within the service territory. Therefore, high-scoring assets can be interpreted as having the potential of a greater benefit relative to lower-scoring assets. The BCJ analysis is rooted in two main values: 1) number of customers and 2) number of critical facilities.

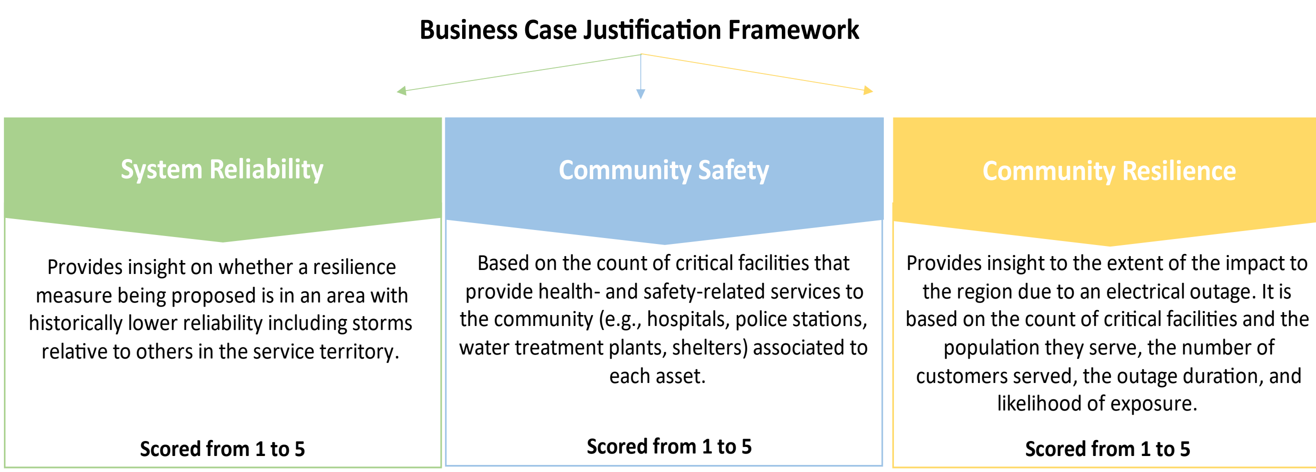

Figure 6. Business Case Justification Framework Components.

System Reliability Score

The reliability score assesses whether a proposed resilience measure is being considered in an area with historically lower reliability, including storms, as compared to other areas in the service territory. This score is composed of the three-year average System Average Interruption Frequency Index (SAIFI) from 2020 to 2022.

The average SAIFI value is used to obtain a quintile score, which becomes the circuit reliability score. The worst performing circuits receive a score of 5, and the best performing circuits receive a score of 1. For substations, the reliability score is assigned from the worst performing circuit associated with it.

Community Safety

The Community Safety score characterizes the impact to health and safety services for the community during an outage and is based on the count of Tier 1 and Tier 2 customers associated to each circuit. Tier 1 and 2 customers are facilities deemed critical to the overall health and safety of the community. These facilities include hospitals, emergency responder facilities, water treatment facilities, municipal buildings, buildings designated as evacuation shelters, etc. When calculating the Community Safety score for a substation, the highest quintile of all the associated circuits is rolled up to the substation. A higher quintile indicates that the asset has more influence in community safety, based on the number of critical facilities associated with it.

Community Safety scores for each circuit were ranked from 1 to 5 based on the following criteria:

- 5 = Tier 1 facility count is more than 4 facilities.
- 4 = Tier 1 facility count is between 1 and 4.
- 3 = Tier 2 facility count is more than 3 and Tier 1 facility count is 0.
- 2 = Tier 2 facility count is between 1 and 3 and Tier 1 facility count is 0.
- 1 = Tier 1 and Tier 2 facility count is 0.

Community Resilience

The Community Resilience score provides insight into the extent to which daily activities in the community may be impacted due to an electrical outage. It also captures the extent to which a region may be impacted by the loss of power to critical facilities. This score is broken down into two components: Community Activity Loss (CAL) and Avoided Impact to Critical Facilities (AIC). Each component is scored in quintiles, and the average of both is the overall Community Resilience score.

CAL is based on the number of customers associated with an asset and the potential outage duration, specific to the asset sensitivity threshold to a climate hazard exposure. CAL provides a sense of which assets would result in larger disruptions to daily activities for residential and commercial customers. AIC is based on the population in the region served by Tier 1 and 2 critical facilities associated with the asset, as well as its potential outage duration. Each critical facility is assumed to have the potential to serve the population in the region, therefore, AIC informs the asset’s level of influence on maintaining health and safety services in the community. For example, even though a hospital represents one customer, it has the potential of serving the entire region in which it is located.

CAL and AIC are multiplied by the likelihood of exposure to a climate hazard before arriving at the quintile scores. Therefore, each represents the duration of impact to customers or population, respectively, and how likely that is to occur. For flooding calculations, the annualized likelihood of recurrence assumed for flooding was 1% (i.e., a 1-in-100-year flood event). For wind and wind-and-ice, historical storm data was analyzed to arrive at the likelihood of impact by region.

In summary, Community Resilience score is based on the following components:

- Community Activity Loss (CAL), which is a product of
  - Estimated outage duration by climate hazard,
  - Number of customers served by the asset, and
  - Likelihood of exposure.
- Avoided Impact to Critical Facilities (AIC), which is a product of
  - Estimated outage duration by climate hazard,
  - Number of critical facilities served by the asset,
  - Regional population potentially served by the critical facility, and
  - Likelihood of exposure.

The final Community Resilience score of an asset is expressed in quintiles. Quintiles were calculated as the average of the CAL and AIC scores, multiplied by projected event likelihood (e.g., 1% annual recurrence probability for a 1-in-100-year flood event). Assets with the highest activity loss and impact to the community (i.e., potential outage of Tier 1 and Tier 2 facilities) receive a quintile score of 5. Assets with the lowest impact receive a quintile score of 1.

Climate Resilience Measures and Investment Plan

5. Climate Resilience Measures and Investment Plan

RG&E is currently executing several, already-approved projects that increase resilience to climate hazards. The analysis in the CCRP focused on utilizing the CCVS's priority vulnerabilities and the associated climate hazard projections to identify areas where incremental resilience measures were appropriate. The following sections discuss each of the priority climate hazards identified in the CCVS and how resilience to each can be increased. The final portion of this section includes a summary of the incremental investment plan composed of new resilience measures identified in the CCRP.

Table 3. Summary of Priority Vulnerabilities by Asset Family Type

Hazard	Transmission	Distribution	Substation
High Temperature			✓
Flooding			✓
Wind	✓	✓	
Wind & Ice	✓	✓	✓

5.1 Extreme Heat

As identified in the CCVS, ambient temperatures are projected to increase throughout New York State in the coming decades. Notably, most assets are projected to experience 2-5 days per year with daily average temperatures above 30°C in 2050, which is a parameter used in RG&E's existing substation transformer specification. Most assets are not often subjected to temperatures higher than 40°C, which is another important temperature threshold. See the following tables for summary information on temperature projections.

Table 4. Substations and Days Over 30°C using SSP5-8.5 50th Percentile Projections

RG&E Substations Days over 30°C	0-2	2-5	5-10	10-15	15-30	30+
Baseline (1981–2010)	179 (100%)	-	-	-	-	-
2030	179 (100%)	-	-	-	-	-
2050	1 (1%)	178 (99%)	-	-	-	-
2080	-	-	1 (1%)	-	178 (99%)	-

Table 5. Substations and 1-in-10-Year Temperatures using SSP5-8.5 50th Percentile Projections

RG&E Substations 1-in-10-year temps	35°C-38 °C (95°F-100°F)	38°C-41°C (100°F-105°F)	41°C-43 °C (105°F- 110°F)	43°C-46° C (110°F-115°F)	> 46°C (> 115°F)
Baseline (1981–2010)	179 (100%)	-	-	-	-
2030	15 (8%)	164 (92%)	-	-	-
2050	-	179 (100%)	-	-	-
2080	-	-	153 (85%)	26 (15%)	-

5.1.1 Substation Transformers, Regulators, Reactors and Extreme Heat

In the CCVS, extreme temperatures were identified as a priority vulnerability for the following substation equipment: 1) transformers, 2) regulators, 3) reactors, and 4) circuit breakers.

Transformers, Regulators, and Reactors

Transformers, regulators, and reactors all use similar electrical insulating and thermal design principles: the core and coils are wrapped in mineral-oil impregnated insulating paper with the entire assembly mounted in a sealed tank that is also filled with mineral-oil. The mineral-oil serves two purposes: 1) it is a dielectric and provides electrical insulation between energized and unenergized components and 2) it allows for transfer of heat from the core and coils to the ambient air through the transformer tank and any attached radiators. If the temperature of insulating paper and mineral-oil increases and reaches their design limit, they can begin to break down into various byproducts that over time will reduce their effectiveness; accordingly, the heat generation and dissipation profile of these types of equipment is a fundamental component of their design.

Current Designs

RG&E's substation transformers, regulators, and reactors are currently designed in accordance with IEEE C57.12.00 which specifies that for an air-cooled unit the "…ambient temperature shall not exceed 40°C [104°F], and the average temperature of the cooling air for any 24-hour period shall not exceed 30°C [86°F]." Operating in an environment with ambient temperatures above the design specification will cause the cooling capability of a transformer to be reduced below what was expected during design.

If a transformer, regulator, or reactor is operated in an environment with an ambient temperature above its design specification, it will not be able to effectively cool. During high-load conditions that often occur during times of increased temperature, this decrease in cooling capability will lead to an increased winding temperature and increased risk of damage or failure.

Future Considerations for New Transformers, Regulators, and Reactors

Transformers, regulators, and reactors purchased and installed today are expected to remain in service into and beyond 2050. RG&E SMEs reviewed the climate projections generated in the CCVS and determined that in order to avoid potential damage due to the coincident effects of high loading and increased ambient temperatures, future transformers should be specified so that they are suitable to operate in an environment where the average temperature of the cooling air for any 24-hour period will not exceed 35°C. This resilience measure will allow for equipment designed with this new specification to withstand the projected effects of climate change and operate at full rated capacity under expected future climate conditions.

Substation reactors are specialized equipment that are not widely used. RG&E does not currently have plans to purchase any reactors in the next five years. Substation regulators are commonly found on the RG&E system; however, new substations frequently use transformers with load tap changers in lieu of standalone regulators to regulate voltage. Accordingly, the application of a resilience measure to reactors and regulators is not necessary to be included in the CCRP.

Resilience Measure – New Substation Transformers – Strengthen and Withstand, Advance & Adapt

RG&E expects that through the first five years of CCRP it will purchase multiple transformers using the increased ambient temperature specification previously discussed. The specification change to a higher average ambient temperature will make transformers a bit larger and more expensive. Based on feedback from transformer manufacturers, RG&E estimates that the change in ambient temperature capability will increase the cost of each substation transformer by approximately 3%.

There are currently plans to purchase substation transformers in all years of the current rate-plan. The CCRP only includes the incremental cost to increase the ambient temperature specification for the first five years of the CCRP, though this resilience measure will continue to be utilized in the 10- and 20+ year horizons. The following tables provide details on the estimated incremental cost through the first five years of the CCRP.

Table 6. Incremental Cost for Substation Transformer Temperature Specification Update

Year	2025	2026	2027	2028	2029	10-year	20-year
Incremental Cost (in 000's)	$146	$146	$146	$146	$146	✓	✓

Future Considerations for Existing Transformers, Regulators, and Reactors

For existing transformers, regulators, and reactors that were designed with an expected ambient condition of 30°C (average) and 40°C (maximum), the IEEE C57.91 standard has approximate rating reductions that can be utilized to compensate for increased ambient temperatures. Most RG&E transformers, regulators, or reactors are either self-cooled (i.e., no external fans) or utilize forced-air cooling (i.e., external fans). If a rating adjustment were made due to increased future temperatures, transformer ratings would be reduced by 1.5% for self-cooled or 1.0% for forced-air, respectively, per degree Celsius above the designed ambient condition.

Due to the current climate conditions and the relative infrequency with which the RG&E system is currently subjected to 24-hour average temperatures above 30°C or maximum temperatures above 40°C, these rating correction factors do not currently need to be used.

As part of future studies and evaluations, RG&E will continue to review the factors that can contribute to transformer, regulator, and reactor overheating to determine if changes to planning or operating practices become necessary.

Resilience Measure – Existing Substation Transformers – Advance & Adapt

RG&E's Distribution Load Relief Program conducts system-wide facility analyses of thermally overloaded or nearly overloaded substations to develop mitigation strategies so that transformers do not exceed their ratings as loads change over time.

To complement these load relief analyses, RG&E performed a risk-based analysis in the CCRP that evaluated the capability of existing substation transformers against an extreme heat event in the year 2050. This evaluation included the magnitude of load served by a transformer, number of customers served, and the impact of extreme temperatures on increasing demand and decreasing transformer capability to determine the potential for customer interruptions. The results are summarized in Table 7.

Table 7. Top 10 At-Risk Transformers - 1-in-100 2050 Temperature

Substation	Bank	2050 Projected Peak Temp (°F)	Customers Served	Projected MW Required Above Nameplate	DAC
Station 127	1	108.72	4,563	2.8	No
Station 174	1	111.71	810	0.4	Yes
Station 175	1	111.71	886	0.4	No
Station 125	1	108.72	1,473	4.5	No
Station 247	1	111.71	944	0.4	No
Station 153	1	108.72	1,511	1.4	No
Station 163	1	111.71	738	0.4	No
Station 1	1	106.17	5,297	1.1	Yes
Station 1	2	106.17	5,297	1.1	Yes
Station 149	1	108.72	1303	1.1	No

It is expected that the listing of at-risk transformers will change over time due to business-as-usual changes to the electric system including mitigation strategies developed by the load relief program, new customer or generator interconnections, or system reconfigurations, as well as undetermined changes to factors that drive load magnitudes including electrification of transportation and heating. This information is presented in the CCRP for informational purposes only, and at this time, these assets do not require near-term resilience measures to mitigate the expected climate results in 2050. Accordingly, no Business Case Justifications were developed for these locations. As future CCRPs are completed and the electric system evolves, this type of information will continue to be reviewed and updated.

5.1.2 Circuit Breakers and Extreme Heat

In comparison to transformers, regulators, and reactors, circuit breakers have a relatively straightforward thermal design. RG&E circuit breakers are designed in accordance with IEEE C37.04, which specifies that normal service conditions for outdoor circuit breakers are where "…ambient air temperature does not exceed 40°C and its average value, measured over a period of 24 hours, does not exceed 35°C." Like transformers, regulators, and reactors, circuit breakers generate heat through resistive losses that are exponentially proportional to loading. Circuit breakers can be designed with low resistive losses and generate less heat during operation so external cooling is not often required.

Future Considerations for Existing and New Circuit Breakers

Circuit breakers that are heavily loaded at ambient temperatures exceeding their design parameters have an increased risk of failure or damage to circuit breaker insulation, internal contacts, or other components. Outdoor circuit breakers purchased and installed today are expected to remain in service into and beyond 2050s.

Due to the relative infrequency with which the RG&E system is and will be subjected to 24-hour average temperatures above 35°C or maximum temperatures above 40°C through the year 2050, RG&E SMEs have determined that the ambient temperature specifications used for existing and new equipment will remain suitable. As part of future studies and evaluations. RG&E will continue to review future conditions to determine if specification changes are necessary.

5.1.3 Transmission Lines and Extreme Heat

Extreme heat and transmission lines were not identified as a priority vulnerability; however, RG&E is currently in the process of deploying new technology that will actively account for the impact of ambient temperature during real-time operation of transmission lines. The following information is listed in the CCRP for informational purposes only. The CCRP is not requesting additional funding for this initiative.

Advanced Technologies - Ambient Adjusted Ratings – Advance and Adapt

Historically, transmission line ratings have been calculated for normal and emergency scenarios using environmental assumptions, like ambient temperatures, which are different for the summer and winter seasons. These ratings were static and did not vary based on real-time environmental conditions. For example, the 2019 New York Transmission Owner's Tie-Line Ratings Report[14] specifies that the maximum and average temperatures for transmission facility rating calculations in the summer season should be 35°C (95°F) and 30°C (86°F) respectively.

Ambient Adjusted Ratings

If actual experienced ambient temperatures are different than the assumed values used when calculating facility ratings, transmission lines may have more or less capacity than represented by the static rating. FERC Order 881[15] "Managing Transmission Line Ratings" will require the use of Ambient Adjusted Ratings (AAR) on transmission lines. AARs are continuously updated in pseudo real-time based on the ambient temperature measured at a location that may not be immediately adjacent to the transmission line. This allows for asset design parameters, particularly conductor maximum operating temperature, to be followed regardless of the ambient temperature. As part of implementing FERC Order 881 RG&E will be implementing AARs on its bulk electric system lines.

[14] https://www.nyiso.com/documents/20142/1402024/NYTO-2019-Tie-Line-Report-V01-2020-January-9.pdf/7029e9e9-3f76-5355-5646-8b1f18699750
[15] https://www.federalregister.gov/documents/2022/05/25/2022-11233/managing-transmission-line-ratings

5.2 Flooding

Statewide floodplains generated by the First Street Foundation (FSF), were leveraged for the flooding analysis in the CCVS and the CCRP. The results show inundation depths for 100- and 500-year storm events in present-day and projected flooding to 30 years in the future (representing the 2050 planning scenario). Return periods of 100- and 500-years indicate an annual occurrence probability of 1% and 0.2% per year, respectively. Substation evaluations to determine exposure were done against 100-year flood depth.

5.2.1 Substations and Flooding

Prior to the initiation of CCVS and CCRP, RG&E developed substation review criteria that identifies flood exposure critical substation equipment (e.g., breaker control cabinets and control houses) that are below the 100-year floodplain as needs that must be addressed. In addition to the review of these criteria, RG&E has recently updated its minimum design elevation for critical substation equipment. Previously RG&E substation design criteria for new equipment defined that the minimum elevation of critical equipment be at the FEMA 100-year flood elevation plus an additional 2 feet; however, this was revised to add an additional 1 feet (final elevation of FEMA 100-year + 3 feet) to mitigate future projected flood events.

Identification of Additional At-Risk Locations

Substation evaluations to determine exposure of equipment to floodwaters were done against the 100-year flood depth. As noted in the CCVS, substation 100-year return period flood depths increased by, on average, 2 inches between the current-day baseline 100-year flood depth and 2050 100-year flood depth.

In the analysis the Study Team leveraged the 100-year return period flood depths from the FSF and GIS overlays of substation locations to assess the flooding impact to RG&E substations.

First, a screening was performed to identify which substations were at risk of significant outages due to flooding. The focus was on identifying which facilities, if exposed to damaging floodwaters, would have a larger impact relative to other stations due to the number of customers served, impact to the transmission system, or have the potential for an extended path to restoration. In addition, a visual inspection of flooding data and substation equipment was performed to identify sites that did not have exposure to widespread flooding. If significant flooding was not widespread inside of a substation location, it was removed from further consideration.

There was a single substation identified as being at risk of flooding. This location is listed in Table 8 and is a sub-transmission/ distribution substation that is involved in directly serving customer load.

Table 8. CCRP Identified Flooded Station

Substation	FSF 100-year Floodplain	FEMA Data	Approximate Customers	DAC
Station 85	Yes	FEMA 100-year Floodplain	2,100	Yes

Business Case Justification

Using the Business Case Justification framework detailed in previous sections Station 85 was scored based on its impact to System Reliability, Community Safety, and Community Resilience. As a reminder, a higher score indicates a more impactful substation in each category.

Resilience Measure – Substation Flood Mitigation – Strengthen and Withstand, Advance & Adapt

There are three common resilience measures to mitigate against flood damage in substations, each of these measures can meet different resilience objectives:

1. Rebuild a substation away from the floodplain (Advance and Adapt)
2. Raise affected equipment out of damaging waters (Anticipate and Absorb)
3. Install floodwalls or flood barriers (Strengthen and Withstand)

Each of these potential resilience measures has trade-offs between categories that can include feasibility, cost, or other ancillary benefits (e.g., mitigation of asset condition issues). For solution evaluation, RG&E utilized the following qualitative scoring categories:

- **Asset Improvement:** Scored based on the extent to which a resilience measure may result in improving asset condition, capacity, or redundancy.
- **Flexibility:** Scored based on the extent to which the resilience measure can be augmented as needed over time.
- **Hazards Addressed:** Scored based on the number of climate hazards that the resilience measure reduces the risk to.
- **Passive or Active**: Scored based on the level of interaction required to active the resilience measure.
- **Cost**: Scored based on the approximate order of magnitude of costs to construct a measure.

Station 85 (34.5 kV / 12 kV)

Table 9. Station 85 Evaluation

Measure	Asset Improvement	Flexibility	Hazards Addressed	Passive or Active	Cost	Total Score
Rebuild	4	3	3	5	1	64
Floodwall	1	3	3	3	5	60
Elevate	-	-	-	-	-	-

Station 85 in Rochester, NY, serves approximately 2,000 customers and has been identified as being at risk of significant flooding. Station 85 is located just outside census tract 36055011603 DAC. The station has moderate asset conditions issues with equipment in “fair” or “poor” condition. When additions were made substation in the late 1970’s, they were built in an elevated position that reduces the overall exposure of this substation to flooding.

Due to the age of the substation, its existing equipment condition, and location in a floodplain, rebuilding Station 85 outside of the floodplain is the preferred conceptual solution.

Table 10. Substations and Flooding

Substation	FSF 100-year Floodplain	Conceptual Solution	DAC	Cost Estimate
Station 85	Yes	Offsite Rebuild	Yes	$15M

5.3 Extreme Wind / Wind-and-Ice

As noted previously, the focus of the CCRP was to develop solutions to asset deficiencies identified through the evaluation of the priority vulnerabilities and the associated climate hazard projections.

Wind Gusts

The CCVS generated quantitative projections for future wind-gust speeds and discussed qualitative projections for future wind-speed intensities. Qualitative projections indicated that extreme wind speeds and gusts are projected to increase in both frequency and intensity by mid- through late century based on available peer-reviewed research on these infrequent but highly impactful events (Thrasher, 2022). These qualitative sources were unable to quantify increases to peak wind gusts for evaluation against current design standards. The quantitative projections that RG&E performed in the CCVS showed minimal changes in peak wind gusts at the measured locations throughout New York State.

Wind-and-Ice

Quantitative projections for the influence of climate change on ice and simultaneous windstorms remain uncertain due to the specific atmospheric conditions required for ice storms to occur (Intergovernmental Panel on Climate Change (IPCC), 2021). However, there has been qualitative analysis that shows that the overall frequency of ice storms is projected to decrease in the service areas as temperatures increase, but that the intensity of these events could increase (Zarzycki, 2018).

5.3.1 Transmission Assets and Extreme Wind / Wind-and-Ice

RG&E's transmission lines and substation structures are designed to meet or exceed the applicable structural loading criteria specified in the most recent version of the NESC (includes extreme wind, a combination of wind and ice loading, and a heavy-ice condition).

The CCVS did not quantify any changes to wind or wind-and-ice events in the RG&E service area that require any changes to RG&E's transmission design and construction practices; accordingly, the CCRP is not proposing any additional transmission line upgrade projects. However, the continuation of extreme climate weather events underscores the importance of the work that RG&E is doing to identify transmission lines deficiencies and solutions via targeted repairs or line rebuilds.

Ongoing Transmission Line Projects

RG&E has multiple ongoing projects that directly address transmission vulnerabilities to wind and wind-and-ice. As the NESC code is revised from time to time, existing transmission structures designed to previous versions of the NESC are not required to be brought up to the requirements of the latest version. Accordingly, replacing aging transmission infrastructure with modern designs increases their resilience to the priority climate hazards. The following selection of projects are being described in the CCRP to provide a fuller account of the resilience measures currently being used by RG&E on its system. The CCRP does not include any additional funding requests or rate impacts for these projects.

Line 906 Rebuild – Wind/Wind-and-Ice – Strengthen and Withstand

Following a 2022 order from the NY Public Utilities Commission, RG&E performed a generator deliverability analysis of the "Southern Tier" Z1 Area of Concern which includes RG&E's Genesee Valley region. As part of this analysis more than 30 different projects were selected to alleviate generator deliverability concerns; one of those projects is the complete rebuild of RG&E's 115 kilovolt (kV) Line 906.

Line 906 is approximately 29.7 miles long, running from RG&E's Station 82 in Brighton, NY, to Station 128 in Leicester, NY. Currently Line 906 uses a 336 kcmil Linnet ACSR conductor that is approximately 46 years old installed on poles with an average age of 56 years. There were six structures that were identified in need of replacement due to structural deficiencies.

To alleviate identified transmission line overloads and existing asset condition concerns, it was determined that Line 906 should be rebuilt on new structures using 1590 Falcon ACSR conductor. This new line will be rebuilt on new light duty steel monopoles and designed to all current and applicable NESC requirements for wind and wind-and-ice loading, etc.

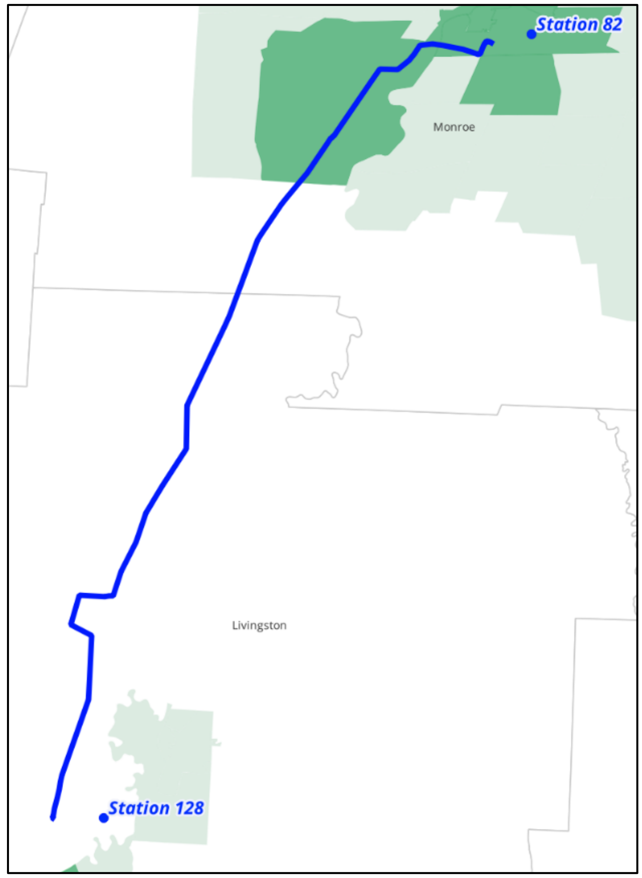

Figure 7. Line 906 Project Diagram

Monroe County Reliability Project (MCRP) – Wind/Wind-and-Ice – Strengthen and Withstand

The MCRP is an ongoing RG&E project to rebuild multiple 115 kV transmission lines between RG&E's Station 418 and Station 7: Line 947, Line 946, Line 945, and Line 917. This project is the result of the 2010 FERC "Brightline" threshold that redefined bulk electric system transmission elements as those operating at 100kV and above. In response, the North American Electric Reliability Corporation (NERC) updated its reliability standards and issued a "Brightline Order".

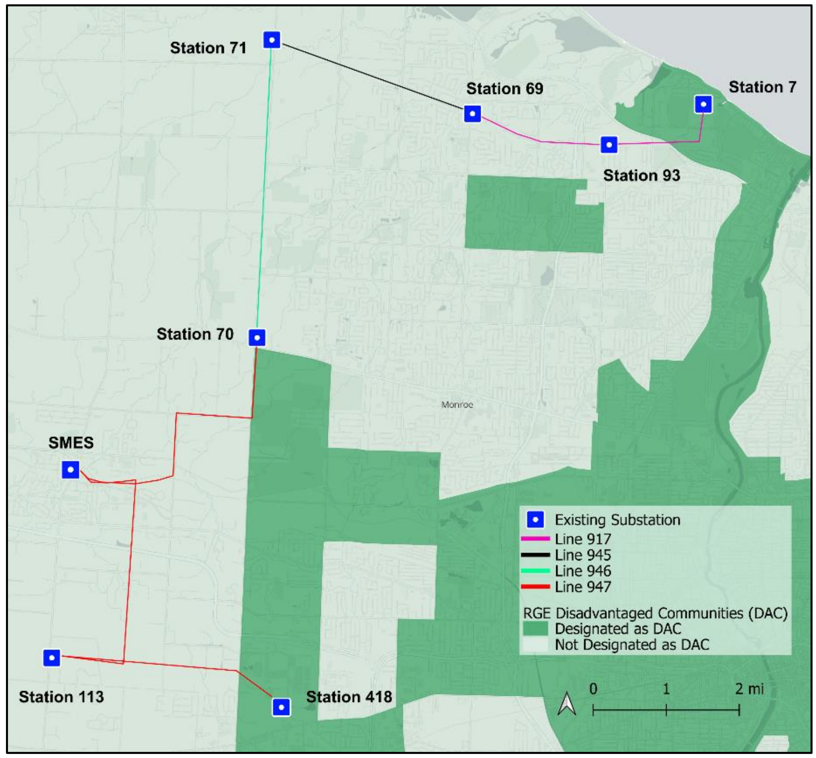

Figure 8. MCRP Project Diagram

Along this transmission path, there are numerous distribution substations that are only served by these lines: Station 113, Spencerport Municipal Electric Substation (SMES, non-RG&E), Station 70, Station 71, Station 69, and Station 93. In total, there are approximately 34,000 RG&E customers, as well as customers fed from SMES, served by the affected substations. These RG&E substations directly serve multiple DACs in this region.

The rebuild of these lines was identified to address thermal overloads caused by high customer demand as well as significant asset condition issues. In total, the rebuild includes over 400 structures spanning approximately 22.5 miles. The new lines will be built on steel monopoles designed to all current and applicable NESC requirements for wind, wind-and-ice loading, etc.

Table 11. Approximate Customers Affected by MCRP

Substation	Customers	Serves DAC
Station 69	5,500	Yes
Station 70	10,200	Yes
Station 71	7,700	No
Station 113	5,000	Yes
Station 93	5,500	Yes

5.3.2 Distribution Assets and Extreme Wind / Wind-and-Ice

As identified in the CCVS, distribution circuits are vulnerable to extreme wind, and extreme wind-and-ice events as their effects can directly damage these assets or cause secondary impacts due to the hazard's effect on nearby vegetation.

Ongoing Distribution Resiliency Activities

In response to severe storm events experienced throughout its service area, RG&E has developed a distribution resiliency guide for assets up to 35 kV, which specifies changes to construction practices aimed at increasing the reliability and resiliency of its distribution circuits to prepare for impacts caused by future storm events. The resiliency guide includes the following:

- Designing to meet or exceed the 2017 NESC, including Rule 250B Heavy Loading criteria (40 mph wind and 0.5 inches of radial ice).[16]
- Restricting pole classes to Class[17] 1, 2, or 3 and defining when each pole class should be used.
- Defining when tree wire should be used to reduce impacts from momentary contact with nearby vegetation.

This distribution resiliency guide is used to establish design standards that inform annual RG&E Distribution Resiliency Plans; this plan focuses on increasing the storm-hardening of distribution circuits and reducing restoration costs, and customer outage times.

Three main focuses of the Distribution Resiliency Plan are:

1. **Infrastructure Hardening:** Hardening of the distribution circuits through conductor replacement, replacement of defective poles, and selective undergrounding.
2. **Topology with Automation:** Upgrades made to improve the ability to restore customers quickly for temporary faults, or to reconfigure circuits in case of permanent faults.
3. **Enhanced Vegetation Management**: select application of "ground-to-sky" clearance when performing vegetation management.

Infrastructure Hardening

Stronger, Contact-Resistant Conductor
RG&E's overhead distribution systems have been built over decades with multiple sizes and designs of conductors. Most of these overhead conductors are bare (uninsulated). Some are smaller than RG&E's most current standards or are made of material that is less resistant to physical damage or breakage from tree contact. For new construction, RG&E's Distribution Resiliency Guide specifies that bare aluminum wire will be used in areas where tree encroachment is not possible. Tree wire will be used in areas where tree encroachment is likely. Tree wire is an aluminum conductor covered with multiple layers of material that provides electrical insulation and physical protection from incidental tree contact. Tree wire has been shown to reduce electrical faults from tree contact dramatically. When used in spacer cable configurations, overhead distribution lines can withstand impacts from larger branches.

[16] The current version of the resiliency guide identifies the 2017 NESC, but internal SMEs confirmed that the designs also meet or exceed the 2023 NESC.
[17] Pole class refers to the horizontal loading capability of a pole with lower numbers indicating stronger poles.

Replacement of Failure-Prone Poles
Experience has shown that stronger, higher-class poles are significantly less prone to failure from storm damage. RG&E's Distribution Resiliency Guide specifies that only Class 1, 2, or 3 poles will be used for new construction. The purpose of this specification is to improve the resiliency of distribution systems during storm and severe weather events. This Resiliency Plan calls for replacing defective poles, as identified by the Distribution Line Inspection Program, on circuits selected for resiliency work to ensure all known asset condition needs are mitigated on an identified circuit.

Selective Undergrounding
Undergrounding is the replacement of overhead primary electric wires with underground cables. From a resiliency perspective, undergrounding makes the power lines less susceptible to outages during high winds, thunderstorms, heavy snow, or ice storms. Some communities and municipalities express an interest in undergrounding because of the aesthetic benefits and the resiliency benefits it can provide. However, undergrounding of wire and associated infrastructure is usually uneconomic except in densely populated areas. Undergrounding may be a viable option where common facilities support multiple overhead circuits, such as at substation gateways in urban communities.

Topology Updates with Automation

A distribution system topology describes the configuration of infrastructure that comprises the distribution system. Most of the distribution systems within the RG&E territory consist of radial circuits. These circuits are characterized by a design in which power is received at a substation from the transmission system and distributed to customers via three-phase or single-phase lines. An interruption caused by a single tree can affect numerous homes, businesses, and public safety infrastructure, creating a critical resiliency challenge. This circumstance is exacerbated during major storms when there are multiple sites of damage along a circuit path.

Circuit Ties
If feasible, Distribution Resiliency Plans look to propose adding circuit ties for most projects. A circuit tie creates an alternate power source by connecting to an adjacent circuit served by a different substation. If the power from the primary source is lost due to an upstream outage, the circuit tie can be closed to re-route power from the alternate source. Adding automated switching makes it possible to quickly transfer customers from the primary source to the alternate source so that the interruption customers experience is momentary in nature.

Distribution Reclosers and SCADA Switches
Reclosers and switches are electrical devices that allow utilities to connect and disconnect portions of a distribution circuit to an upstream power source. Strategically placed reclosers and switches can help isolate faulted parts of a distribution circuit and reduce the number of customers that lose power when a fault occurs. RG&E can automate reclosers and switches to enable remote or coordinated control by sophisticated automatic switching schemes. Fault Location, Isolation, and Service Restoration (FLISR) is an available distribution automation application that uses reclosers and switches to automatically reconfigure one or more distribution circuits to isolate faulted portions of a distribute on circuit and keep power flowing to as many customers as possible.

Distribution Reclosers
Reclosers have relays that can detect the excessive electric current associated with a short circuit (fault) caused by tree contact, animal contact, or other abnormal condition. Upon detection of a fault, the recloser can open to safely interrupt the fault current and de-energize the downstream portion of the circuit until crews can fix the problem. Some faults, such as a tree branch brushing against a line, can be temporary and may not require repair. Reclosers can be programmed to

reconnect ("reclose") the downstream circuit quickly. If the fault is cleared, the recloser remains closed and downstream customers may only lose power for a moment. If the fault is not cleared, the recloser may "reclose" multiple times (typically up to three times) and "lockout." Under this scenario, local operations personnel would be dispatched to fix the underlying damage and reconnect the line safely to restore power to customers.

SCADA switches
SCADA switches have telecommunications and intelligence that enable remote and coordinated operation without requiring the presence of an onsite crew. These automated switches are often used with reclosers and help system operators isolate an outage and connect customers to an alternate power source. Unlike reclosers, utilities do not use these switches to interrupt faults. However, fault detection capabilities are built into these switches and can help utility operators identify and locate the source of a fault more quickly.

Line Upgrades, Voltage Conversions, and Step-Transformers
Creating a circuit tie requires sufficient capacity and voltage support on both circuits so that each one can serve additional customers during restoration. Sometimes this requires upgrading portions of each circuit to 3-phase and replacing conductors with a larger size. Adding voltage support with a voltage regulator or capacitor bank might also be needed. In some cases, RG&E may want to connect two circuits that operate at different voltages, such as one circuit at 12.5 kV and the other at 34.5 kV. In such a case, a step-transformer is needed. Engineers and distribution planners might also consider adding a new circuit.

Substation Upgrades
Upgraded and new substations, along with sub-transmission lines and circuit breakers, enable RG&E to create new circuits to reduce outage exposure to customers located on long circuits. They may also provide a second transmission feed into a substation to protect against the loss of a sole power source.

Enhanced Vegetation Management

RG&E's standard vegetation management reliability programs work to maintain clearance between vegetation and distribution system infrastructure on thousands of miles of distribution lines. The programs have two main parts:

1. Inspecting and pruning all forested rights-of-way to standard clearances. This "cycle" trimming program also includes tree removal inside rights-of-way.
2. Supplemental "hot-spot" pruning for faster-growing vegetation species that could encroach upon electric facilities before subsequent cycle trimming occurs (i.e., within the cycle).

For the circuits identified in the distribution resiliency plans, RG&E may apply enhanced "ground-to-sky" clearance (i.e., "Enhanced Vegetation Management" or EVM) as appropriate in conjunction with the Topology with Automation and Hardening resiliency programs. In developing the circuit plans, engineers and field technicians endeavor to coordinate and optimize multiple improvements to deliver best-value resiliency to customers.

Existing Rate Case

RG&E's Distribution Resiliency Plan is currently included in the existing rate plan. In that rate plan, RG&E expects to spend approximately $12M per year specifically for these types of distribution resiliency projects.

CCVS Results

RG&E distribution construction standards meet or exceed the 2023 updates to the NESC. The CCVS did not quantify significant changes to the severity of wind or wind-and-ice events in the RG&E service area that could be used to modify distribution construction specifications and designs or selective undergrounding practices. However, the expected continuation of extreme weather events, their impact to RG&E assets, and the effects on customers caused by the wind and wind-and-ice climate hazards underscore the importance of continuing the ongoing resilience work that the Company is performing.

CCRP Results

To continue enhancing the resilience of distribution circuits to climate change RG&E anticipates that the existing annual expenditures for the following resiliency activities will continue throughout the existing rate plan and into the timeframe covered by the CCRP.

Table 12. CCRP Distribution Resiliency[18]

Capital Project/Category	2025	2026	2027	2028	2029
Resiliency - Group	Rate Plan	Rate Plan	9,800	9,800	9,800
SCADA/Automation	Rate Plan	Rate Plan	1,700	1,700	1,700
Recloser Automation	Rate Plan	Rate Plan	600	600	600

Sample Prioritization Frameworks: Distribution Circuits and Extreme Wind

Using the BCJ Framework described in Section 4.3, the top 10 BCJ scores for distribution circuits and extreme wind are listed below. The resulting BCJ scores are a product of the System Reliability score, Community Safety score, and Community Resilience score. The following listing is presented for informational purposes only; the final order of implementation of Distribution Resiliency Projects will be determined by the Distribution Planning group using the most recent information available.

Table 13. Top 10 Wind BCJ Scores

Substation Name	Circuit Number	System Reliability Score	Community Safety Score	Community Resilience Score	BCJ Score	DAC
Station 71	5110	5	5	5	100%	No
Station 71	5109	5	5	5	100%	No
Station 71	5130	5	5	5	100%	No
Station 104	5288	5	5	5	100%	Yes
Station 106	5166	5	5	5	100%	No
Station 124	5127	5	5	5	100%	No
Station 124	5128	5	5	5	100%	No
Station 230	5162	5	5	5	100%	No
Station 230	5161	5	5	5	100%	No
Station 418	5201	5	5	5	100%	Yes

[18] 2025/2026 data are available as part of Appendix R of the Joint Proposal

Sample Prioritization Frameworks: Distribution Circuits and Extreme Wind-and-Ice

Using the BCJ Framework described in Section 4.3, the top 10 BCJ scores for distribution circuits and extreme wind-and-ice are listed below. The resulting BCJ scores are a product of the System Reliability score, Community Safety score, and Community Resilience score. The following listing is presented for informational purposes only; the final order of implementation of Distribution Resiliency Projects will be determined by the Distribution Planning group using the most recent information available.

Table 14. Top 10 Wind-and-Ice BCJ Scores

Substation Name	Circuit Number	System Reliability Score	Community Safety Score	Community Resilience Score	BCJ Score	DAC
71	5109	5	5	5	100%	No
71	5110	5	5	5	100%	No
71	5130	5	5	5	100%	No
104	5288	5	5	5	100%	Yes
106	5166	5	5	5	100%	No
124	5127	5	5	5	100%	No
124	5128	5	5	5	100%	No
230	5162	5	5	5	100%	No
230	5161	5	5	5	100%	No
418	5201	5	5	5	100%	Yes

5.3.3 Substations Assets and Extreme Wind / Wind-and-Ice

In the CCVS, RG&E found that substations and wind-and-ice were a priority vulnerability for analysis in the CCRP due to the high consequence of damage to a substation and the medium sensitivity of some equipment to ice accumulation.

There are two primary risks to substation equipment due to wind-and-ice: 1) additional physical stress on components due to the weight of ice accumulation and force from wind and 2) possibility of flashover caused by ice and other contaminants reducing the insulating potential of insulators or equipment bushings.

Wind-and-Ice Physical Stresses

Ice accumulation on substation components, including strong winds, increases the physical stresses on these components that can lead to possible damage or failure. However, much of the equipment in a substation is ground-mounted and constructed without long distances between supporting structures. These two features reduce the potential for impact from high wind speeds and for cantilever forces that can cause physical damage.

Wind-and-Ice Flashover Risk

In addition to the physical stress placed on equipment, ice accumulation reduces the insulating capability of insulators and bushings, creating an increased risk of flashover between energized components and equipment at ground potential.

Equipment insulators and bushing are designed with transverse ridges, also called sheds, which maximize the surface distance between energized and unenergized components. In the case of an insulator, the unenergized component is likely a support structure, whereas for a bushing, the unenergized component is a piece of equipment, like a transformer. In most cases, the arc or fault that results from flashover is quickly detected protective relaying and the equipment is quickly isolated before permanent damage can occur.

Substation insulators and bushings are designed to continue operation even with significant ice accumulation. As identified in the CCVS, in the warming future climate, ice storms are expected to become less frequent but may become more intense.

Future Considerations for Substations

Due to the lower likelihood of ice storms, physical characteristics of substations, and the temporary nature of flashover issues, RG&E did not identify any necessary resilience measures to mitigate the impacts of climate change on the substation and wind-and-ice priority vulnerability.

5.4 10- and 20-Year Plan for Resilience Measures

A focus of the CCRP was to identify resilience measures that address the results and conclusion reached in the CCVS. These conclusions are summarized in the list of priority vulnerabilities, each of which has been discussed at length in the CCRP, along with the existing work that RG&E is doing to mitigate against these climate hazards, as well as the incremental changes necessary to prepare the Company's electric system for climate hazard projections. RG&E will be preparing a new CCRP at least once every five years; as standards change, or new data and projections become available, those results will be incorporated into future CCRPs.

RG&E's business-as-usual activities that increase distribution, transmission, and substation assets' resilience against the identified priority vulnerabilities are expected to continue for the foreseeable future.

Table 15. Priority Vulnerability & Resilience Measure Mapping

Priority Vulnerability	Corresponding Resilience Measure
Substations & High Temperature	Transformer Specification Change
Substations & Flooding	Application of Flooding Criteria
Transmission & Wind/Wind-and-Ice	Asset Condition Review/Needs Assessment
Distribution & Wind/Wind-and-Ice	Distribution Resiliency Projects

Substations & High Temperature

Substation Transformer Specification Change: RG&E will utilize the updated transformer specification to install substation transformers with higher ambient temperature capability. This update will build resilience to extreme temperature scenarios allowing substations transformers to better withstand extreme temperatures projected to be experienced in the future.

Substation and Flooding

Substation Flood Mitigation: Based on the analysis included in the CCVS, substation flooding exposure at RG&E substation assets are not significantly different between now and 2050. By utilizing the Company's substation review criteria, flooding is regularly analyzed as part of developing the scope for substation projects. RG&E will continue to utilize this practice into the future to build resilience to substation flooding events. At a minimum, RG&E expects to perform flood mitigation at the identified stations in the 10- and 20-year portions of the CCRP. Specific scopes, estimates, and timeframes will be developed and included in future CCRPs as necessary.

Transmission and Wind, Wind-and-Ice Priority Vulnerabilities

Transmission Line Upgrades: RG&E routinely inspects and assesses the need to upgrade or rebuild existing lines with new lines and more modern designs. Replacing older infrastructure with new lines designed to meet current requirements boosts their resilience to the challenges posed by the extreme wind and wind-and-ice climate events.

Distribution and Wind, Wind-and-Ice Priority Vulnerabilities

Grid Modernization: RG&E is currently executing programs designed to harden and automate its systems to reduce the number of customers interrupted, restoration time, and interruption costs from weather events. RG&E has invested substantially in grid modernization, incorporating advanced technologies such as smart meters, automated devices, and real-time monitoring systems. These additions will continue into the future of the CCRP to improve the system's ability to respond swiftly to outages caused by climate-related disruptions. This modernization can reduce the scope of outages, their duration, and the cost to restore customers.

Resilient Infrastructure: For the expected impact of extreme weather due to climate change on distribution systems, RG&E has existing programs designed to harden key distribution infrastructure components, such as poles, lines, transformers, and substations, to better withstand extreme weather events. This proactive approach minimizes infrastructure damage, ensuring more reliable service during extreme weather events will continue into the future of the CCRP.

5.5 Estimated 5-Year Rate Impact for Incremental CCRP Resilience Measures

As discussed throughout the CCRP, RG&E has ongoing programs, projects, and processes currently included in its business-as-usual activities that identify weaknesses and build resilience to a many of the priority vulnerabilities identified in the CCVS.

The CCRP did identify that updates to the substation transformer ambient temperature specification should be made to build resilience to future extreme heat events. This resilience measure is not currently included in the approved RG&E rate plan so the cost of the updates to the substation transformer ambient temperature specification are incremental (approximately $146,000 per year in the first 5 years of the CCRP). The incremental rate impact based on these costs is *de minimus* and will not be recouped through the surcharge mechanism discussed in PSL §66 (29). Instead, RG&E will defer these capital costs for recovery in the next rate case.

Governance

6. Governance

The Company's governance of climate risk and resilience will expand upon previous frameworks and policies to maintain accountability and continue to provide consistent, transparent communication regarding its work on climate adaptation.

As of March 22, 2022, New York Public Service Law §66 (29) requires utilities to include certain information and goals in the Climate Change Vulnerability Study and Resilience Plan, as well as to create a Climate Resilience Working Group (CRWG). A CRWG was formed with representatives from the government, environmental advocacy groups, universities, large customers, energy industry associations, utilities, service providers, and low-income advocates. The Working Group will continue to meet at least twice annually as outlined by the Public Service Law. During these meetings, the CRWG will discuss the resilience plan and provide feedback. Continuing discussions with stakeholders following the submission of the CCRP will ensure that RG&E remains responsive to customer and community priorities while continuing to enhance asset reliability and complying with regulatory requirements.

Additionally, RG&E will continue to use the most current and appropriate climate science data sets validated by industry standards to re-evaluate and refine its adaptation measures. RG&E used quantitative climate hazard projections from three main sources for the CCVS and CCRP: Columbia/NYSERDA, First Street Foundation, and NASA Center for Climate Simulation. As the Company will re-evaluate its resilience plans at least once every five years, they will evaluate the use of the most recent data and climate assessment tools to ensure they are acting on the most appropriate information available. To support this, RG&E is creating a Climate Change Data Governance Working Group with participation from groups across the organizations. This group will help to develop and define roles and responsibilities required to socialize the importance of climate change data and to support studies like the CCVS and CCRP.

RG&E is dedicated to applying the best practices in governance, and transparency is integral to this endeavor. The Company will maintain consistent and transparent communication with stakeholders. Consistent communication involves regular, public updates on resilience measure implementation, as well as targeted, individual outreach to address specific areas of concern. RG&E must file an updated plan with the Commission for approval at a minimum of every five years to ensure constant evaluation and improvement. Overall, these governance measures will provide RG&E with the guidance and oversight necessary to achieve successful implementation, monitoring, and evaluation of resilience measures.

Performance Measures

7. Performance Measures

PSL §66 (29) requires utilities to file a report with the Commission detailing its activities to comply with its current plan after the second full year of plan implementation, and biennially thereafter. As part of this biennial filing RG&E will prepare a comparison between the latest approved CCRP cost and timeline and actual expenditures and resilience measure progress.

In addition, RG&E will provide performance metrics for incremental proposals included in the CCRP:

1. **Transformer Specification:** Total number of transformers owned by RG&E that meet the latest temperature specification.
2. **Substation Flood Damage:** Description of flood damage experienced at locations that have had flood mitigation performed under the CCRP.
3. **Distribution Circuit Resiliency:** Report on circuit customer outages experienced, including storm and non-storm activity, for the first three full years following the completion of a Distribution Circuit Resiliency project compared to three full years prior, excluding outages related to transmission and substation.

As of the publication date of this CCRP, there are no industry standard resilience performance metrics. RG&E is committed to collaborating with other entities, including the New York utility companies, to discuss and potentially develop resilience performance metrics to improve the system performance for our customers.

Conclusion and Next Steps

8. Conclusion and Next Steps

The CCRP aimed to propose resilience measures to address key climate hazards and priority climate vulnerabilities for RG&E's assets and operations identified in the 2023 Climate Change Vulnerability Study. The Company is dedicated to asset resilience, as seen through its numerous past studies, projects, and programs. Due to the increasing impacts of climate change, the continuation of proactive planning to ensure consistent, equitable, and reliable service for customers is imperative.

The resilience measures and activities discussed in this plan are designed to make assets more resilient to four key climate hazards identified in the CCVS: 1) high temperature, 2) flooding, 3) wind, and 4) wind-and-ice. When designing or reviewing these measures, RG&E utilized a multi-pronged resilience strategy, focusing on four key objectives: Strengthen & Withstand, Anticipate & Absorb, Respond & Recover, and Advance & Adapt. All resilience activities that are already being performed, or are newly proposed in the CCRP, meet one of these key objectives.

In order to characterize the benefits of newly proposed projects and programs, RG&E used the Business Case Justification (BCJ) Framework. The BCJ was performed to aid in identifying priority assets identified for resilience measure implementation. The framework shows the respective asset's score for each of the following considerations: System Reliability, Community Safety, and Community Resilience.

Implementing resilience measures to protect against flooding and extreme heat will be necessary for achieving electric system-wide resilience under future climate change projections. This CCRP proposed two new or incremental resilience measures: the transformer specification updates and additional substation flood mitigation. The transformer specification update involves purchasing new transformers that meet the latest temperature specifications. Substation flood mitigation involves rebuilding a substation away from floodplains, raising affected equipment out of damaging waters, and installing flood walls or flood barriers.

In the future, performance measures will be used to the success of the proposed incremental CCRP resilience measures. Performance measures will be filed biennially in accordance with PSL §66 (29) and include an implementation update with respect to the original CCRP cost and timeline.

In addition, RG&E will file an updated climate resilience plan within five years after the approval of this plan; these updated plans will utilize the most up to date standards, data, and climate projections with the results incorporated into future CCRPs.