Central Maine Power
An Avangrid company

Climate Change Resilience Plan

December 2025

1. Executive Summary

CMP is deeply committed to providing its customers with safe and reliable power. In support of this commitment, CMP has developed this Climate Change Resilience Plan (CCRP) to identify measures to mitigate climate-related risks facing its assets and operations. This CCRP builds from the climate-related vulnerabilities identified and prioritized in the Climate Change Vulnerability Study (CCVS). The CCRP aims to build resilience to these vulnerabilities by recommending updates to operating practices and enhancement of assets' physical resilience.

The CCRP, along with the CCVS, make up CMP's Climate Change Protection Plan (CCPP), originally filed under Title 35-A § 3146 of Maine Public Law Chapter 702, "An Act Regarding Utility Accountability and Grid Planning for Maine's Clean Energy Future." These documents serve to guide CMP's planning, investment, and responses to climate change.

1.1 Exposure and Vulnerabilities

The CCVS identified levels of exposure to different climate hazards, as well as the specific assets and operations vulnerable to those hazards. This process utilized global climate models with consideration of multiple climate futures developed by the Intergovernmental Panel on Climate Change, as well as on multiple sources of quantitative data and input from Maine-based government and academic institutes. As a result of this in-depth climate analysis, CMP identified severe storms and wind, flooding (inland and coastal), heat events, and wood decay as climate hazards presenting high exposure and correspondingly high vulnerability for assets and operations. The CCVS also identified wildfire as a climate hazard with a potentially high impact, but relatively limited change in exposure from today's levels. Frozen precipitation and cold events were determined to present lower exposure due to the expectation of rising overall temperatures, but the risk of extreme cold and ice events cannot be ignored.

1.2 Resilience Framework

The CCRP utilizes a resilience framework that helps ensure a balanced and robust strategy to mitigate the impacts of climate change on the grid and CMP operations. This framework is made up of 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. The selected resilience measure in the CCRP aligns with at least one of these objectives.

Withstand | Absorb | Recover | Advance and Adapt

1.3 Resilience Measures

The resilience measures identified in this CCRP serve to help prepare for climate hazard exposures and asset and operational vulnerabilities identified in the CCVS. These include both resilience measures that CMP already utilizes in parts of the system and have proven effective; as well as new strategies, technologies, and/or approaches to further resilience. The CCRP is structured into three main sections. The first provides an overview of the CCVS analysis, summarizing the key climate vulnerabilities facing the CMP system; the second identifies asset-related resilience measures; and the third section identifies priority areas for improvements to CMP operations to make them more resilient to climate change.

Within these sections, there are two groupings of resilience measures designed to help address the most pressing climate vulnerabilities identified within the CMP system—the on-going and increasing risk of storm events and wind. These include:

- **Storm Events and Wind/Strategic and Site-Specific Hardening Measures** that primarily improve asset resilience to storm and wind events (a current leading cause of outages within the CMP system and is projected to be a priority vulnerability for CMP operations and all asset families). Some of these measures also provide benefits to mitigate the impacts of flooding, frozen precipitation, and wildfire. Specifically, these measures include stronger wood poles, fiberglass crossarms, spacer cable, tree wire, steel poles, circuit topology updates, and targeted undergrounding. These hardening strategies are well established within the industry as effective, and some are already in use at CMP with positive results.
- **Continued Investment in Vegetation Management** that helps to mitigate risks to assets posed by contact with vegetation, which is the leading cause of outages within the system. These risks are expected to increase due to conditions caused by climate change including increasing storm events and wind, increased temperatures that can alter growth cycles, changes in environmental conditions (e.g., drought), and the proliferation of invasive species. CMP's current vegetation management practices consist of multiple successful programs; the CCRP identifies that it is highly desirable to accelerate implementation of CMP's Ground to Sky (GTS) trimming program that was previously designed to occur over a 20-year period as well as expansion of CMP's hazard tree program, which targets trees likely to interfere with the electric system but are outside of any right of way. These enhancements would help to address vegetation-related climate risks and be critical to reducing outage events and the cost of storm restoration.

The CCRP also includes broad evaluation of potential site-specific substation flooding mitigation as well as discussion of potential system-wide enhancement like implementing advanced distribution monitoring and management systems. For each identified resilience measure CMP recognizes the importance of designing and implementing efficient multi-value projects that utilize resilient designs standards, as well as operational improvements.

CMP's climate planning process is dynamic and is expected to continue to evolve to address the changing nature of climate science and the identified climate impacts. By integrating climate considerations across system planning and operations, these processes aim to address the most pressing and immediate climate risks facing the system.

2. Overview of CMP Climate Vulnerability

The CMP Climate Change Vulnerability Study (CCVS) provided an assessment of climate change's potential impacts on CMP's assets and operations[1]. This study consisted of a multi-step process integrating years of efforts undertaken by CMP in close collaboration with Subject Matter Experts (SMEs), and local stakeholder engagement using Intergovernmental Panel on Climate Change (IPCC) best practices and the best available climate data. It aimed to assess both quantitative and qualitative vulnerability and climate risk to utility assets and operations to future climate conditions. The key findings of the CCVS are summarized throughout this section.

2.1 Exposure to a Changing Climate

The CCVS included the evaluation of multiple primary hazards (storm events and wind, extreme heat, inland flooding and extreme precipitation, coastal flooding, extreme cold, frozen precipitation, drought and wildfire, and wood decay) over moderate and high emission scenarios through the end of the 21st century. It is critical to note that these exposure findings are relative to current conditions; for example, a low exposure score indicates minimal future change or a change for the better across a long time horizon, but does not indicate that the current exposure level is insignificant, or that acute threats will not persist in the near term or remain a risk well into the study period. The analysis then focused on future change from current conditions. A summary of CMP's climate exposure can be found in the box below.

Exposure Summary

Storm Events and Wind have been increasing in the service territory and are likely to intensify due to climate change. The risks and impacts associated with high winds are expected to intensify with climate change, although there is a high degree of uncertainty as to the extent and timing of these changes to storm events.

Extreme heat is expected to rise to a high level of overall exposure from an observed low level. However, this high exposure is projected to only impact the area surrounding the Alfred service station. Other areas of the service territory are projected to retain a low level of heat exposure.

Inland flooding and extreme precipitation are projected to retain an overall high level of exposure. There are multiple assets in the inland 100- and 500-year FEMA floodplains. Precipitation exposure is projected to remain at moderate levels throughout the service territory through late century.

Coastal flooding is at an overall high level of exposure because multiple CMP asset types are located within the 100- and 500-year FEMA floodplains.

Extreme cold exposure is projected to remain at a low level from present day through late century due to the observed warming trend.

Frozen precipitation exposure is projected to remain at a low level from present day through late century.

Drought & Wildfire exposure is projected to remain consistent with current conditions. This is based on 30-year averages and does not capture potential year-to-year variability where drought conditions could be extreme with a high wildfire risk.

[1] CMP Climate and Grid Planning Site: Link

Using qualitative projection methods that relied on historical trends and the latest scientific research, the study team's analysis found that exposure to storm events and wind is expected to be high and continue to grow. The qualitative climate projections in the CMP service territory align with much of the rest of the Northeast United States with storm events, including extreme precipitation and wind, projected to intensify, inland and coastal flooding expected to increase, and sea level to rise. While temperatures are expected to rise, the CMP service territory remains relatively insulated from these impacts except for the Alfred area which is expected to experience significant enough warming by mid-century to be disruptive. Extreme cold and frozen precipitation are expected to decrease by mid-century, drought and wildfire exposure to remain relatively consistent with current conditions through late century with continued concern for year-to-year variability. Wildfire already presents a vulnerability, and although that vulnerability is not expected to grow as significantly as storm risk, the potential for devastating damage from wildfire nevertheless requires resilience measures.

2.2 Vulnerability Assessment

Vulnerability expresses the degree to which an asset is exposed to a climate hazard and the implications upon being impacted. To assess vulnerability, the CCVS adopted a framework rooted in IPCC best practices and an approach that has been utilized across the utility industry. This approach determined asset vulnerability by combining the projected exposure of an asset to climate hazards with its sensitivity to a given hazard, and its criticality. Sensitivity and criticality scores were determined with the support of the CMP core team.

- Exposure is defined as the degree to which assets could face climate hazards. This is determined based on an asset's location and climate hazard projections in that area.
- Sensitivity is the degree to which assets could be affected by exposure to climate hazards.
- Criticality is defined as the magnitude of negative outcomes for the CMP systems, customers, or staff when an asset is damaged.

The assessment included both transmission, substation, and distribution assets. The figure below illustrates the vulnerability assess process.

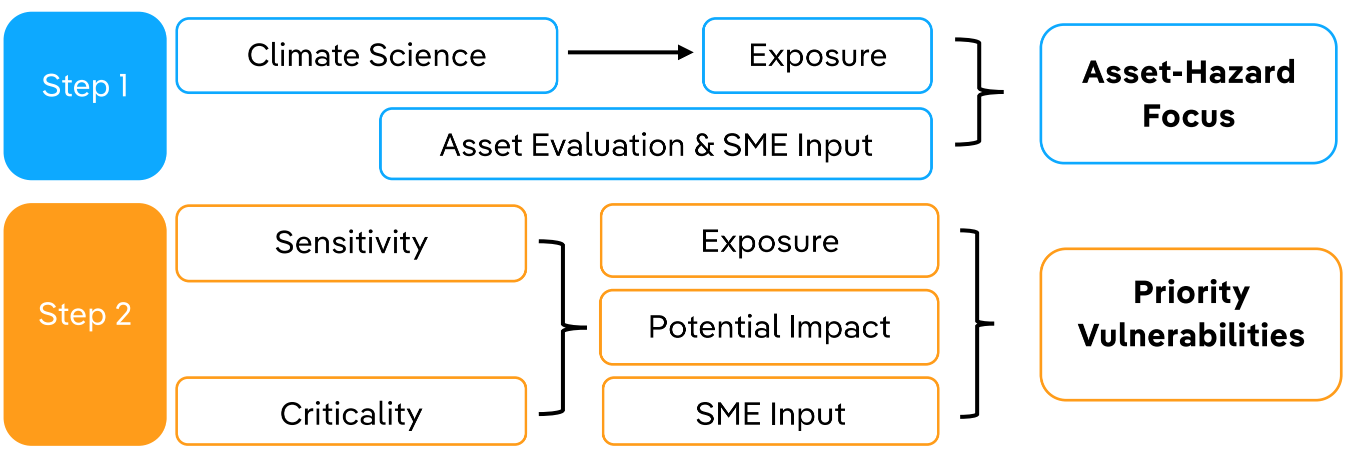


Figure 1 - Vulnerability Assessment Overview

The CCVS also examined the vulnerability of CMP operations to climate change. This assessment was qualitative in nature and utilized a combination of climate projections produced during the asset vulnerability assessment, TRC in-house experts, and interviews with relevant CMP SMEs. This analysis included the assessment of the following operational groups: Asset Management, Facility Rating, Load Forecasting, Vegetation Management, Reliability Planning, Workforce Safety, and Emergency Management.

The vulnerabilities associated with these impacts range in magnitude and severity, affecting both assets and operations. The table below illustrates whether an asset family or operational group had at least one asset or operational area that was identified as having a priority vulnerability to a given hazard.

Table 1 - CCVS Climate Hazard Exposure, Asset Vulnerabilities, and Operational Vulnerabilities

Hazard	Exposure	Most Vulnerable Assets	Greatest Operational Vulnerabilities
Storm Events & Wind	**High Exposure**	• Overhead conductors • Line structures • Reclosers • Transformers • Dynamic reactive devices • Support structures • Control house • Circuit breakers	• Asset management • Reliability planning • Emergency management • Vegetation management • Workforce safety
Flooding (Inland and Coastal)	**High Exposure**	• Overhead and underground conductors • Line structures • Reclosers • Transformers • Dynamic reactive devices • Support structures • Control house • Circuit breakers • Regulators	• Asset management • Reliability planning • Emergency management • Vegetation management • Workforce safety
Heat Events	**High Exposure**	• Overhead and underground conductors • Line structures • Reclosers • Transformers • Dynamic reactive devices • Support structures • Control house • Circuit breakers • Regulators	• Asset management • Reliability planning • Emergency management • Vegetation management • Workforce safety • Load forecasting
Wood Decay	**High Exposure**	• Wooden poles • Wooden crossarms	
Wildfire	**Low Exposure (high impact)**	• Line structures • Transformers	• Asset management • Reliability planning • Emergency management • Vegetation management • Workforce safety
Frozen Precipitation	**Low Exposure**	• Overhead conductors • Line structures • Support structures	• Asset management • Reliability planning • Emergency management • Vegetation management • Workforce safety
Cold Events	**Low Exposure**		

2.3 Summary of Key CCVS Findings

Both coastal and inland flooding pose a significant risk to CMP assets as well as operations. While the substation coastal and inland flood risk analysis found that the number of substations at risk is limited, this analysis relied solely on current FEMA floodplains and NOAA sea level rise data. Projected increases in extreme precipitation and as well as storm events may increase the risk of flooding in the future. The impacts of flood events to CMP may be extreme as there are multiple asset types with high potential impacts associated with both coastal and inland flooding, as well as many operational divisions that could be severely affected. Further, repairing flood and storm damage to assets may be impeded by flooded access roads.

Storm events have been increasing in the service territory and are likely to intensify in the future due to climate change, potentially causing major challenges for CMP. The risks and impacts associated with high winds are expected to intensify with climate change, although there is a high degree of uncertainty as to the extent and timing of these changes to storm events. Given that severe wind can cause significant problems for critical overhead assets and severely impact multiple operational groups, it is a high priority vulnerability.

For many utilities in the United States, heat risk is one of the biggest challenges posed by climate change as many utility assets are highly sensitive to the impacts of heat. This study found that by 2050, **CMP's heat risk is somewhat limited compared to peer utilities** except for the southernmost regions of the CMP service territory. Heat risk is expected to increase by late century and the confluence of even moderate increases in temperatures alongside load growth caused by electrification and energy intensive customers may cause future issues for assets and operations as soon as mid-century.

Drought has limited direct impacts on most transmission and distribution grid assets but can create conditions that increase the likelihood or severity of other hazards. This includes potentially increasing risk of conditions conducive to wildfire, and when paired with sudden extreme precipitation after drought conditions, there can be increased risk of flooding, landslides, or mudslides. Utility equipment is generally not designed to be exposed to fire; accordingly, wildfire poses a threat to many assets as it has the potential to cause significant damage or destruction. Future projections suggest a wetter and warmer Maine service area which will likely increase vegetation growth overall. The drought indicator used as a proxy for wildfire risk suggests that current conditions will continue. **Year-to-year variability of droughts could continue to be an issue, amplified by vegetation growth, suggesting continued exploration of wildfire risk** and future trends is necessary.

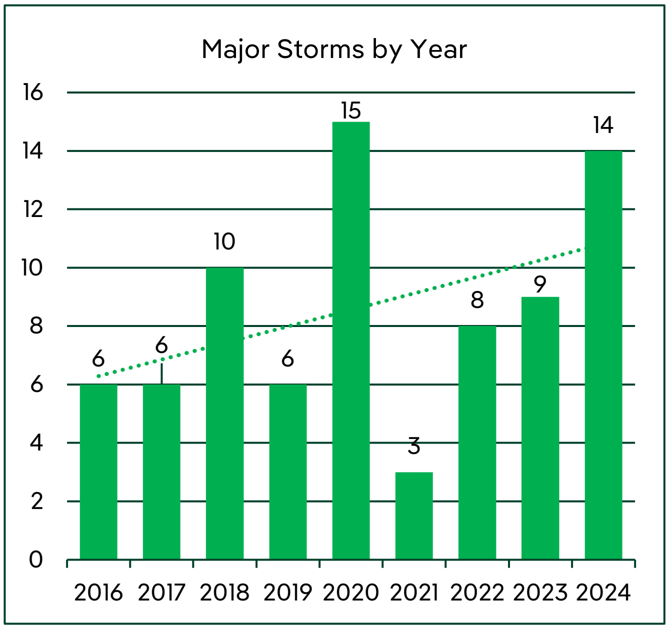
Although drought exacerbates wildfire risk, drought conditions are not necessarily determinative of wildfire risk. As vegetation growth increases with higher temperatures, the presence of dead and downed trees, brush, and other vegetation that can ignite from both natural and artificial sources, wildfire risk also increases. The possible significant and widespread damage resulting from wildfire indicates that it must be a priority vulnerability.

Operational impacts to climate change are widespread and cross cutting. However, **CMP has already taken significant steps to mitigate climate risk** and many resilience measures that can be taken to adapt to climate change apply to multiple hazards and/or multiple operational divisions.

Frozen precipitation is expected to decrease over the next few decades in response to climate change, though the potential severity of the most intense events may increase. As other risks increase, the leading causes of outages is likely to shift as well.

2.5 Major Storms and Outage Trends

Maine and its residents continue to be affected by major storm events that bring high winds, heavy precipitation, and other hazardous conditions. These events have been occurring with increasing frequency and intensity, resulting in a growing number of customers experiencing outages. As noted in the CCVS, climate change is projected to further intensify these weather patterns, posing additional reliability challenges for CMP and its customers. In fact, a trend of increased major storms, and their increased effect on CMP customers has been observed and is shown in the figures shown below.



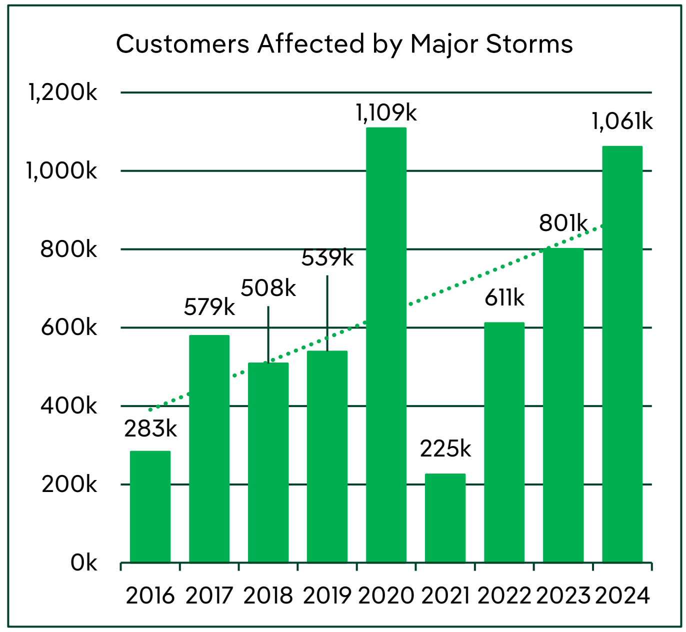


Figure 2 - Major Storms Experienced by CMP Customers, and CMP Customers Affected by Major Storms

These challenges faced in Maine due to major storms are a timely and pressing issue that requires proactive solutions. The electric grid in use today has been developed and expanded over the past century. While engineering practices and available technologies have evolved significantly during that time, much of the infrastructure currently in service was installed decades ago. This presents two key challenges. First, many components—ranging from poles and wires on distribution circuits to substation equipment like circuit breakers—are at or near the end of their service life. Aging equipment is more prone to failure and may no longer perform as designed under stressed conditions. Second, legacy infrastructure was not built to withstand the frequency and severity of today's storms, which climate change is expected to intensify. Without upgrades to enhance system resiliency, higher vulnerability to storm impacts and climate change is expected to continue.

Investing in modern, resilient infrastructure is essential to reduce the likelihood of equipment failure and widespread outages during acute weather events. Upgrading aging assets with more robust designs—such as storm-hardened poles, advanced protection systems, covered wire, and automated switching; or enhanced processes like ground-to-sky vegetation management—can *significantly* improve system performance and reduce restoration costs. These investments not only enhance reliability for customers but also position CMP to meet the evolving demands of a changing climate with a more resilient system.

3. Physical Asset Resilience

Following completion of the CCVS, the Study Team evaluated each of the priority vulnerabilities to determine which are currently the most impactful to CMP and its customers in the near term and which may not be routinely impactful today. This evaluation was performed to ensure that the contents of this CCRP provide clear direction and recommendations, while helping to acknowledge that climate planning must become a core component of the electric system's planning process.

Section 3 of the CCRP outlines a range of resilience measures identified to address the most prevalent vulnerabilities identified in this CCVS. These resilience measures can be broadly categorized into Strategic Resilience Measures and Site-Specific Resilience Measures:

> **Strategic Resilience Measures:** Activities like updating equipment specifications and/or internal processes to gradually incorporate climate resilience into the electric system through business-as-usual activities.
>
> **Site-Specific Resilience Measures:** Activities to address acute climate hazard vulnerabilities for a specific site or group of assets.

CMP is committed to building a robust and resilient grid, and to continuously understand and reduce its climate vulnerability over time. The following measures are intended to guide, inform, and support CMP's strategies for implementing climate and reliability planning, decision-making, and project prioritization, and will continue to be an area of focus for the company.

3.1 Resilience Framework

To identify resilience measures and the variety of ways they can impact its system and processes, CMP utilized a framework that explores enhancing resilience with four key objectives: 1) strengthen assets and operations to withstand the adverse impacts of a climate hazard event; 2) increase the ability to anticipate when a climate hazard event may occur and/or absorb its effects; 3) bolster the capability to quickly respond and recover following 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.

Strengthen and Withstand

CMP's assets are projected to be exposed to a wide variety of climate hazards. This resilience objective explores measures that harden physical assets to additional withstand impacts that may occur during extreme weather events like major storms or flooding events.

Anticipate and Absorb

In some cases, reinforcing assets with a resilience measure designed to strengthen and withstand may be insufficient or impractical. The Anticipate and Absorb resilience measures explore ways to reduce the impacts should outages occur, regardless of physical strengthening. These types of measures limit the level or extent 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 service. Respond and Recover is focused on activities and procedures to more quickly or efficiently restore service to normal levels following 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, or optimization of equipment staging.

Advance & Adapt

The final objective addresses a continuously changing climate threat landscape and seeks to 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 exposure to climate hazards, when feasible, is an example of an adaptive resilience measure.

The following graphic of the resilience framework utilized in this analysis shows when, and how each of the four objectives discussed can impact utility service before, during, and after a climate hazard.

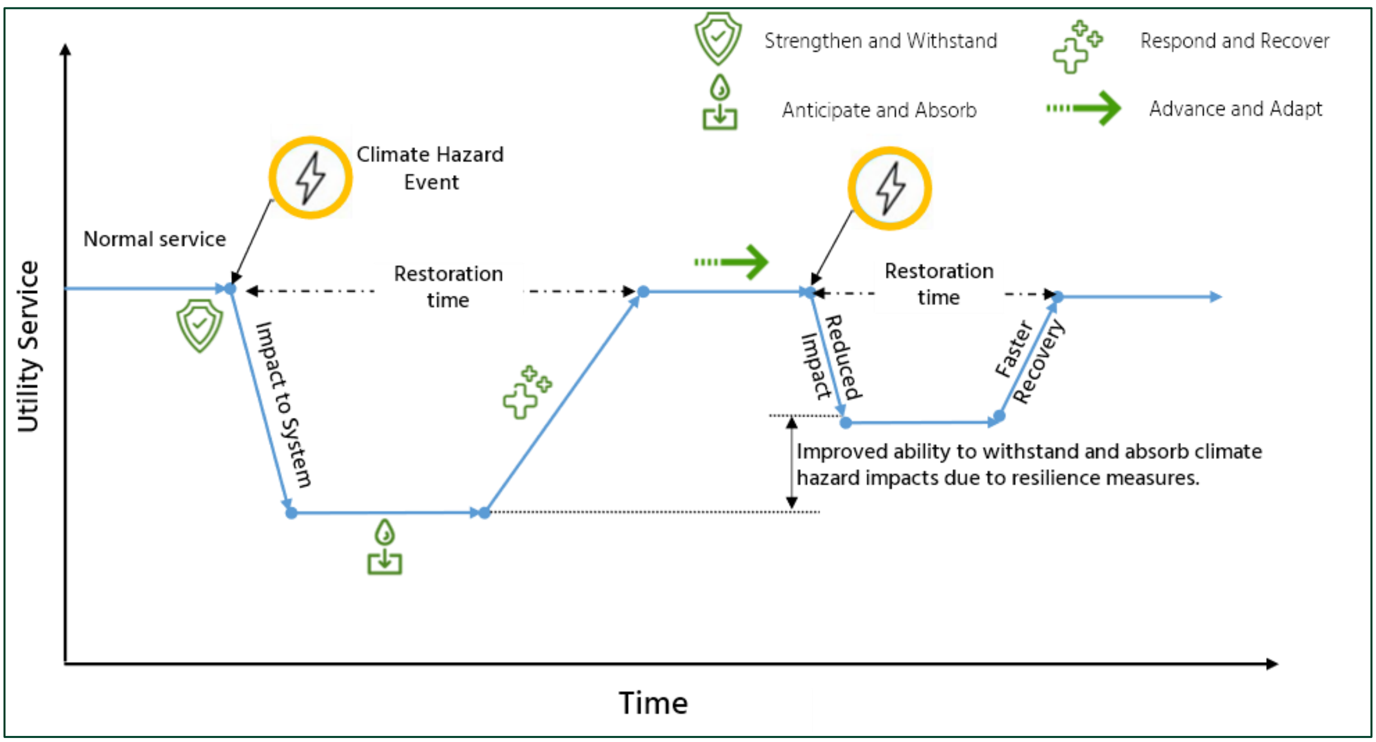


Figure 3 - Resilience Framework

3.2 Climate Hazard Resilience Measures: Storm Events and Wind

When major storms occur, their effects on the electric system can be widespread and varied depending upon a number of factors. These factors, including the severity of the storm and damage caused to the electric system, have a direct effect on the restoration time and restoration costs of an outage. The frequency that outages occur during major storm events is related to when objects, frequently vegetation, contact energized utility equipment causing a fault, and/or when equipment fails directly due to impacts from climate hazards such as the high winds and precipitation that accompany storm events. These disruptions, commonly called faults, require sections of the electric system to be quickly and automatically disconnected to maximize safety and minimize damage.

Faults that occur on the grid can be classified into two major types: temporary and permanent. A temporary fault occurs when an object touches an energized piece of equipment but does not cause significant damage and the object is not in permanent contact with the line (e.g., a falling branch). The other type is a permanent fault where an object permanently impacts equipment (e.g., a tree resting on the line) and/or the object impact causes enough damage to utility equipment that repair is required before reenergization (e.g., a downed wire). When discussing ways to improve system reliability and resiliency it can be helpful to discuss a potential system improvement's ability to affect the system in a few key ways:

1. Ability to reduce the likelihood of objects impacting energized lines (e.g., ground-to-sky trimming, spacer cable, tree-wire)
2. Ability to reduce the number and extent of permanent outages that occur (stronger poles, stronger wires, automation) and,
3. Ability to quickly restore the system following temporary outages through automatic/remote controlled re-energization (automation)

Approximately 90% of recent outages experienced by CMP customers are caused by issues that have occurred on the distribution system, with the remaining approximately 10% caused by events on the transmission or substation systems. Accordingly, the following resilience measures in Section 3.2 are focused on enhancing the resilience of the distribution system.

3.2.1 Spacer Cable

Spacer cable is a distribution system design that consolidates the three-phase overhead distribution conductors into a close triangular cross-section using polymer coated conductors, all supported by a high strength messenger wire. Spacer cable is easily recognizable by the distinctive mid-span spacers, shown in Figure 7, that are utilized to support conductors, and prevent them from contacting and tangling.

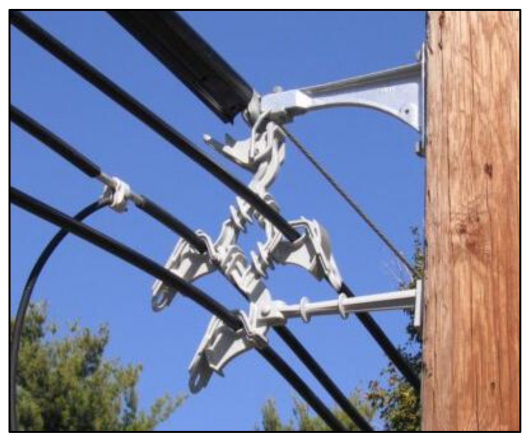


Figure 4 - Spacer Cable

System Improvements

Usage of spacer cable is a proven technique to reduce outages frequently caused by storm events and wind, including the potential for reducing outages caused by trees by up to 90% compared to traditional bare wire construction[2]. Where possible and applicable, usage of this construction would be a significant improvement over the traditional bare-wire construction used in approximately 90% of CMP's distribution system due to three significant differences between the two construction types:

1. Spacer cable assemblies utilize conductors covered with three concentric layers of a polyethylene coating (see **Error! Reference source not found.** below). These coatings help provide electrical insulation between the energized conductor and the contacting hazard providing additional protection from faults that may occur due to the impact from momentary or permanent vegetation, animal, or other foreign objects.

[2] Eversource study of spacer cable reliability improvements: https://www.tdworld.com/overhead-distribution/article/21276550/system-hardening-and-other-benefits-of-covered-conductors

2. The messenger wire utilized in spacer cable construction is significantly stronger than the copper or aluminum conductors used in traditional construction (selected due to their desirable electric characteristics.) For example, CMP's standard for spacer cable utilizes a steel and aluminum messenger wire with a rated breaking strength of 17,120 lbs. whereas the rated breaking strength of a common 477 kcmil all aluminum conductor (AAC) is 8,360 lbs. (i.e., approximately 50% the strength of the messenger)[3].
3. Spacer cable construction has a significantly reduced width compared to open wire construction. The distinctive spacers utilized by CMP have a width of approximately 17" compared to a typical crossarm which is 8' wide, a reduction in width of approximately 82%. This reduction in size requires less vegetation management and reduces the likelihood of tree-strikes or branches resting across conductors.

Resilience Recommendation

The materials and orientation of spacer cable construction provides significant strength improvements over traditional open wire; this hardening, coupled with the conductor insulation reduces the impact from vegetation, including sustained contact from leaning trees, while remaining energized and supplying customers. Spacer cable is preferred by CMP for installation in most locations as it can greatly reduce the likelihood of momentary faults, reducing outages and potential wildfire ignition risk.[4] Utilizing spacer cable in areas identified as part of the CMP hardening and resilience projects will reduce the number of outages caused by storm events and wind, resulting in a reduction in customer outages and storm restoration costs.

Table 2 - Spacer Cable Resilience Improvements

Hazards	Storm Events & Wind	Frozen Precipitation	Wildfire
Spacer Cable Resilience Improvements	Improved stability and spacing helps withstand impacts from storms and wind, including direct damage from high winds or contact with downed vegetation or blown debris. Insulation and the use of steel messenger wire also help prevent damage to cables caused by contact with vegetation or debris.	Improved strength and stability from steel messenger wire helps withstand the weight and pressure from ice and snow accumulation. Insulation can also reduce the chance of ice accumulating on wires.	Insulation and spacing minimizes the risk of faults (e.g., sparking or arcing) caused by contact with vegetation or other wires, reducing accidental wildfire ignition risk.

3.2.2 Tree Wire

Historically distribution conductors have been bare metal, with original vintages being made from copper though over time varieties of aluminum wire have replaced copper in most instances. Approximately 90% of CMP's distribution system utilizes bare metal conductors which are susceptible to all types of faults, including those caused by animal and vegetation contact, in addition they are directly exposed to weather elements such as rain and snow.

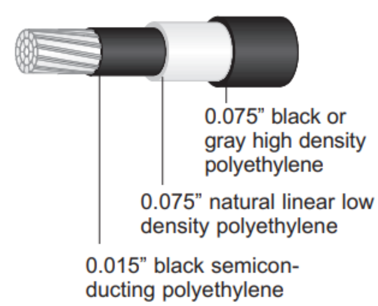


Figure 5 - Sample Tree Wire Construction - Hendrix.com

Recently parts of the utility industry have shifted towards utilizing wires that include polyethylene coating, similar to what is used in spacer cable, in locations where contact with vegetation is anticipated to frequently occur. This

[3] kcmil is a measurement of a wire's cross-sectional area expressed a thousand circular mils.
[4] Hurst, R. (2021). United Power installs Hendrix aerial spacer cable solution to address fire mitigation needs. *Electricity Today.* Retrieved from https://www.electricity-today.com/overhead-td/united-power-installs-hendrix-aerial-spacer-cable-solution-to-address-fire-mitigation-needs

gives this technology its colloquial name of *tree wire*. Similar to spacer cable, the provided polyethylene coatings on tree wire can help prevent both temporary and permanent faults that can be caused by animals, vegetation, or other foreign objects that may contact an energized line, but do not cause permanent damage like breaking the wire, crossarm, or pole. In addition, the coatings also provide protection from precipitation which can potentially reduce corrosion of the conductor and an associated loss of strength.

Table 3 - Tree Wire Resilience Improvements

Hazards	Storm Events & Wind	Wildfire
Tree Wire Resilience Improvements	Reduced risk of faults and related outages caused by contact from vegetation and debris blown into conductors during storm events and high winds.	Reduces risk of accidental ignition from faults caused by vegetation and debris colliding with bar-wire conductors.

System Improvements

Tree and vegetation contact with distribution conductors is a leading cause of outage at CMP, accounting for over 60% of all customer interruptions between 2022-2024, including during major storms. Tree-wire and bare-wire conductors have virtually identical mechanical strength when exposed to foreign objects like fallen limbs or trees; the main reliability and resiliency improvements gained from the wire coating are due to its prevention of faults caused by foreign object contact that do not result in broken wire, crossarms, poles or other equipment. In fact, data from a 2015 EPRI study cited in a recent report from California Investor-Owned Utilities (IOUs) identified the potential for a 40% reduction in tree related outages. This reduction in outages caused by object contact also reduces the likelihood of faults causing fires.

Resilience Recommendation

Spacer cable is the preferred construction method due to the benefits described in Section 3.2.1. However, for instances where it may not be feasible to utilize spacer cable, CMP has recently updated its distribution material and construction standards to incorporate tree wire in locations where tree or vegetation impact is expected. This change will improve the system performance during weather events, but CMP does not expect to upgrade all portions of its expansive network of distribution lines in the short-term. Instead, to accomplish this roll-out, tree-wire will be utilized during projects that focus on reliability improvements, as well as projects that build new or upgraded distribution lines to supply new customers, or projects that are needed to enhance the capacity of the system.

3.2.3 Stronger Wood Poles

Table 4 - Higher Class Wood Pole Resilience Improvements

Hazards	Storm Events & Wind
Higher Class Wood Poles Resilience Improvements	Increased stability and strength provided by a higher pole class reduces the risk of poles toppling from exposure to high winds or contact with downed vegetation or other debris.

CMP owns and maintains approximately 667,000 distribution poles, with 99% of those poles being traditional round wooden poles that are installed directly embedded in soil. The average age of these poles is approximately 34 years old with ~143,000 (21%) of these poles being more than 50 years old. CMP has observed that once a pole's age reaches 50 years old the rate of pole inspection failures begins to increase exponentially.

System Improvements

The strength of wooden utility poles is grouped into different classes (e.g., Class 1, Class 2, etc.) with Class 1 being the highest strength available before moving to even stronger "H" class poles. Class 1 poles are rated to withstand a horizontal load of 4,500 lbs., with each lower class having an approximate 25% reduction in strength. I.e., a Class 2 pole is 25% weaker than Class 1, and Class 3 is 25% weaker than Class 2[5].

In 2019, CMP began to utilize new distribution resiliency and hardening standards that eliminated the use of Class 4 and higher poles. Acknowledging the hardening advantages of higher-class poles, CMP now installs Class 1 and Class 2 wherever possible. From 2020 through 2024, CMP installed approximately 10,700 poles each year. As of the end of 2024, the approximate distribution of pole classes at CMP are as follows:

Table 5 - CMP Pole Class Distribution

Pole Class	% of Population
Class 1 (strongest)	0.21%
Class 2	4.16%
Class 3	12.13%
Class 4[1]	40.42%
Class 5[6]	42.22%
Other	0.86%

Resilience Recommendation

Poles are a fundamental component of the distribution system, and most pole-break events result in sustained customer outages, where replacing a pole requires approximately 8 hours[7]. During major weather events where there are a significant number of broken poles, the outage duration and storm restoration costs increase as replacing a pole requires additional time and specialized equipment. If a pole break occurs off-road, replacement becomes even more difficult. Continuing to upgrade CMP's lower class poles, which are a majority of the pole population, to the new higher standard classes will help prevent broken pole events. In addition, it is expected to speed up storm restoration times and reduce storm restoration costs due to a reduction in pole break events. Accelerating the rate of replacement of older, weaker poles with higher-class poles will correspondingly accelerate resilience.

[5] North American Wood Pole Council
[6] No longer used at CMP as part of standard construction.
[7] For example, during a December 2023 storm approximately 1,300 poles were broken.

3.2.4 Steel Poles

Utilities have utilized wooden poles to support and elevate their equipment for more than 100 years due to the ability to quickly harvest poles from nearby forests, as well as their longevity, particularly once they are treated to enhance their resistance to environmental factors. However, the modern utility system, and the reliability and resilience needs of customers, have evolved, and there are new solutions that can be used to enhance the resilience of the electric grid.

The transmission portion of the utility industry have largely standardized on the use of steel poles when building transmission lines due to their high-strength, customizability, and robust manufacturing tolerances. CMP and other utilities have now found that there are specific circumstances on the distribution system where the use of alternate pole materials such as light-duty steel, can be advantageous over traditional wooden poles.

Table 6 - Steel Pole Resilience Improvements

Hazards	Storm Events & Wind	Extreme Precipitation & Inland & Coastal Flooding	Wildfire
Steel Poles Resilience Improvements	Increased stability and strength provided by a higher pole class reduces the risk of poles toppling from exposure to high winds or contact with downed vegetation or other debris.	Increased durability because unlike wooden poles, steel poles cannot rot from water exposure.	Reduces the risk of wildfire damage and ignition, as steel is more flame and heat resistant than wood.

Rot, Infestation, and Woodpecker Resistance

The leading causes of wood pole degradation and inspection failure include fungal rot, insect infestation, and woodpecker damage. Woodpeckers damage utility poles in the process of searching for food or a location to nest; this type of damage can occur extremely quickly between pole inspection cycles while incipient damage caused by rot occurs more gradually. In either case, these types of damage are inevitable with outdoor wooden components but can be delayed with various treatments that inhibit fungal growth and infestation. Over time this protection will wane causing the poles capability to be decreased as evidence by the inspection failure rate significantly increasing once poles reach 50-years-old. Damage to a pole, especially if it compromises the outer shell of the pole, reduces the pole's strength and increases the likelihood that it will fail to withstand physical disruptions like wind, frozen precipitation, and falling vegetation; likely causing a long duration outage.

Pole Strength and Enhanced Resilience

Steel poles do not include any organic compounds and so they are completely immune to these factors. Due to their immunity to these common sources of degradation, it is anticipated that properly maintained steel poles will maintain a significant portion of their design strength for over 50 years resulting in an increased service life. These longevity findings are consistent with industry experience on the transmission system where steel structures often demonstrate a significantly greater service life. For example, Eversource New Hampshire cited the benefits of steel poles, stating that steel poles having a projected lifespan of 90 years and a slower degradation rate.[8]

Light-duty steel poles can be purchased in a variety of classes equivalent to their wooden pole counterparts; however, these steel poles are lighter than their wooden counterparts and have desirable characteristics when

[8] Eversource Energy. (2021). *Eversource New Hampshire Distribution System Assessment*. New Hampshire Public Utilities Commission. (p. 35). Retrieved from https://www.puc.nh.gov/VirtualFileRoom/ShowDocument.aspx?DocumentId=0f96a3e1-282e-4bbb-aee7-c643e77e7cf2

they experience physical disruption. When placed under extreme physical stress, particularly when impacted by falling vegetation, the wooden pole may exceed its design tolerances and snap, likely leading to an outage. In contrast, when a steel pole experiences a similar event above its design tolerances, it may yield (i.e., bends) to absorb the physical impact and can remain in service unless other components fail (e.g., conductors, crossarms, etc.)[9]. This desirable outcome of potentially preventing a broken pole, can prevent outages and allow for repairs to be made in a non-emergency fashion, decreasing customer outages and storm restoration costs.

Resilience Recommendation

The characteristics of steel poles versus the traditional wooden counterparts make them a good candidate for installation in specific strategic circumstances. For example, utilizing a steel pole and its enhanced resilience capability can be beneficial in locations where particularly complex or expensive equipment that may be difficult to quickly repair is installed. In addition, utilizing steel distribution poles may be beneficial in circumstances where maintaining, repairing, or installing wooden poles is difficult, such as pole locations that are not roadside and may require specialized repair equipment (e.g., track vehicles). CMP has identified approximately 2,000 poles that are located in off-road rights-of-way that are candidates for replacement with steel poles.

3.2.5 Targeted Undergrounding

Targeted undergrounding is the replacement of overhead primary electric wires with underground cables. From a resiliency and hardening perspective, undergrounding of distribution lines makes them virtually immune to outages during high winds, thunderstorms, heavy snow, or ice storms, while also minimizing the risk of damage from animals, vehicle collisions, and wildfires.[10] However, undergrounding of wires and associated infrastructure has higher costs when compared with other hardening measures. The benefits of undergrounding increase in densely populated areas, with large numbers of downstream customers, when there are multiple distribution circuits in the right of way, or other non-typical circumstances.

Table 7 - Targeted Underground Resilience Improvements

Hazards	Storm Events & Wind	Frozen Precipitation	Wildfire
Targeted Undergrounding Resilience Improvements	Removes many of the threats faced by overhead conductors posed by storm events and wind, including potential contact with vegetation and damage from wind and ice accumulation by removing the asset from harm's way.	Reduces risk of potential damage from snow and ice accumulation because wires are removed from harm's way and no longer exposed to frozen precipitation.	Reduces the risk of damage of conductors from exposure to flames and residual heat caused by wildfires. Undergrounding also reduces the probability of accidental ignition caused by faults or vegetation contact.

System Improvements

Undergrounding has been proven successful in multiple use cases. The Wisconsin Public Service Commission found a 95% performance improvement in SAIDI during major storms from 2012 to 2021 as a result of an overhead to underground distribution line conversion project. Virginia Electric and Power Company found improvements from a similar project with a 99% improvement in SAIFI after undergrounding of targeted lines was completed, a

[9] Ibid. p. 36.

[10] U.S. Department of Energy, Grid Deployment Office. (2024). *Undergrounding transmission and distribution lines: Resilience investment guide* (p. 2). Retrieved from https://www.energy.gov/sites/default/files/2024-11/111524_Undergrounding_Transmission_and_Distribution_Lines.pdf

27% reduction in system restoration times after a major storm in January 2022 and estimated avoided GDP losses of $270,000 to $3.6 Million during a severe thunderstorm in June 2016. Additionally, researchers at Stanford found that nationally a 10% increase in underground line miles was associated with a 14% reduction in annual interruptions.[11]

As extreme weather events increase due to climate change, the use of targeted undergrounding on portions of the electric distribution system is a proactive solution that could enhance reliability and resiliency. This solution aims to improve system resilience by identifying and performing undergrounding on specific sections of overhead distribution lines that may be more prone to outages, are in locations that are difficult to repair, or if outages could have an outsized impact on the community; for example, based on the number or type of customers that they are served. Using a targeted approach in undergrounding lines is critical as undergrounding has some disadvantages and it is important to ensure the benefits outweigh the costs in their application. Undergrounding lines carry significant direct costs, are harder to access for restoration/maintenance activities than overhead lines, may have shorter lifespans than overhead lines, and may be more susceptible to flood risk.[12] The following table summarizes a subjective analysis of the cost and benefits between strategic undergrounding or overhead hardening.

Table 8 - Overhead vs. Underground Costs vs. Benefits Evaluation

Evaluated Metric	Undergrounding	Overhead Hardening
Initial Cost		✓
Future Replacement Cost		✓
Storm Restoration Cost	✓	
Short-Term Maintenance Cost	✓	
Long-Term Maintenance Cost		✓
Outage Frequency	✓	
Outage Duration[13]		✓
Ease of Modification[14]		✓

The undergrounding of primary electric distribution lines protects the equipment from damage and outages caused by wind, wind-and-ice, and vegetation contact that often accompany major weather events which climate change is expected to worsen. These improvements can nearly eliminate storm restoration costs and outages caused by weather on a specific portion of a circuit, though the overhead sections before or after the underground portion are still exposed to the weather effects.

Resilience Recommendation

Undergrounding is very effective at improving distribution resiliency and reliability, but it is an expensive solution. CMP reliability and resiliency planning must identify specific locations where undergrounding is a feasible and desirable solution. To identify these locations, CMP is utilizing its new Zone of Protection and Outage Geolocation tools discussed further in Section 3. CMP will continue to utilize these tools and frameworks to identify and propose projects to underground specific portions of its distribution system that provide the most benefit to its customers.

[11] Ibid. p. 3.

[12] Ibid. p. 4.

[13] While there may be fewer total outages for underground, locating and repairing underground equipment failures typically requires specialized equipment and takes longer to complete compared with overhead equipment.

[14] Modification to overhead facilities to add customers or upgrade capability is a relatively simple process for overhead facilities. For underground construction this can involve significant planning and costs to install the necessary supporting equipment (e.g., splicing chambers, etc.)

3.2.6 Fiberglass Crossarms

Crossarms are an important part of a utility pole assembly; these pieces provide an attachment point for the insulators that support the energized distribution conductors; historically crossarms have been made from wood. CMP has identified that updating its distribution construction standards to instead utilize fiberglass crossarms can enhance the reliability and resilience of the distribution system due to multiple desirable characteristics.

Figure 6 - Fiberglass Crossarms

When a crossarm breaks, often caused by trees falling onto conductors, it leads to a significant number of customer outages. Repairing a broken crossarm is typically easier than repairing a broken pole, but crossarm replacement still requires several hours to complete. The mechanical strength of a wooden crossarm is the greatest when it is first installed, with its strength degrading over time due to wood rot and insect damage as it is exposed to the elements. As noted in the CCVS, it is anticipated that climate change will cause an increase in the Scheffer Index in Maine; this increase is anticipated to accelerate the degradation of the mechanical strength of wooden crossarms which would likely result in more frequent replacement of crossarms either due to failing inspection or by breaking during major weather events.

There are alternative materials that can be used as utility crossarms including metal and fiberglass. Fiberglass is the most popular alternative for use on the distribution system in the northeast. Fiberglass crossarms can be easily differentiated from their wooden counterparts by their grey or silver color. The most beneficial characteristics of these new crossarms are their mechanical strength, longevity, and electrical characteristics.

Table 9 - Fiberglass Crossarm Resilience Improvements

Hazards	Storm Events & Wind	Frozen Precipitation	Extreme Precipitation & Inland Flooding
Fiberglass Crossarms Resilience Improvements	Increased strength and deflection ability reduces risk of damage or failure from wind or collisions with vegetation or other debris.	Increased strength and deflection ability reduces risk of damage of failure from loading caused by ice and snow accumulation.	Increased durability because unlike wooden crossarms, fiberglass crossarms do not rot from exposure to precipitation and humidity.

Mechanical Strength

One of the most notable benefits of switching to fiberglass crossarms is their mechanical strength. A fiberglass crossarm; comprised of multiple layers of materials, exhibits superior mechanical strength compared to wooden crossarms. In testing conducted by EPRI, fiberglass crossarms were found to withstand over twice as much static loading force as wooden crossarms and were also able to deflect almost twice as far before breaking.[15] This enhanced strength allows the crossarms to withstand more severe impacts from wind or falling vegetation without breaking. This improvement can reduce both permanent and temporary outages as impacting vegetation

[15] EPRI. (2015). Distribution Grid Resiliency: Overhead Structures. Retrieved from: https://www.epri.com/research/products/3002006780

can fall to the ground allowing customers to be quickly re-energized. If coupled with tree-wire an outage may be avoided altogether.

Longevity

In addition, the materials used in fiberglass crossarm construction do not include biodegradable compounds. Accordingly, they are impervious to rot, decay, and insects. Due to these characteristics, it is expected that fiberglass crossarms could have a service life of more than 60-years; superior to the expected longevity of wooden crossarms. A benefit of this anticipated longevity is the way that the mechanical strength of a fiberglass crossarm changes over time. A wooden crossarm's mechanical capability steadily decays over its service life due to environmental factors including rot and decay. Fiberglass crossarms are not subject to rot and decay and are expected to maintain a significant amount of their mechanical strength over their service life.

Electrical Properties

In addition to the longevity provided by fiberglass construction, these crossarms are also electrical insulators and do not conduct electricity. Major weather events and vegetation impacts can cause energized conductors to be knocked from their supporting insulator. If there is a wooden crossarm which is no longer a good insulator after intrusion of decay or moisture, there is potential for a fault to occur leading to the circuit to be de-energized. In addition, if the electrical fault has a high impedance there is potential for the wooden crossarm to catch fire. Due to its insulating properties, fiberglass crossarms are not as likely to result in a fault or lead to a potential ignition in these situations. The following table summarizes some of the benefits of fiberglass crossarms over wooden crossarms.

Table 10 - Fiberglass vs. Wooden Crossarm Comparison

Category	Fiberglass Crossarms	Wooden Crossarms
Durability	Highly resistant to rot, corrosion, insects, and moisture. No on-going preservative treatments necessary.	Prone to decay, insects, and moisture damage.
Storm/Vegetation	Strong and specific mechanical capability; manufacturing process can produce equipment within tight tolerances.	Strong mechanical strength but potential for irregularities in wood growth to cause failure.
Weight & Installation	Much lighter than wooden crossarms. Can reduce installation/replacement time and required hardware.	Heavier, requiring additional support hardware and a longer installation/replacement time.
Lifespan	Lifespan in excess of 40 years while maintaining a high percentage of its mechanical strength throughout its lifecycle.	Typically, 40 years. Environmental factors may increase or decrease this expected life. Susceptible to gradual strength loss caused by rot, decay, or insect damage.
Electrical Performance	Excellent electrical insulator reducing likelihood of lightning flashover, or outage caused by conductor coming off of mounting insulator.	Conductive when wet, decayed, or contaminated. May cause fault if conductor comes off of mounting insulator.
Initial Cost	Higher initial equipment cost.	Lower initial equipment cost.

Lifecycle Cost	Longer lifespan, reduced maintenance, and improved performance results in a lower lifecycle cost.	Shorter lifespan, potential for required maintenance, and eventual replacement results in a higher lifecycle cost.

Resilience Recommendation

Fiberglass crossarms represent proven way to enhance the reliability and resiliency of the distribution system challenged during major weather events. The advantageous material properties are expected to reduce customer outages due to broken crossarms, eliminate the impact of rot and infestation on these components, and increase the longevity of these pieces of equipment. As CMP modifies or expands the distribution system to enhance reliability, resiliency, or capacity for future load growth the use of fiberglass crossarms should be utilized wherever feasible.

3.2.7 Topology Updates

A distribution system topology describes the configuration of infrastructure that comprises the distribution system. Most of the CMP's distribution circuits are radial circuits meaning that they are powered from a single substation with electricity delivered via three-phase or single-phase lines. In CMP's service territory, long circuits often serve multiple communities and are exposed to many miles of trees along their rights-of-way. 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.

Table 11 - Topology Update Resilience Improvements

Hazards	Storm Events & Wind	Frozen Precipitation	Extreme Precipitation & Coastal & Inland Flooding	Wildfire
Topology Updates Resilience Improvements	Increased ability to absorb and limit impacts of outages caused by storm events and wind by containing impacts to immediately affected areas; increased restoration times after storm events and wind related outages.	Increased ability to absorb and limit impacts of outages caused by frozen precipitation by containing impacts to immediately affected areas; increased restoration times after frozen precipitation related outages.	Increased ability to absorb and limit impacts of outages or necessary de-energization caused by extreme precipitation and flood events by containing impacts to immediately affected areas; increased restoration times after precipitation and flood related outages.	Increased ability to absorb and limit impacts of outages or necessary de-energization caused by wildfire events by containing impacts to immediately affected areas; increased restoration times after wildfire related outages.

Circuit Ties

Adding a circuit tie between two nearby circuits is a proven way to enhance the reliability and resiliency of distribution circuits. Circuit ties connect two circuits together with a normally open device that when closed can allow power flow between them when the primary source for either circuit becomes unexpectedly unavailable. If the power from the primary source is lost due to an upstream outage a circuit tie can be closed to re-route power from the alternate source restoring some of the customers who are normally supplied from the disrupted circuit. Re-routing power could be achieved through centralized visibility and control via SCADA-controlled switches, or, if circuit ties are created using devices capable of automated switching, it is possible to quickly transfer customers from the primary to the alternate source so that restoration can occur without needing operator intervention, and the interruption experienced is brief.

Topology Upgrade Example

The following figure is an example of the topology upgrades that are used as part of the process for identifying resiliency and hardening improvements to a circuit. In the sample circuit configuration, there is a single distribution feeder supplying 1,046 customers protected by a single substation breaker and one downstream recloser. This arrangement also includes one non-automated circuit tie.

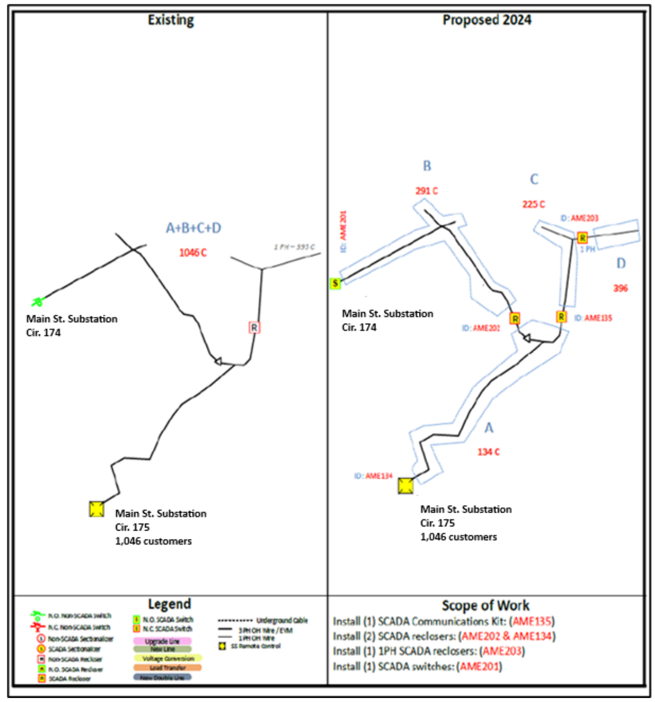


Figure 7 - Circuit Tie Example

As part of enhancing resiliency, engineers review the system topology to determine if there are opportunities for significant improvement to the circuit topology and automatic capabilities. The solution proposal included installation of three new automatic devices: two reclosers and one normally open switch with remote control capability at the location where the circuits are tied. Installation of the reclosers enables the circuit to be divided into multiple smaller segments so that a smaller number of customers are affected in the event of an outage. For example, if a permanent fault occurred on a particular section of the existing circuit all 1,046 customers would be automatically de-energized; in the proposed topology this same event would only result in 291 customers being de-energized, up to the first recloser - a 70% improvement. In addition, the normally open circuit tie switch allows for a remote-controlled or automatic backup that can be switched in or closed to reenergize the circuit from the alternate source.

Increasing Circuit Tie Capability

When outages occur on the main portion of a circuit, they typically affect a large number of customers located downstream from the event. As shown in the previous example, having ties between circuits enables a backup power source that allows for a portion of these customers to be quickly re-energized while permanent repairs are made. This type of scheme or capability is often referred to as sectionalizing, automatic grid restoration, or FLISR (Fault Location, Isolation, and Service Restoration), among others.

Less than 40% of CMP customers are served by circuits with a viable backup circuit tie. Unfortunately, due to the large geographic extent of the CMP system there are some circuits which do not have a feasible backup source. This lack of backup predominantly occurs at the edges of the system, rural locations, or locations near geographic features such as coasts or mountainous areas; overall 44% of the circuits without a tie are located in the rural portions of CMP's service territory. Providing a backup source to these communities generally requires installation of generators or batteries, which are discussed later in Section 3.

Substation Hardening

Enhancing distribution circuits is a significant focus of preparing the CMP system for the effects of climate change primarily due to their extent and susceptibility to climate hazards. However, ensuring that the substations that energize these distribution circuits do not become compromised during climate events hazards is crucial. As part of comprehensive needs assessments CMP has identified a number of improvements that can be used to boost the resilience of identified facilities. These upgrades can include things like installation of communication infrastructure to enable advanced restoration schemes or enhanced system intelligence, strategic relocation and/or replacement of poor condition structures, equipment, and foundations.

These enhancements will help harden these substation systems, allow for greater situational awareness, and enable greater grid flexibility.

Resilience Recommendation

Hardening the distribution system through the physical resilience measures outlined in Section 3 will help reduce the impact of major weather events on CMP customers. However, it is not possible to eliminate all hazards or prevent every outage. To further strengthen reliability, enhancing the distribution system's topology and improving the capabilities of its connecting substations should be prioritized. Incorporating features such as circuit ties, automated restoration, and advanced visibility enables customers to be served from multiple resilient and diverse sources. These measures significantly reduce the impact of outage events and improve overall system resilience.

3.3 Climate Hazard Resilience Measures: Flooding

The results of the CCVS identified that among the most significant risks to CMP substation assets are both inland and coastal flooding caused by severe storms, during high tides, and during more routine storms. As noted in the CCVS, the primary impact to CMP facilities is during storms that are expected to occur once every 100 years. For coastal storms the primary concern is storm surge that can be caused by tropical cyclones and nor'easters where water is pushed inland from the Gulf of Maine, potentially inundating the coastline. Inland flooding is caused by large amounts of precipitation, especially if it occurs while there is a significant snowpack. This precipitation and potentially the snowmelt that can travel through watersheds can cause creeks, streams, and rivers to overflow their banks.

Table 12 - Substation Flood Mitigation Resilience Improvements

Hazards	Extreme Precipitation & Inland & Coastal Flooding
Substation Flooding Resilience Improvements	Reduced risk of damage from floodwaters by removing substation from the floodplain; raising sensitive equipment above projected flood elevation; and/or hardening substation with protective barriers, such as floodwalls.

The CCVS identified limited impact to its substation facilities from present day 100-year flooding events, with three substations being substantially located in an inland FEMA floodplain (Bridgton, Bethel, South Berwick) and no substations substantially located in a FEMA coastal floodplain; though one facility, Cape Substation, is in an area where sea level rise and storm intensification are expected to increase its exposure to coastal flooding.

Resilience Benefit of Substation Flood Mitigation

Substation electrical equipment is highly sensitive to flooding. The flood depths and extents, complexity of and level of damage suffered by equipment, as well as the ability for crews to access the substations have a significant impact on the likelihood and duration of outages. Restoration of a facility that experiences significant flooding requires that asset damage be assessed, and then equipment mobilized to repair and re-energize the substation and its customers. In addition, once a facility is re-energized, there may be additional repairs that must be completed after emergency restoration activities are completed. For more minor flooding events that cause less damage, outage durations are likely to be shorter.

Site-Specific Resilience Measures

Three proven resilience measures that are used to mitigate against flood damage in substations are included below; each of these measures fulfill different resilience objectives:

1. Relocate a substation outside of 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 solution characteristics including feasibility, cost, or other ancillary benefits (e.g., mitigation of asset condition issues). For solution evaluation, the following qualitative scoring categories can be used to identify a preferred measure:

- 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 activate the resilience measure.
- Cost: Scored based on the approximate order of magnitude of costs to construct a measure.

For example, while initially it may be less expensive to build a permanent floodwall around a substation, that solution may not be efficient if multiple other needs remain unresolved or require their own standalone solutions. Ultimately, the solution for substations at risk of flooding will incorporate the findings of the CCVS, CCRP, Integrated Grid Plan and CMP's routine planning efforts.

South Berwick & Weston Hydro Substations

As part of its comprehensive needs assessment process CMP has initiated a project to rebuild the South Berwick substation that is currently located in the FEMA 100-year floodplain.

As part of the needs assessment at South Berwick, it was identified that there are significant site and asset condition issues, including exposure to flooding, that needed to be remedied to maintain reliable service. The South Berwick project is an example of a multi-value project that concurrently addresses all site and asset condition issues, enhances resilience to a priority climate vulnerability, and increases the capacity at the substation for future load growth. If done individually, resolution or improvements to each of these three areas would be expensive and could involve duplicated effort; however, encompassing each into a single holistic solution enables significant efficiency and cost savings.

At Weston Hydro the identified resilience measures include selected equipment elevation, installation of flood barriers to protect critical areas from water ingress, and construction of a new control house designed to withstand potential flooding. Use of these specific and targeted resilience measures allows for protection of the substation without requiring a complete facility rebuild, which was not identified as necessary and would cost substantially more.

Resilience Recommendation

CMP's current substation assessment criteria identifies if a substation is all or partially located in a FEMA 100-year floodplain. If so, mitigating the risk of flooding must be considered when evaluating a substation's condition and developing solutions as shown in the previously discussed examples. The remaining facilities identified as being at risk due to being in a 100-year floodplain are substations where transformer voltage ranges from 34.5 kV to 12 kV to serve local distribution customers, and if damaged by flooding, are not expected to have widespread impact to the transmission system. If these facilities were to be damaged, CMP can restore affected customers using circuit ties, or, once flood waters recede and a substation is accessible, CMP may be able to utilize its mobile substation/transformers to assist in emergency repairs without requiring extensive rebuild efforts to restore affected customers. As these facilities continue to be evaluated over time CMP will evaluate all potential needs and perform mitigation work when identified.

The Cape substation is a more complex facility, but as noted, does not have equipment located in the present-day floodplain. However, as utility equipment often have multi-decade service lives, any significant construction work at facilities like the Cape substation should consider future flooding scenarios, including sea level rise, into the facility design.

As future load growth throughout Maine is expected to be significant and, in some cases, likely to require substation upgrades, the facilities identified by the CCVS as most at risk for flooding, i.e., those that are currently located in a floodplain, must have flooding vulnerability factored into a solution that holistically addresses all issues. For example, if a substation that is at risk of flooding is forecasted as being overloaded due to electrification, all potential capacity solutions must consider how to enhance its resilience to flooding events as well, including the potential to relocate, raise select equipment, or install a floodwall. The identified at-risk facilities and associated flooding data will be included in the substation asset condition reports for mitigation as part of future multi-value projects.

3.4 Advanced Management Systems

From its inception until very recently, the utility distribution system was operated unidirectionally with power always flowing from a substation to the customer meter for consumption. Utility systems like voltage regulation and fault protection were always designed to sense power flow and operate in a unidirectional nature. In addition, utilities have historically had limited ability to routinely control electricity usage of customers and have had to instead plan their system to ensure that they could meet peak usage.

The recent and rapid growth of distributed energy resources (DER), which have now begun to frequently produce more power than is consumed on-site or by nearby customers, has changed portions of the system to truly have bi-directional power flow. This paradigm shift in system behavior has presented numerous challenges, particularly to utilities that are first to experience this transition. These utilities are frequently comprised of rural or light suburban areas where there may be lower population density and lower electric demand coupled with ample land to install DER compared to urban areas. Maine, with its significant influx of DER and largely rural service territory, has been challenged by this shift. To accommodate these changes CMP has adapted its system planning and design practices to analyze the system in new ways and install equipment or protective schemes that are able to operate correctly regardless of the direction of power flow.

With the challenges presented by the influx of DER there are opportunities – through the application of advanced management systems like System Automation, Advanced Distribution Monitor System (ADMS) or Distributed Energy Resource Management (DERM), utilities can gather data from points across the system and dynamically adjust the system topology and/or operation.

The following discussion on advanced systems are a mixture of in-use, in-development, or are discussions on implementations that could potentially be utilized to enhance resiliency of the system, including enhancing CMP's ability to operate its distribution system.

3.4.1 System Automation

For much of the 20th century the majority of switching equipment located on the distribution system, like circuit tie switches, needed to be operated manually. In some rare cases equipment was equipped with radios, allowing for rudimentary control. Following outage events, this manual-only control schema required field crews to be dispatched to operate equipment to tie circuits and then move on to making repairs. This was a multi-step process for the crew(s) that responded to the outage.

1. Switching would be completed to isolate the failed equipment and restore a portion of the de-energized circuit and restore customers.
2. Repairs to the isolated equipment were made while a portion of initially de-energized customers remained without power.

3. Once all repairs were completed, the system could be returned to normal, and all affected customers restored.

With the proliferation of microprocessor utility relaying, high-speed communication technology, and SCADA-controlled devices; the visibility into the conditions on the distribution system has been greatly enhanced, unlocking the ability to operate equipment on the distribution system automatically or remotely through operator action, and expanding the complexity of schemes that could be utilized to quickly restore customers during fault conditions. With system automation in place for the previous example, Steps 1 and 3 listed above could be completed through a combination of automatic and operator action from the CMP Energy Control Center (ECC); likely reducing the number of customers that experience an outage and the duration of the outage. Enabling these types of schemes on parts of the distribution system will require CMP to continue installing specialized switching devices and communication systems.

Table 13 - System Automation Resiliency Improvements

Hazards	Storm Events & Wind	Frozen Precipitation	Extreme Precipitation & Coastal & Inland Flooding	Wildfire
System Automation Resilience Improvements	Increased ability to respond to outages caused by storm events and wind by greatly reducing restoration times by automating switching and re-energization processes and reducing the amount of labor needed to restore power.	Increased ability to respond to outages caused by frozen precipitation by greatly reducing restoration times by automating switching and re-energization processes and reducing the amount of labor needed to restore power.	Increased ability to respond to outages caused by flooding and precipitation by greatly reducing restoration times by automating switching and re-energization processes and reducing the amount of labor needed to restore power; increased ability to quickly de-energize affected areas and improve public and line worker safety.	Increased ability to respond to outages caused by wildfires by greatly reducing restoration times by automating switching and re-energization processes and reducing the amount of labor needed to restore power; increased ability to quickly de-energize affected areas and improve public and line worker safety.

3.4.2 Advanced Distribution Management System

An Advanced Distribution Management System (ADMS) is a sophisticated software platform that enables electric utilities to monitor, control, and optimize the performance of their distribution networks in real time. It integrates a range of functionalities including Supervisory Control and Data Acquisition (SCADA), Distribution Management Systems (DMS), and Outage Management Systems (OMS)—into a unified interface. This integration allows utilities to quickly detect and respond to outages, perform detailed network analysis, and optimize power flows to reduce losses and improve operational efficiency. ADMS also enhances situational awareness by providing real-time data and analytics, enabling operators to make informed decisions that improve reliability and service quality.

ADMS can play a critical role in strengthening the grid's ability to withstand and recover from extreme weather events and other disruptions. It supports the integration and management of DERs, such as rooftop solar, battery storage, and electric vehicles, which are increasingly common in modern grids. By balancing supply and demand dynamically and maintaining voltage and frequency stability, ADMS helps ensure grid reliability even under variable conditions. Incorporating ADMS into a resilience strategy demonstrates a forward-looking approach to grid modernization, ensuring that utilities are equipped to meet both current and future challenges. However, establishing robust system visibility and control through automation and monitoring devices on the network, along with robust back-office platforms, are essential for successful ADMS deployment.

Distributed Energy Resource Management System (DERMS)

Distributed Energy Resource Management Systems (DERMS) are an advanced control platform used by utilities for centrally managing the DER, like solar farms, connected to their system, and operates in coordination with ADMS. DERMS cover a wide range of use cases; one important capability they have is to monitor and manage the flow of electricity across the distribution network, particularly in areas with high levels of installed DER. Unlike traditional passive grid management approaches, these tools can enable dynamic, real-time control of network assets, including generation, storage, and demand-side resources. By continuously assessing network conditions—such as voltage, frequency, and load—the system can make automated decisions to ensure that the system operates within its design parameters. This can include curtailing or ramping up generation, adjusting voltage levels, and managing load to prevent network constraints and maintain stability. CMP has seen significant interconnection of DER to its system so incorporating a suite of tools to manage the impacts from these systems as part of an ADMS solution is critical. As with ADMS, establishing robust system visibility and control through automation and monitoring devices on the network, along with robust back-office platforms, are essential for successful DERMS deployment.

ADMS and DERMS technology can allow for a more flexible and adaptive grid, allowing utilities to maintain grid reliability by actively balancing supply and demand, even under rapidly changing conditions while supporting the integration of intermittent renewables by managing their variability and ensuring they do not compromise grid reliability, making them key components of a modern, resilient energy system.

Table 14 - ADMS Resilience Improvements

Hazards	Storm Events & Wind	Frozen Precipitation	Extreme Precipitation & Coastal & Inland Flooding	Wildfire
ADMS Resilience Improvements	Increased ability to respond to outages caused by storm events and wind by increasing the ability to immediately detect outage events and mobilize repair crews, thereby reducing restoration times.	Increased ability to respond to outages caused frozen precipitation by increasing the ability to immediately detect outage events and mobilize repair crews, thereby reducing restoration times.	Increased ability to respond to outages caused by flooding and extreme precipitation by increasing the ability to immediately detect outage events and mobilize repair crews, thereby reducing restoration times.	Increased ability to respond to outages caused by wildfire by increasing the ability to immediately detect outage events and mobilize repair crews, thereby reducing restoration times.

3.4.3 Battery Storage

Battery energy storage systems (BESS) can play a role in enhancing the resilience of the electric grid by providing reliable backup power during outage conditions. During grid disruptions caused by extreme weather events or equipment failures, utility systems can be designed to automatically reconfigure and allow for the BESS to immediately begin supplying power to specific parts of the system. This type of configuration could be referred to as a microgrid if it can operate separately from the wider grid while repairs are made. This configuration can reduce outage frequency and duration to critical infrastructure and support emergency response or other critical services.

The cost and complexities of these types of microgrid installations are significant and are typically reserved for specific scenarios where other resiliency enhancing measures may not be sufficient, for example at the end of a long circuit without nearby tie capability. While discussions on ownership and usage of BESS continue, CMP will assess the feasibility of these solutions, including reviewing how this type of resiliency enhancing technology is being utilized at other utilities.

Table 15 - BESS Potential Resiliency Improvements

Hazards	Storm Events & Wind	Frozen Precipitation	Extreme Precipitation & Coastal & Inland Flooding	Wildfire	Extreme Heat
SCADA Resilience Improvements	Reduced outages/impacts to customers from outages caused by storm events and wind by providing a temporary back up source of power	Reduced outages/impacts to customers from outages caused by frozen precipitation by providing a temporary back up source of power	Reduced outages/impacts to customers from outages caused by extreme precipitation and flooding by providing a temporary back up source of power	Reduced outages/impacts to customers from outages caused by wildfire by providing a temporary back up source of power	Reduced outages/impacts to customers from outages caused by extreme heat by providing a temporary back up source of power

3.5 Investment Identification

CMP expects future load growth due to electrification as well as intensification of weather events due to climate change, both of which will require substantial investment across its system. These conditions, coupled with an aging electric system, make proper project prioritization a crucial component of grid planning efforts.

CMP capital projects on the distribution, transmission, and substation systems are generally driven by one or more broad category of needs:

- **Asset Condition**: This refers to the physical or electrical condition of an asset. As an asset ages, its condition gradually deteriorates even though routine maintenance may be performed. For example, foundations crack, wooden components degrade, and metallic components corrode. Assets in poor condition are more likely to fail or have reduced capability to perform their designed tasks. Proactive replacement of a poor condition asset can improve system capability and prevent customer outages caused by failure.
- **Capacity Needs:** As system load grows the capability of the electric system to deliver power to downstream customers may be challenged due to system limitations. CMP utilizes long term planning processes to forecast and study future conditions to pro-actively identify areas where system capacity may become constrained.
- **Reliability / Resiliency:** Maintaining a reliable and resilient electric system that is able to absorb or withstand the expected effects of weather is a crucial component of CMP serving its customers. These projects are typically focused on specific areas with poor outage performance.

Asset condition and capacity driven needs are identified during assessments or inspection of CMP facilities that have been part of routine system planning activities for decades. In contrast, the techniques utilized for reliability and resilience planning are newer, rapidly evolving, and are explained in further detail in Section 3.5.1.

When needs are identified CMP seeks to prioritize projects that are "multi-value;" (i.e., projects that make improvements across multiple different areas of need). Fortunately, CMP's new standards, and the resilience recommendations discussed in the CCRP, can often provide benefits across all three categories noted above. For example, rebuilding a distribution line with spacer cable improves asset condition, enhances capacity, and improves reliability and resiliency simultaneously through a single effort.

3.5.1 Reliability and Resiliency Planning

One focus of CMP's project planning efforts is to identify areas of the system that have poor reliability performance, with the key metric being the number of customer outages experienced, commonly referred to as the System Average Interruption Frequency Index (SAIFI.) SAIFI is an annualized value that indicates, on average, how many interruptions per-year that a customer may experience[16]. CMP routinely identifies which areas of the system are exhibiting poor outage performance and designs projects to help improve performance. To aid this, CMP utilizes multiple tools and datasets; recently the company developed and begun to utilize two new tools, the Zone of Protection and the Outage Geolocation tools, to help ensure that system hardening practices are targeting the appropriate areas of the system.

Zone of Protection Evaluation Tool

The new internally developed Zone of Protection tool automatically parses through distribution system topology and recent outage data to identify which circuit portions are experiencing the highest number of customer outages. This tool works by automatically identifying all protective devices (e.g., circuit breakers, reclosers, fuses)

[16] A SAIFI value of 1.0 means that there is 1 outage per customer, per-year. This metric is aggregated across the entire system so it is likely that some customers will experience zero outages in a year while others may experience one or more outages.

and determining each device's Zone of Protection (i.e., the portion of the circuit they are designed to protect from faults.) Next, recent outage data is mapped into each Zone of Protection to identify which specific areas are experiencing the most outages. This tool can help to quickly identify specific circuit locations where the combination of downstream customers and external factors are the most impactful.

This tool allows for engineers to quickly parse through thousands of protective devices to identify which of them has experienced the most outages, and depending on the specific situation, could provide the most benefit from installation of new devices, undergrounding, or other hardening measures.

Outage GeoLocator Tool

Similar to the Zone of Protection Tool, the Outage Geolocator tool provides a unique way for engineers to view and interact with historical outages to help inform reliability planning decisions. The Outage Geolocator tool focuses on individual circuits by mapping where each outage has occurred and noting the cause of the outage. By grouping outages by cause and location, engineers can easily identify what type of solutions may be most appropriate to address the issues that have affected each circuit. For example, if a portion of a circuit has experienced a large number of outages from animal contact, the most effective solution would be significantly different than if the primary cause of outages was due to vegetation contact. Once a potential solution has been identified the tool then allows the engineer to select the outages that would have been mitigated (e.g., installation of animal guards or installation of tree wire) and automatically calculate the customer count and outage duration that would have been mitigated.

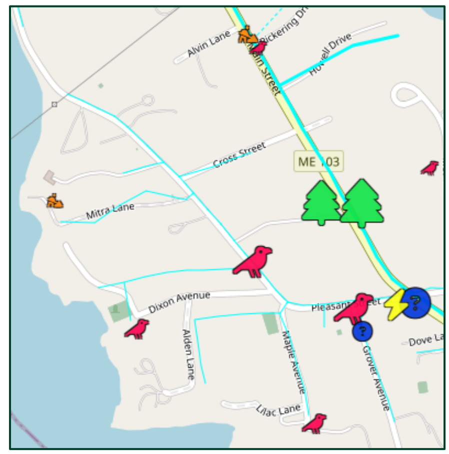


Figure 8 - Outage GeoLocator Tool Example

3.5.2 Benefit-Cost Analysis

Quantifying the degree to which a project may improve the system is a crucial component of a well-planned electric system. The more a project improves one or more of the fundamental characteristics of the system, the more significant the benefit. The benefit-cost analysis (BCA) calculation developed by CMP computes a function that includes inputs for reliability and resiliency improvements, efficiency gained from reduced operations and maintenance activities, and the quantity of customers or demand that may be unserved given a probability of asset failure.

The BCA consists of comparing the calculated benefits and the estimated cost of a project to identify which proposed projects in the capital portfolio may have the highest priority. When a benefits to cost ratio is > 1 it indicates that over its anticipated lifecycle a project is anticipated to deliver more benefits than it costs to construct the project, thereby providing a net benefit to a community or region.

3.6 Implementation of Resilience Measures

Maine is currently expected to undergo a dramatic shift in the quantity of electric power that it uses. This is in large part due to the decarbonization and electrification goals set by the State of Maine. This shift in usage is expected to primarily occur in the heating and transportation sectors as the state continues to phase out heating predominantly provided by the transportation of oil and gasoline.

As this shift occurs, CMP's electric system will need to be upgraded to increase its capability to meet the future needs of its customers. Upgrading CMP's distribution system through the utilization of more reliable and resilient equipment and construction standards will take a considerable amount of time and cost; performing this work alongside other system needs enables CMP to gradually enhance all facets of its system's capability through multi-value projects. The initiating need for some of those projects may be to target areas of particularly poor reliability, or to build capacity for customer electrification – but in either scenario the use of updated standards, including expanding the use of spacer cable, fiberglass crossarms, more robust poles, etc., allows CMP to efficiently build a robust system in a cost-effective manner.

CMP's routine planning, climate planning, and the recently filed Integrated Grid Plan each help to demonstrate a vision for a potential future electric system in Maine and identify what may be necessary to meet statewide energy goals, while also providing reliable and resilient electric service.

4. Operational Resilience Measures

While physical resilience measures focus on hardening assets against climate-related hazards, operational resilience measures ensure that the systems, processes, and people can continue to function effectively under stressed conditions expected to be exacerbated by climate change. Section 4 and the following subsections outline the potential strategies that can enhance CMP's ability to anticipate, respond to, and recover from disruptions and help to ensure the Company's ability to deliver reliable and resilient electric service in an increasingly uncertain future, exacerbated by the impacts of climate change.

4.1 Vegetation Management

Vegetation contact is the leading cause of outages on CMP's system; accounting for more than 60% of total outages from 2022-2024. Impacts from climate change are anticipated to exacerbate this in a variety of ways, leading to increased customer outages, barring CMP's investment in resilience and reliability improvements:

1. **Increased intensity of storm events and wind** may increase the likelihood of trees contacting grid infrastructure.
2. **Increased flooding** (both inland and coastal) can create conditions that can weaken trees, causing hazardous conditions.
3. **Increases in temperature** can lead, and in some instances have already led, to changes in growing degree days, leading to longer growing seasons and denser vegetation.
4. **Chronic changes to environmental conditions**, e.g., potential for drought, additional atmospheric carbon, water, etc., leading to changes in vegetation growth patterns and tree health.
5. **Invasive species** spreading, or being introduced, to the CMP service territory (e.g., Emerald Ash Borer or Hemlock Wolly Adelgid) and damaging tree health.
6. **Changes in tree species location**; climate change is expected to cause an expansion or shifting of the locations where tree species regularly are found, which may lead to trees which are unsuitably adapted to a further north climate, risking additional tree mortality.
7. **Wildfire conditions may also increase,** and vegetation near the ROW greatly increases the risk of fire-related damage.

Existing Vegetation Management Program Details & Performance

Vegetation management plays an essential role in protecting grid infrastructure from multiple extreme weather/climate hazards by limiting potential contact between vegetation (e.g., trees) and utility assets, including but not limited to poles and overhead conductors. Vegetation management is the monitoring, trimming, and removal of potentially hazardous vegetation along the utility's right-of-way (ROW) to reduce the risk of vegetation-related outages. CMP's vegetation management plans are primarily comprised of four main programs that contribute across a variety of management applications and timeframes:

1. **Cycle Maintenance Program** focused on trimming in an area around each section of CMP's 22,500 miles of overhead distribution system once every 6 years. The clearance specification includes 15' above conductors, 8' on each side, and 8' on either side of the pole to the ground.
2. **Ground to Sky** (GTS) trimming focused on increasing the clearance between vegetation and the three-phase overhead portions of CMP's distribution system. In the 2022 CMP rate plan this program was configured to cover CMP's entire service territory over a 20-year period. This clearing specification calls

for 8' on either side of the outside-most energized conductors extending from the ground through the tree canopy.

3. **Enhanced Work** program designed to target specific areas for vegetation management outside of the routine maintenance programs including Hazard Trees, Hot Spots (i.e., specific areas where accelerated vegetation growth may cause an emergent issue) and Maintenance Incidental.[17]

4. **Risk Tree** (increased Hazard Tree) addresses tree failure risks from dead, deteriorating, diseased, or insect-infested trees, including trees outside the utility ROW, which have a high potential to fail and cause damage to CMP facilities.

While CMP's vegetation management program has helped mitigate customer outage frequency from tree-related events, there has been gradual increase in tree-related outages over time. Due to the challenges presented by climate change discussed at the beginning of this section, it is anticipated that this trend of increased vegetation-related outages will continue over time. Existing vegetation programs may be unable to keep pace with an increase in tree related hazards and, consequentially, outage rates could increase. Enhancing vegetation management programs through increased investment in staffing, equipment, and planning will help bolster CMP's resilience to a variety of climate hazards including storm events and wind, extreme precipitation, and wildfires.

Table 16 - Tree Related Interruptions

Year	Total Tree-Related Customer Interruptions
2019	418,737
2020	525,188
2021	547,298
2022	529,825
2023	575,067
2024	587,862

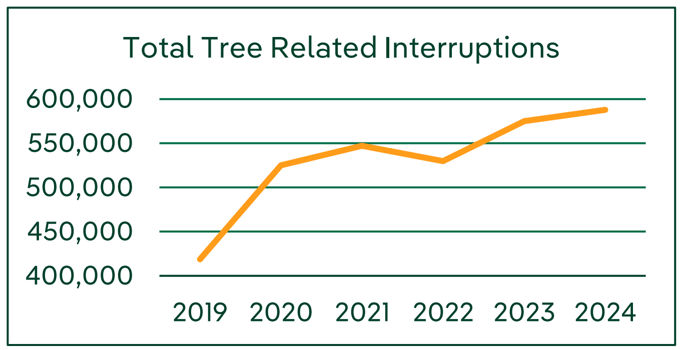


Figure 9 - Tree Related Interruptions

Vegetation Management Performance

To identify areas for improvement of its vegetation management processes and help adapt them to Maine's climate future, CMP performed an analysis to identify a more precise origin of vegetation contact that leads to outages, as well as a performance analysis of areas where GTS trimming has been performed to gauge its effectiveness.

As outages occur on the system, CMP keeps detailed records of the outage cause and likely origin of debris that initiates contact leading to outages. For vegetation, this categorization is frequently divided into two categories contact from vegetation that originates from either inside or outside of the Cycle Maintenance trimming area, denoted as "Tree Inside ROW" or "Tree Outside ROW." The following table summarizes the non-storm tree-related outages experienced on CMP's distribution system from 2019 to 2024. The use of non-storm statistics is important as it provides a degree of normalization of statistical data for weather severity.

Table 17 - Vegetation Management Performance Information

Year	Tree-Related Customer Interruptions	Inside ROW Interruptions	Inside ROW%	Outside ROW Interruptions	Outside ROW%	Other Tree Interruptions	Other-%
2019	418,373	12,675	3%	401,564	96%	4,134	1%

[17] The Maintenance Incidental portion of the Enhanced Work is used when trees are identified that need to be removed immediately outside of the standard cycle maintenance program in lieu of making a second trip to remove the hazard.

2020	525,188	23,427	4%	497,476	95%	4,285	1%
2021	547,298	31,798	6%	510,278	93%	5,222	1%
2022	529,825	19,130	4%	499,365	94%	11,330	2%
2023	575,067	42,582	7%	532,485	92%	4,675	1%
2024	587,862	24,372	4%	563,490	92%	25,812	4%

Even while CMP has been performing its suite of vegetation management programs during the analyzed timeframe, the number of annual customer interruptions caused by vegetation contact over this period has on average *increased* by nearly 28,000 customer interruptions each year. The year over year increase in vegetation-related outages in this weather-normalized dataset suggests that existing vegetation management practices may not be sufficient to keep up with vegetation growth, infestation, and decay occurring throughout CMP's service territory.

Identifying Vegetation Management Improvements

To enhance the existing vegetation management program and allow it to build resilience to severe weather events, CMP analyzed the origin of outages to identify what improvements could be made. The previously included table shows that outages caused by vegetation contact originating from outside of the ROW (i.e., the area where CMP's is not able to easily manage vegetation) is causing an overwhelming majority of these outages; accounting for roughly 94% of all vegetation-related outages. These outside ROW outages are generally caused either through vegetation falling from the canopy area above distribution lines, or trees falling horizontally and contacting the distribution lines. Based on field observations of these outside ROW outages, it is estimated that roughly 50% of the outside ROW outages are caused by overhead canopy branches falling into the lines.

The use of GTS trimming permits utilities to expand the area where they can manage vegetation to include an additional area on either side of the energized conductors all the way through the overhead canopy, a major source of vegetation contact. To date, CMP has performed GTS trimming across a small subset of its distribution circuits and performed an analysis to identify the effectiveness of this program. As with other reliability and resilience improvement projects, accumulation of post-project outage data is necessary to perform comparisons of historical performance. For this analysis, CMP utilized storm and non-storm data for six circuits located in the Alfred division that had previously had GTS trimming performed in a timeframe that could aid in evaluations.

Table 18 - Ground to Sky Outage Performance Improvement:

Customers Affected by Vegetation-related Outages

Storm Included

Circuit	2023 Customers Affected	2024 Customers Affected	2025 YTD Customers Affected
605D1	11,489	14,617	829
629D1	5,906	2,721	94
632D1	18,722	13,372	2,391
632D2	9,287	7,064	1,319
634D4	6,756	5,953	18
695D1	4,404	4,146	1,392

Storms Excluded

Circuit	2023 Customers Affected	2024 Customers Affected	2025 YTD Customers Affected
605D1	3,236	6,997	829
629D1	3,533	640	93
632D1	11,528	7,670	2,320
632D2	2,918	4,295	919

634D4	1,941	2,415	17
695D1	2,262	2,257	120

In addition to this recent GTS work in Alfred, CMP analyzed post-resiliency performance of two circuits dating back to 2019 that had GTS trimming performed as part of targeted resiliency projects. These two circuits experienced a **72% reduction** in customers affected from 2019 to 2024. This data, while currently only available across a small sample size, is largely corroborated by experiences of other utilities across North America. A 2019 study conducted by the University of Connecticut studied the efficacy of GTS trimming. Statistical analysis performed in the study found that GTS trimming reduced outages between 49% and 65%. In addition, this study included analysis using an outage prediction model that considered the variability of storm intensity, finding significant outage reductions of 16% to 48%.[18] Given the success that CMP and others have had with GTS trimming, CMP is confident that the GTS program is one of the most effective ways to reduce outages and storm-restoration costs.

Resilience Recommendation

Vegetation-related outages affecting CMP customers have been increasing annually, a trend that the CCVS report indicates is likely to continue—and potentially worsen—in the future. Proactively removing vegetation hazards is essential to improving the resiliency and reliability of CMP's system. The GTS program significantly enhances CMP's ability to manage and eliminate outage-causing vegetation. To maximize its benefits, the program should be accelerated from its current 20-year timeline to a much shorter timeframe, enabling customers to experience improved service reliability sooner.

Additionally, the CCVS highlights that climate change is expected to increase the risk of vegetation disease and infestation, either by intensifying existing threats or introducing new ones. While accelerating GTS trimming will help mitigate these risks, increased focus is also needed for the removal of hazard trees—often weakened by disease or infestation—that emerge between regular maintenance cycles. This targeted vegetation management will help reduce outages and lower storm restoration costs.

4.2 Workforce safety

Maintaining safe conditions for its workforce is paramount to CMP. CMP works to develop rules and standards, provide resources and trainings, and invest in necessary equipment to ensure its workforce is kept safe from a large variety of hazards they may encounter on the job. The CCVS found that as multiple climate hazards are projected to intensify across the service territory, this will likely change the threat landscape requiring workers to be increasingly aware of potential hazards that may not have been previously impactful. In addition, CMP's workforce may experience an increasing number of events occurring in a short time frame, which can lead to worker burn out and exhaustion affecting workforce safety.

4.2.1 Additional Staffing

As referenced in the CCVS, the expected increase in hazard events due to climate change will likely create conditions that will require more frequent emergency activations and deployment of emergency response crews. Increased emergency activations can lead to overworked staff as storm restoration work can require overtime work, unpredictable hours, and/or deviation from blue-sky roles. Additional operations staffing can help mitigate this problem, preventing staff burnout, increasing retention, preventing potential mistakes that occur when staff are fatigued, and potentially preventing delays or interruptions that may result from staff not being able to perform the duties of their blue-sky roles.

[18] Cerrai, D., Watson, P., & Anagnostou, E. N. (2019). Assessing the effects of a vegetation management standard on distribution grid outage rates. *Electric Power Systems Research, 175*, 105909. https://doi.org/10.1016/j.epsr.2019.105909

In particular, additional staffing of field workers, such as line workers and emergency response teams, can also prevent burnout of these workers that may be required to respond to increasingly frequent and widespread outage events, and may also improve restoration times. Importantly, increasing staffing levels of internal CMP line workers will help limit dependence on contracted crews, which can often be expensive and/or whose availability may be limited as climate change causes more outage events across New England and the rest of North America.

4.2.2 Protecting Workers from Climate Impacts

CMP maintains strict standards to keep workers safe from a variety of weather and occupational hazards; investment in new PPE and technology to monitor conditions, as well as continuous review of safety standards and work protocols can help minimize the risks workers face caused by a changing climate. For example, heat historically has not been major threat for CMP staff; however, the CCVS found that temperatures could more frequently reach hazardous levels in the southern part of the service territory by midcentury and the rest of the service territory by late century. Future investment in OSHA-recommended heat-related PPE, such as heat dissipating uniforms and cooling vests, and monitoring equipment, such as handheld thermometers, alongside continued education and training can help maintain worker safety against this hazard and other emerging conditions. For example, implementation of additional guidance, standards, and training for CMP staff and contractors around safe working conditions and how and when to seek refuge to avoid injury from climate hazards (e.g. when to cool off to avoid heat exhaustion or heat stroke) can also greatly improve worker safety and help prevent injury related to climate hazards.[19]

Figure 10 - Example of OSHA Heat Illness Prevention Poster

4.3 Load Forecasting

Load forecasting personnel at CMP are responsible for projecting both the peak and base loading of the CMP system. Climate change is expected to impact system loading as increases in ambient temperature will likely lead

[19] Occupational Safety and Health Administration. (n.d.). *Heat - Engineering Controls, Work Practices, and Personal Protective Equipment*. U.S. Department of Labor. Retrieved May 28, 2025, from https://www.osha.gov/heat-exposure/controls

to increased air conditioning usage, potentially resulting in the emergence of a localized summer peak particularly in the warmer, urban parts of the service territory. Climate change may also result in unpredictable temperature extremes, ranging from heatwaves to cold snaps, which may result in deviations from historical loading assumptions. Simultaneously, load is expected grow from increased electrification because of efforts to reduce greenhouse gas emissions, as well as the potential addition of high-demand customers, such as data centers or industrial customers.

The forecast for the entire state of Maine's 90/10 peak demand developed by the Independent System Operator of New England (ISO-NE) and included in the Capacities, Energy, Load and Transmission (CELT) report is shown below in Figure 15. This forecast shows the weather driven peak with a 10% chance of occurring in the listed year. Importantly, it shows the emergence of Maine as a winter peaking region due to the increased usage of electric heating and transportation (orange and blue bars, respectively.) It is noteworthy that the increase in demand due to electrification is expected to be orders of magnitude more than the increases due to the direct effects of climate change. Due to the summer peak demand being historically higher than the peak experienced during winter, many parts of the Maine electric system were limited only on their ability to deliver power during warmer summer months. However, this is projected to change drastically throughout the 21st century. The 10-year forecast shown below shows an increase in the winter demand of more than 1,000 MW; under previous usage behavior this amount of load growth is akin to adding hundreds of thousands of customers to the state of Maine in less than 10 years. As ISO-NE's CELT forecast is revised each year it is likely that the timing and magnitude of peak demand will change; but given Maine's aggressive state goals for electrification much of these changes are expected to be realized at some point in the future. The specific impacts and how to best resolve them are not a primary focus of the CCRP and are instead being handled through a variety of other study efforts; however, the effect of this growth in demand is an important consideration when designing a resilient system that meets expected future needs.

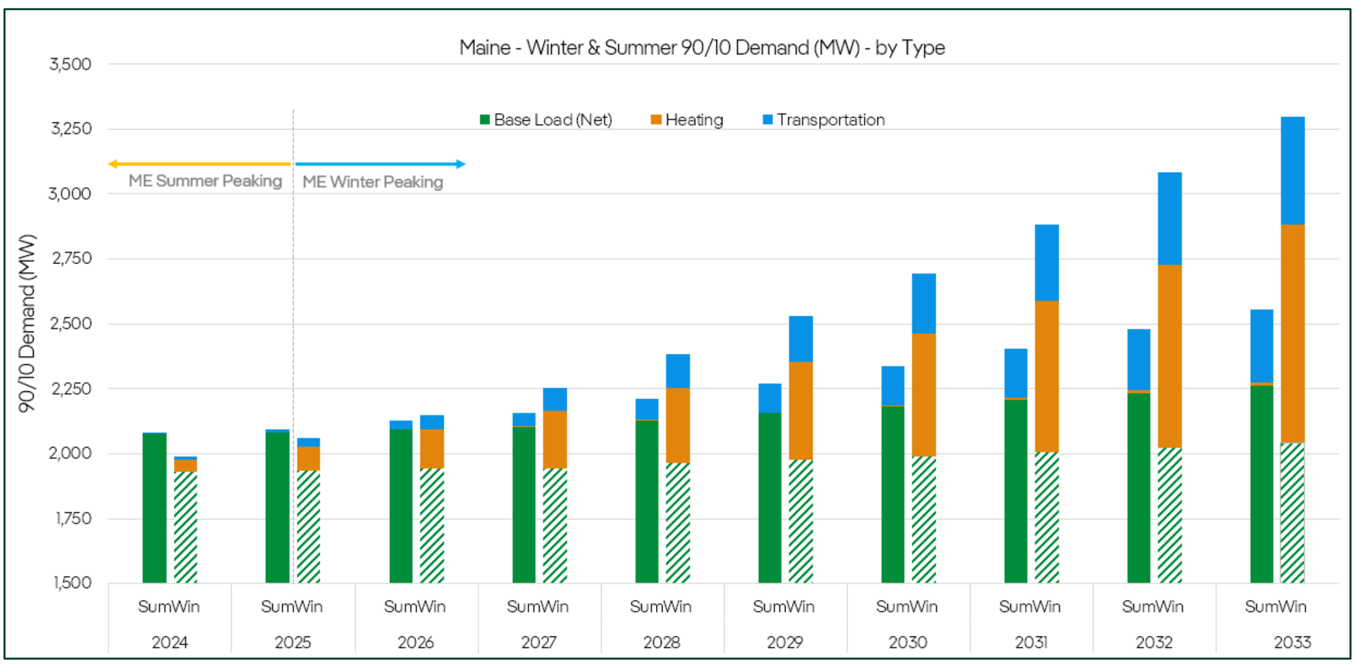


Figure 11 - ISO-NE 2024 CELT Forecast for Maine

Currently, CMP's load forecasting processes utilizes historical and present-day weather data to forecast peak loads. While the current forecast uses historical data with impacts from climate change implicitly included, incorporating future temperature projections due to climate change into load forecasting models can increase the ability to accurately forecast load and account for changes in temperatures due to climate change and can help inform future planning efforts to ensure that system capacity can accommodate future load growth.

4.4 Facility Ratings

Facility ratings are the maximum operating limit, typically expressed in amperes, that an asset can safely supply given specific ambient conditions like temperature. At CMP, ratings are determined by the Ratings and Modeling group and apply to all transmission lines, transformers, and other devices connected in series from the transmission system all the way to the customer meter connection. Of the hazards included in the CCVS, temperature was the only hazard identified as impactful to the calculation of facility ratings. As noted in the CCVS, warming temperatures, especially in the southern parts of CMP's service territory, may exceed the current assumptions used by CMP's assets, leading to a reduction in the capacity of lines and transformers, limiting electrification and future load growth. In the most extreme circumstances, outages could be caused by line sag/clearance violations, load shedding, or equipment failure. Additionally, climate change is expected to generally increase variability in weather trends and deviations from historic norms, which can also lead to unseasonably warm or cool temperatures, in addition to extremes.

Traditional asset rating systems use assumed seasonal ambient temperature maximums to calculate facility ratings. These rating calculation methods do not allow for nuanced adjustments to real-time temperature conditions. This lack of capability to adjust may at times require operators to limit capacity out of caution or risk asset failure. To address these risks there are multiple options; currently CMP is actively pursuing one method, Ambient Adjusted Ratings (AAR). There is a second methodology, Dynamic Line Ratings, which are more costly to implement and have been traditionally reserved for facilities that may be constraining renewable generation. Finally, it is possible to increase the underlying ambient temperature specifications utilized when calculating facility ratings to match Maine's future climate. At present this is not necessary but will continue to be evaluated into the future.

4.4.1 Ambient Adjusted Ratings

Ambient Adjusted Ratings (AAR) is the practice of adjusting facility ratings based on real-time temperature data. This allows assets to be more accurately rated for real-time conditions, increasing the ability to adapt to temperatures that deviate from traditional historically based assumptions. Federal Energy Regulatory Commission (FERC) Order 881 requires utilities to adopt AAR for transmission lines. CMP is in the process of implementing rating practices that utilize AAR and are compliant with this order. Continuing to invest in this rollout is critical for maintaining compliance and building reliability.

In day-to-day operations, using real-time ambient temperature data allows transmission line ratings to reflect actual conditions rather than conservative historical assumptions. This often results in higher ratings when temperatures are cooler than the assumed baseline, improving system efficiency. Conversely, during periods of extreme heat, AAR may lower ratings compared to static values. This reduction is intentional and beneficial—it helps prevent conductors from exceeding their maximum operating temperature and reduces the risk of excessive sag. By dynamically adjusting ratings, AAR not only optimizes capacity under normal conditions but also enhances safety and resilience during hot weather events.

4.4.2 Dynamic Line Ratings

Dynamic Line Ratings (DLR) are similar to AAR in that they utilize real-time weather data to inform facility ratings, but unlike AAR, they consider conditions other than just temperature to measure weather, sense tension, temperature, and sag on lines, and communicate conditions back to system operators to adjust the line rating. For example, wind, solar heating intensity, and real-time measurements of line tension or sag are commonly measured to enable DLR. The incorporation of these additional factors can further refine the accuracy of the rating calculation and has been proven to allow for increased transmission capacity. A partnership program between the New York Power Authority (NYPA) and the U.S. Department of Energy to develop best practices for

DLR found that DLR can allow for 5-25% additional capacity in certain conditions.[20] Additionally, if more accurate information of current conditions is available, then it reduces the likelihood of asset damage or outages that can be caused during extreme heat conditions when current-carrying equipment such as transmission lines and transformers are subjected to extreme conditions because DLR can adjust to that more accurate data. In October of 2024, the Maine Governor's Energy Office (GEO) was selected for a federal grant to work with CMP and Versant Power to deploy DLR on select transmission lines to enhance renewable generation capacity[21].

4.5 Spare Equipment

The analysis presented in CMP's CCVS indicates a likely increase in a variety of extreme weather conditions that can cause damage to CMP assets. Storm events and wind, a leading cause of asset damage, are expected to increase across the service territory in frequency and intensity (and already have in recent years); other weather events that can also damage assets are also expected to increase, including extreme heat, which can shorten the typical useful life of many assets, or in extreme conditions cause sudden failure; and flooding, caused by precipitation, storms, and sea level rise, can cause sudden asset failure or damage through corrosion or scouring. These events may necessitate the replacement of whole assets or parts to facilitate repairs. Having access to a stock of spare equipment is critical to rapid service restoration and achieving reliability targets. The importance of having spare equipment is heightened by supply chain considerations. Many essential assets, such as substation transformers, pad mount transformers, and certain class wooden distribution poles are already difficult to source and sometimes have long lead times to procure. These supply chains may become more constricted as extreme events caused by climate change increase the demand for replacement assets, while also potentially disrupting logistics and manufacturing. Strategic reserves of essential equipment are critical for CMP to advance their climate resilience.

4.6 Customer Outreach

Establishing effective outreach and communication with customers is critical to bolstering resilience at CMP and in the communities it serves. Customer outreach can help prevent outages through the use of programs like energy efficiency, and also help customers prepare, respond to, and recover from outages.

Energy efficiency programs, such as Efficiency Maine rebates for energy efficient appliances or managed EV chargers, can help reduce overall demand and free up capacity for load growth from climate change or electrification.

Additionally, during, before, and after outage events, communicating with customers is critical to customers' ability to properly prepare for and respond to losses of power. This can sometimes directly impact customer safety, especially for customers that rely on electrically powered medical equipment, or critical facilities such as hospitals, police stations, and fire houses. CMP currently engages with customers on these topics in a variety of media and platforms, including social media, outbound telephone calls, texts, emails, in-person fora, and its website and mobile app. Maintaining and growing these outreach efforts is critical. Effective communication with customers requires a robust outreach program that strives to utilize the following best practices: Increasing investment in proper staffing and resources to facilitate such outreach practices will also greatly bolster CMP's resilience efforts.

[20] U.S. Department of Energy. (2017). Improving efficiency with dynamic line ratings. Department of Energy. Retrieved from: https://www.energy.gov/sites/prod/files/2017/01/f34/NYPA_Improving-Efficiency-Dynamic-Line-Ratings.pdf

[21] https://www.maine.gov/energy/press-releases-firm-grant-announcement-oct-2024

5. Conclusion and Next Steps

The CCRP presents timely, realistic, and actionable resilience measures that help to mitigate the most pressing and immediate risks posed by climate change to CMP and its ability to serve its customers. The selection of these measures was directly rooted in the results of the CCVS and targeted priority vulnerabilities, in particular storm events and wind, which are impactful each year. This report and its findings are a significant step in advancing CMP's climate change planning and directly addressing the impacts of climate change, and intentionally included resilience measures that were attainable and have been proven effective in mitigating climate risk. The measures included in this report have been successfully utilized elsewhere in the industry or have already been implemented in limited areas of the CMP system to improve reliability and address the risks posed by relevant climate hazards.

Of particular note are investments in hardening to storm events and wind through asset-based interventions (i.e., fiberglass crossarms, spacer cable, steel poles, higher class wooden poles, etc.), increased investment in vegetation management to support key programs, such as Ground to Sky trimming, and continuing to invest in staffing across the utility to ensure that CMP is able to successfully manage increased challenges caused by climate change. These investments can improve reliability and resiliency immediately by mitigating impacts of present-day hazards and continue to foster a system resilient to the growing threats of climate change.

CMP will work to implement the resilience measures outlined in this plan through its future investments and grant applications. This will help ensure dedicated funding streams and integration of resilience into capital improvement programs and operational expenditures. CMP will also continue its climate resilience planning efforts by seeking to address longer term and less impactful risks that were identified in the CCVS in future CCRP's and resilience planning efforts. Additionally, CMP will continue studying the potential climate impacts on its system and will adapt its resilience strategies as threat landscapes shift, to maintain and improve resilience and reliability.

CMP is committed to providing safe and reliable power to its customers and to the safety and security of its workforce. Climate resilience planning is central to fulfilling this commitment. To this end, CMP will continue to develop, grow, and integrate climate resilience planning efforts, such as this CCRP, into its broader operations, planning, and investment strategies.