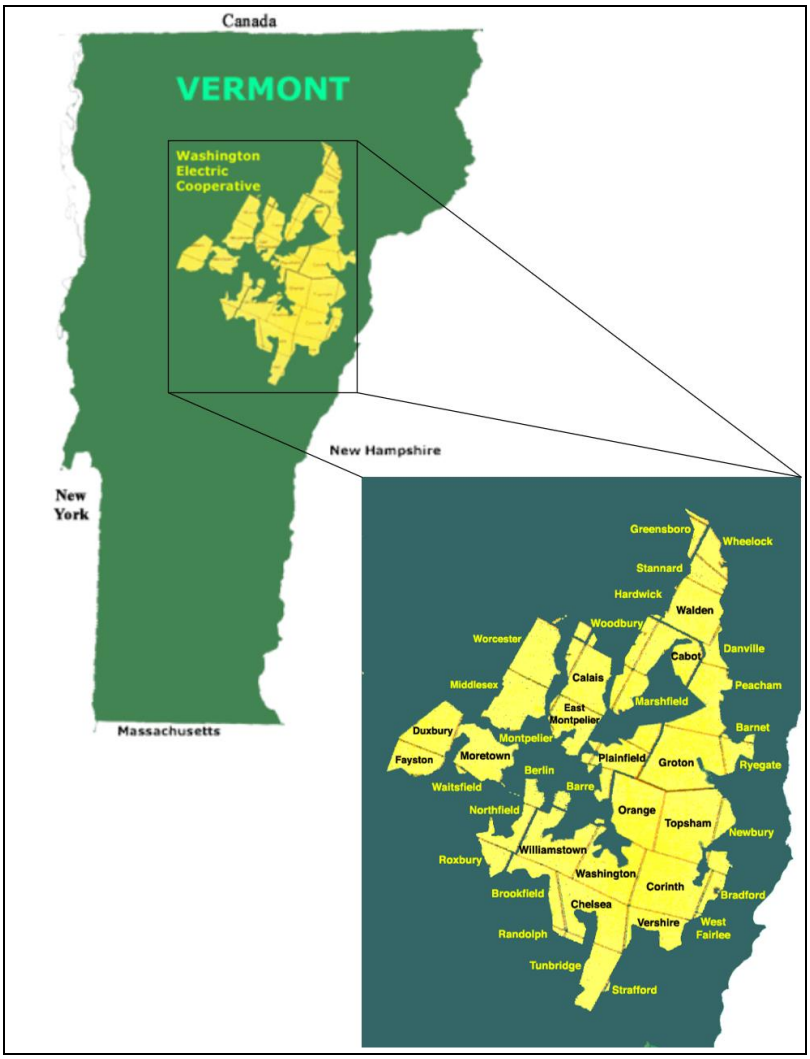
WASHINGTON ELECTRIC COOPERATIVE, INC.

2023 SYSTEM RELIABILITY REPORT

Table of Contents

1. Background

Washington Electric Cooperative served an average of 11,527 members in 2023 via an electrical distribution system that includes 26 miles of WEC-owned transmission line and 1,266 miles of distribution line. The system includes eight distribution substations, seven of which depend on third-party transmission provider Green Mountain Power for service. The remaining substation is served via a WEC owned transmission line interconnected to Vermont Electric Power Company's (VELCO) high voltage substation in Chelsea, VT. WEC's distribution lines are located throughout 41 towns in Central Vermont, covering approximately 2,728 square miles and serve remote locations composed of rural homes, small farms and small businesses. There are approximately 8 service locations per mile of line, many of which are located on unpaved roads in small valleys within the 41 towns.

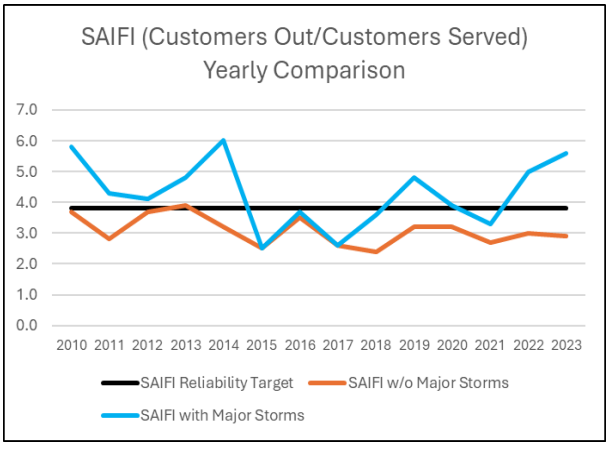


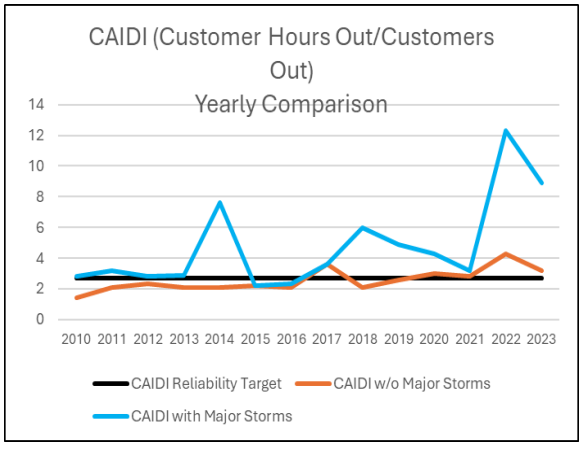
The distribution system was constructed during a time when much of the land in Vermont was open fields and pasture that has since grown in. Vermont lies within a biological transition zone between the northern boreal forest to the southern deciduous forests. The northern hardwood mix of beech, birch, and maple dominates Vermont's forests, accounting for 71% of the forest cover. The remote location of the lines and abundance of fast-growing species such as red maple, poplar and white birch coupled with severe weather events, significantly increases the exposure of the lines to tree-related outages which can only be combated through hardening of the lines and increased maintenance clearing.

WEC records data associated with all power outages occurring over the calendar year and provides a year end Service Reliability Report to the Vermont Public Utilities Commission as required by Rule 4.900. To compare trends more effectively in WEC's reliability performance and associated efforts to make improvements in those performance areas, this report generally excludes those outages associated with severe weather events determined to be "Major Storms" as defined in WEC's Successor Service Quality and Reliability Performance Plan. However, a distinctive increase in frequency and severity of these weather events is significantly contributing to a decline in service reliability across most of WEC's service territory and therefore must be taken into consideration when analyzing service reliability and planning for improvements. While it is true that severe weather events do create conditions that exceed the design capability of the electrical delivery system, it remains obvious that design criteria and maintenance schedules must be improved to counteract the increased severity of these events.

2. Reliability Summary:

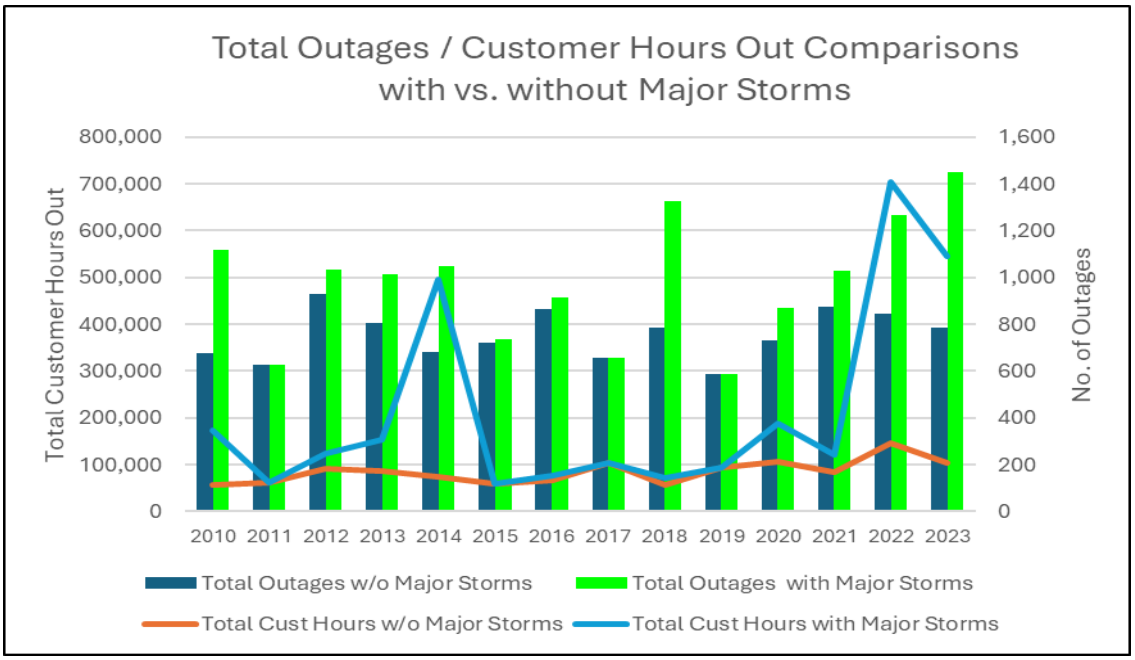
The SAIFI and CAIDI performance measure targets established in WEC's Successor Service Quality and Reliability Plan are **3.8** and **2.7** respectively. The SAIFI and CAIDI indices for 2023**,** exclusive of major storms, were **2.8** and **3.2** respectively. The SAIFI and CAIDI indices**,** exclusive of major storms, have averaged 2.8 and 3.4 over the last three years and the 10-year averages are 2.9 and 2.8 respectively.





3. Outage Totals/Customer Hours Out Summary:

In 2023 WEC experienced 787 separate outages, exclusive of major storms, on the distribution system compared to 843 in 2022. The rolling 3-year average for total number of outages, exclusive of major storms, is 835, and the rolling 10-year average is 753. The total number of consumer-hours-out in 2023, exclusive of major storms, was 103,876 compared to 145,304 in 2022. The rolling 3-year average of consumer-hours-out, exclusive of major storms, is 111,220 and the 10-year rolling average is 89,264.

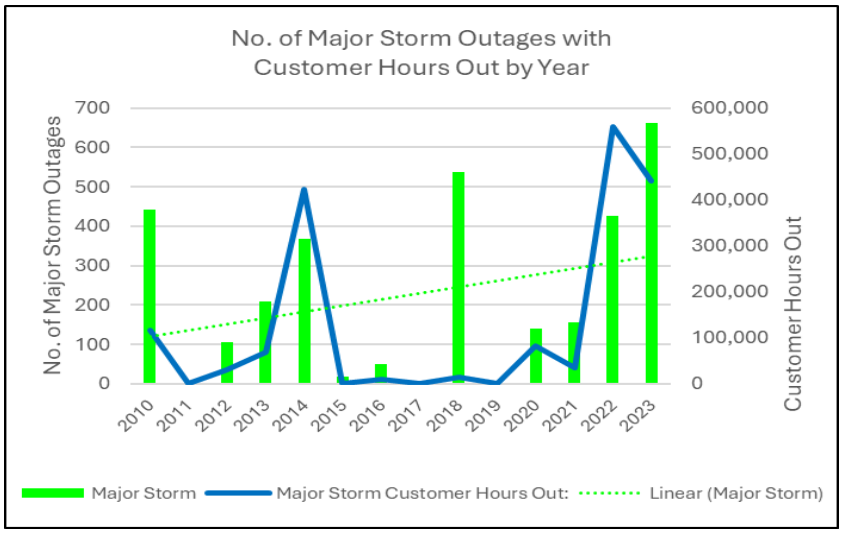


4. Impact of Major Weather Events:

During 2023, WEC experienced four severe weather events that met the criteria for Major Storm. Major Storms are defined in WEC's Successor Service Quality and Reliability Performance Plan as:

1. Extensive mechanical damage to the utility infrastructure has occurred;
2. More than 10% of the customers in a service territory are out of service due to the storm or the storm effects; and
3. At least 1% of the customers in the service territory are out of service for at least 24 hours.

In total, these four major storms almost doubled the number of regular outages WEC experienced in 2023 with an additional 662 outage events involving 29,294 customers out and 441,839 customer-hours-out.



Major Storm Details:

March 14, 2023: This severe weather event produced 8” to 14” of wet heavy snow in much of WEC’s territory and snow totals approaching 40” in southern Vermont. Damages included broken poles and wires downed due to heavy snow loading, winds and falling trees.

Duration: 3/14/23 at 04:00 through 3/16/23 at 18:00
Peak: 3,370 out
Broken poles: 2

July 9, 2023: This severe weather event featured 3” to 9” of prolonged heavy rainfall across Vermont resulting in catastrophic flooding in several parts of WEC’s service territory including several areas where poles, wires and secondary roads were washed away. Several outage locations were not accessible for days due to washed out roads and bridges.

Duration: 7/9/23 at 16:40 through 7/14/23 at 13:00
Peak: 2,135 out
Broken poles: 13

November 27, 2023: Over 8” of heavy wet snow brought down trees which brought down wires and broke poles across WEC’s territory. WEC requested mutual aid for 24 additional line crews and ROW crews to help with outage restoration.

Duration: 11/27/23 at 01:30 through 11/30/23 at 16:00
Peak: 7,260 out
Broken poles: 5

December 3, 2023: This severe weather event seemed to be concentrated over WEC's territory and central Vermont with 4" to 6" of heavy wet snow and winds damaging poles and wires. WEC received restoration help from 15 additional Mutual Aid line crews and ROW crews for this event.

Duration: 12/3/23 at 19:00 through 12/6/23 at 14:00
Peak: 4,824 out
Broken poles: 5

NOTE: Although they did not qualify as Major Storms in 2023 WEC territory would experience two more events in December that damaged WEC's infrastructure including an additional seven broken poles. In total, WEC replaced 32 broken poles in 2023 due to the increased severity of weather events Vermont is experiencing.

December 10, 2023: This severe weather event, for the second weekend in a row, seemed to be concentrated over WEC's territory and central Vermont with an additional 4" to 6" of heavy wet snow and winds. WEC received restoration help from one additional Mutual Aid line crew.

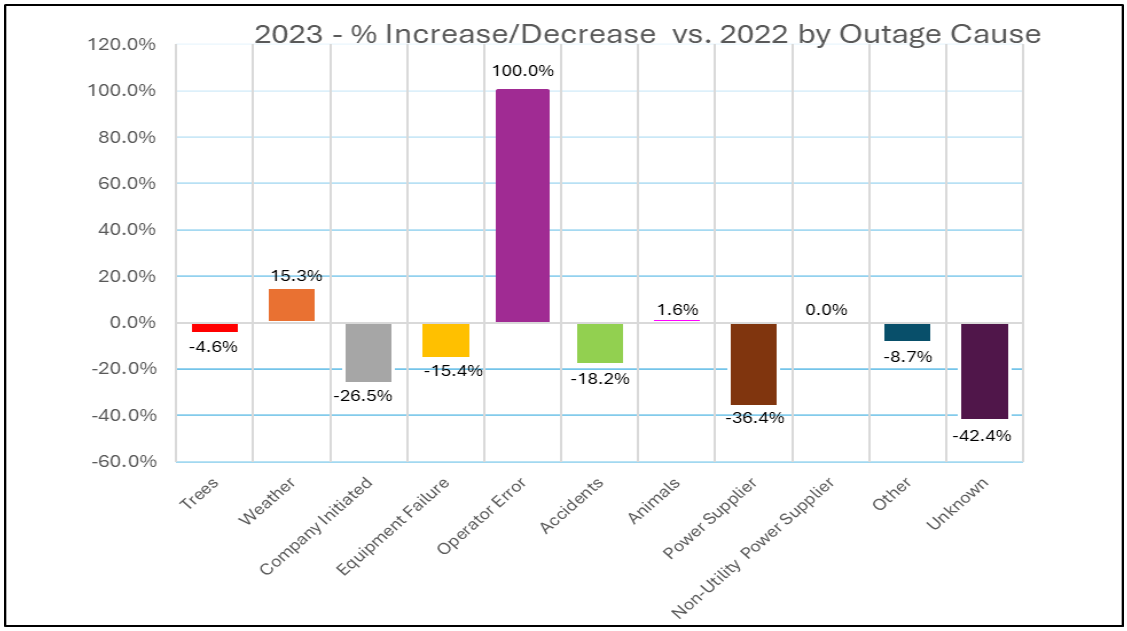
Duration: 12/10/23 at 16:00 through 12/12/23 at 01:00
Peak: 1,166 out
Broken poles: 3

December 18, 2023: This severe weather event brought heavy rains and high winds gusts between 35-55 MPH to Vermont and parts of WEC's territory.

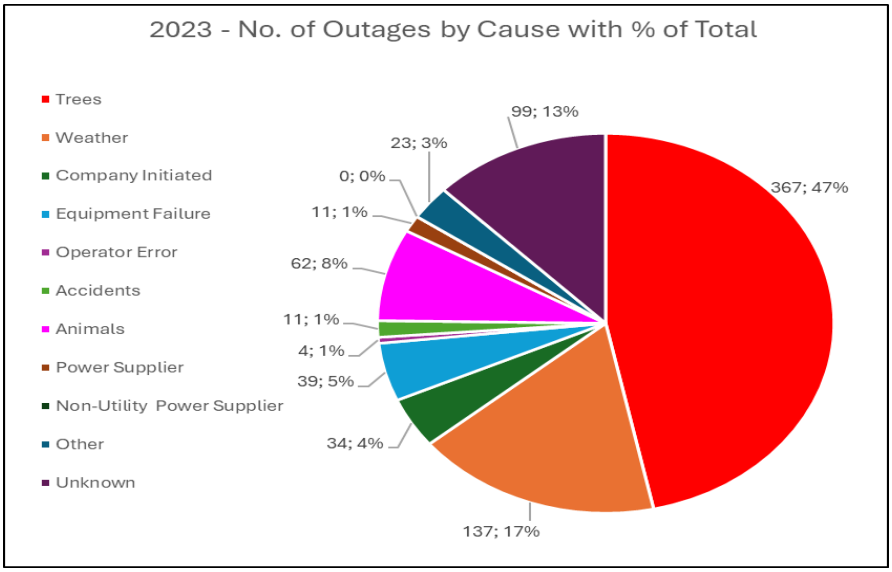
Duration: 12/18/23 at 07:00 through 12/19/23 at 12:00
Peak: 1,552 out
Broken poles: 4

5. Outage causes and assessments:

Most outage categories in 2023 had either slight increases or decreases over 2022 with seven categories having decreases, three having slight increases, and one category, Operator Error, increasing with four outages in 2023 over zero in 2022.



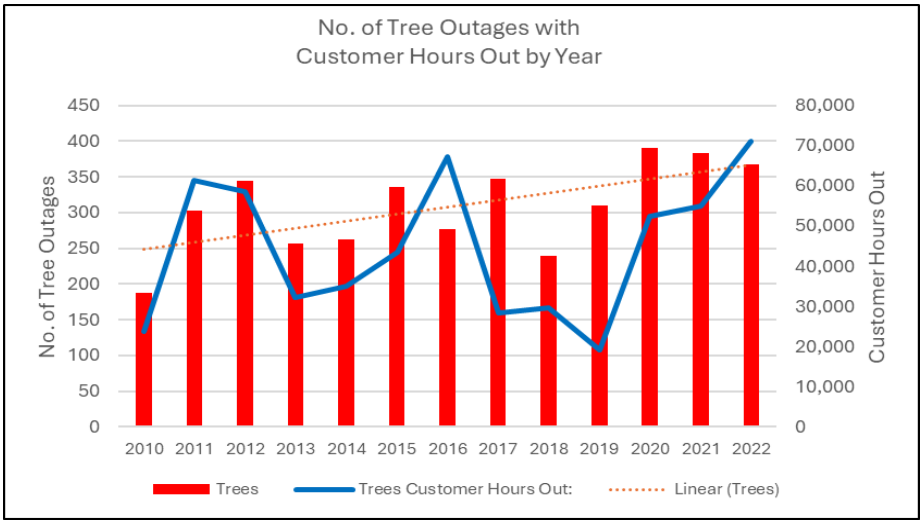
The top three outage categories that WEC experienced most during 2023 are: Trees = 367 outages; Weather = 137 outages; and Unknown = 99 outages. These categories were also the top three in 2022.



6. Outage Category Assessment

6.1 Tree Outages

At 47% of total outages, trees continue to be the largest cause of outage events on WEC's distribution system. In 2023, WEC experienced 367 tree outages with 71,139 member hours out compared to 384 and 55,033 member hours out in 2022. The three-year average for tree outages is 380 and 59,519 member hours out and the 10-year average is 317 and 43,328 member hours out.



In 2023, WEC completed a study of tree outages that occurred on the distribution system over a six-year period from 2017 through 2022 to determine the worse performing substations and circuits.

Sub-Feeder	Miles of Line	No. of Meters	Sub-Feeder	# of Outages
EM-CA	193	277	**1-1**	128
EM-PL	222	610	**1-2**	325
EM-MC	124	888	**1-3**	227
JB	8	80	**2-1**	48
MK-PE	77	1443	**3-1**	172
MK-CO	202	557	**3-2**	512
WD-HV, WD, PE	56	465	**4-1**	94
WAL-GRE	67	507	**5-1**	127
WAL-ECA	64	459	**5-2**	150
WAL-WHP	49	314	**5-3**	123
JC-TO	56	351	**8-1**	113
JC-CH	67	1378	**8-2**	204
JC-NO	163	453	**8-3**	368
MO-MI	62	878	**9-1**	192
MO-MOCO	25	163	**9-2**	81
MO-FA	96	504	**9-3**	216
MC-NCS	42	298	**10-1**	93
MC-MI	72	607	**10-2**	217
TU-CO	109	267	**11-1**	320
TU-ST	40	705	**11-2**	121
TU-BR	49	240	**11-3**	140
21 Feeders	1843	11444	**Grand Total**	**3971**

Results of the study identified the top four worst performing substation/feeders are:

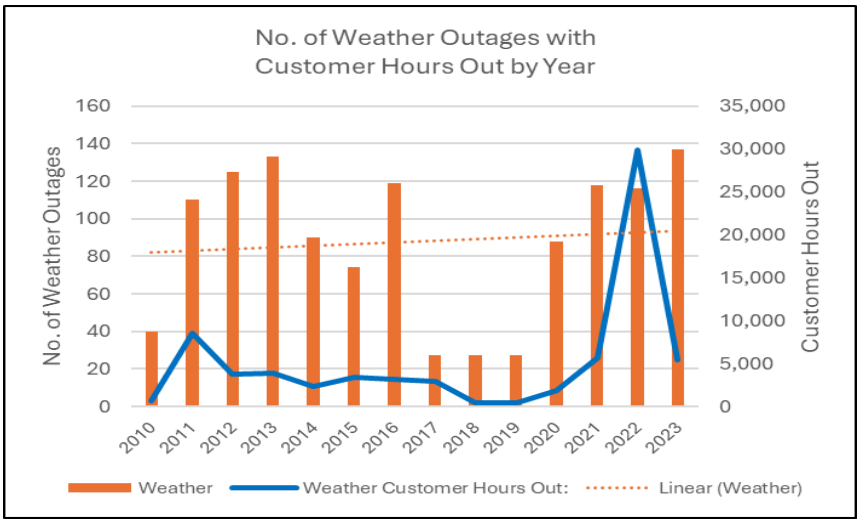
1. Mt. Knox substation, #3 Corinth Feeder
2. Jackson Corners substation, #3 Northfield Feeder
3. East Montpelier substation, 2 Plainfield Feeder
4. So. Tunbridge substation, #1 Corinth Feeder

Note: The Jackson Corners, Mt. Knox and East Montpelier substations also rank as the top three in terms of total number of outages, number of meters served and miles of line.

Sub	Total No. of Outages	Outage Rank	Total Miles of Line	Miles Rank	Total Meters	Rank Meters
EM	680	3	539	1	1775	3
JB	48	9	8	9	80	9
MK	684	2	279	3	2000	2
WD	94	8	56	8	465	8
WAL	400	6	180	6	1280	5
JC	685	1	286	2	2182	1
MO	489	5	183	5	1545	4
MC	310	7	114	7	905	7
TU	581	4	198	4	1212	6

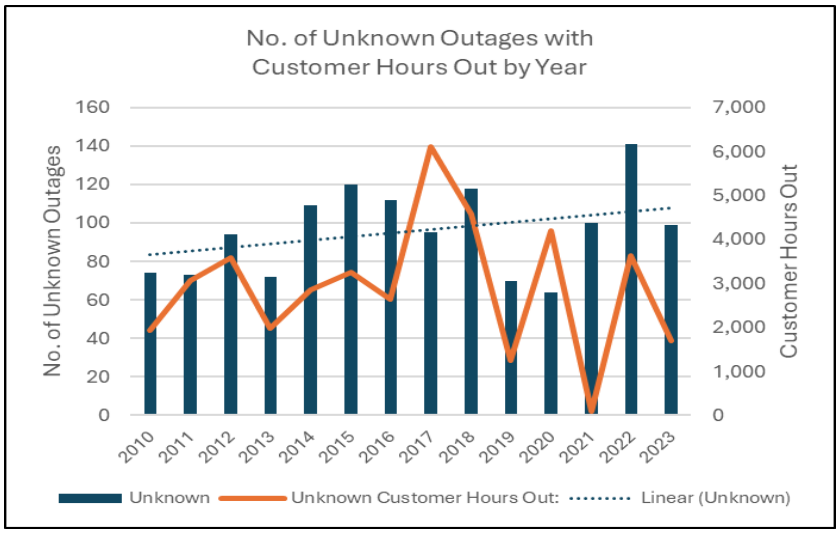
6.2 Weather Outages

At 17% of total outages, weather was the second highest cause of outage events on WEC's distribution system in 2023. WEC experienced 137 weather related outages with 5,474 member hours out compared to 116 and 29,842 member hours out in 2022. The three-year average for weather outages is 124 and 13,645 member hours out and the 10-year average is 82 and 5,536 member hours out.



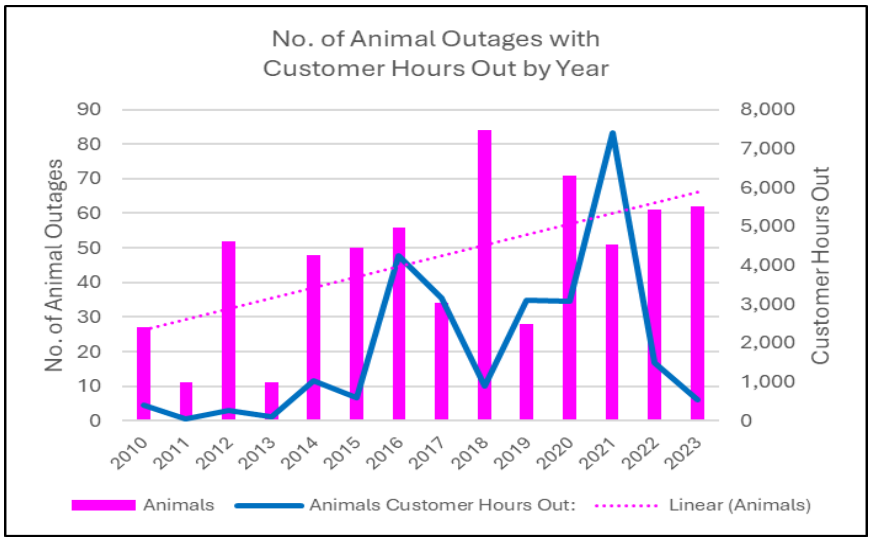
6.3 Unknown Outages

Unknown outages ranked 3rd in 2023 at 17% of total outages. In 2023, WEC experienced 99 unknown outages with 1,705 member hours out compared to 144 and 3,623 member hours out in 2022. The three-year average for unknown outages is 113 and 1,806 member hours out and the 10-year average is 103 and 3,029 member hours out.



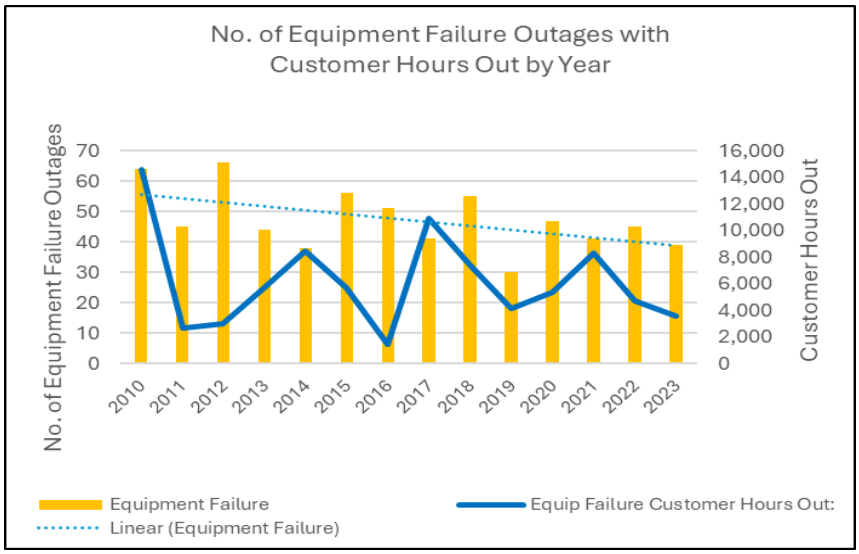
6.4 Animal Outages

Ranked 4th, animal outages were 8% of total outages. In 2023, WEC experienced 62 animal outages with 525 member hours out compared to 61 outages and 1,499 member hours out in 2022. The three-year average for animal outages is 58 and 3,140 member hours out and the 10-year average is 55 and 2,549 member hours out.



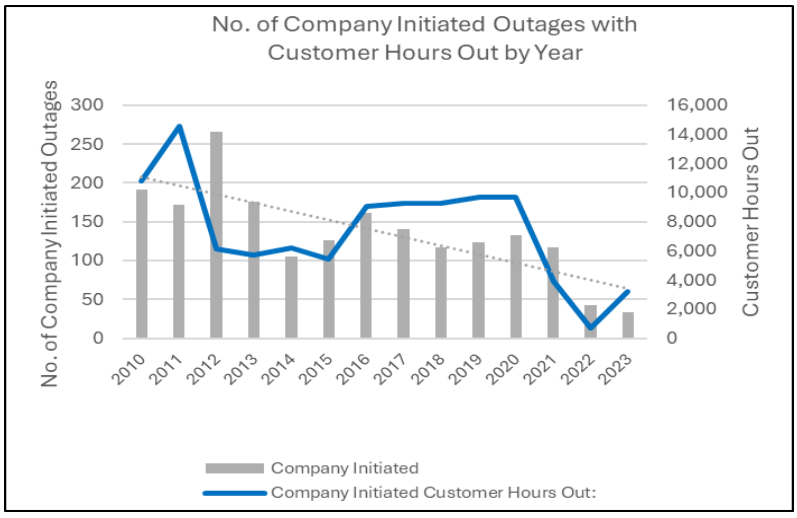
6.5 Equipment Failure

At 5% of total outages, equipment failure outages ranked 5th in terms of number of outages. WEC experienced 39 equipment failure outages with 3,574 member hours out compared to 45 and 4,743 member hours out in 2022. The three-year average for equipment failure outages is 42 and 5,545 member hours out and the 10-year average is 44 and 6,000 member hours out.



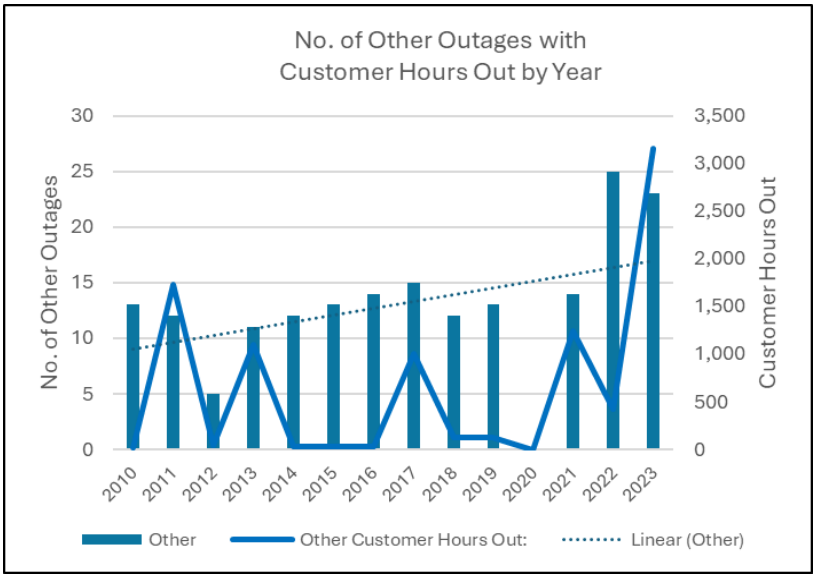
6.6 Company Initiated Outages

Ranked at 6th, company initiated outages made up 4% of the total outages in 2023. WEC experienced 34 company initiated outages with 3,574 member hours out compared to 43 outages and 712 member hours out in 2022. The three-year average for company-initiated outages is 65 and 2,614 member hours out and the 10-year average is 110 and 6,641 member hours out.



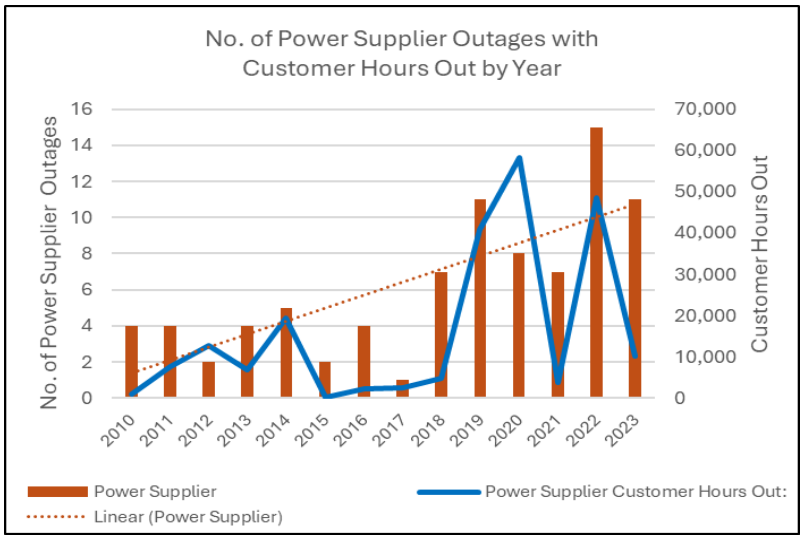
6.1 Other Outages

At 3% of total outages, other outages ranked 7th. In 2023, WEC experienced 23 Other outages with 3,159 member hours out compared to 25 and 418 member hours out in 2022. The three-year average for other outages is 21 and 1,606 member hours out and the 10-year average is 14 and 616 member hours out.



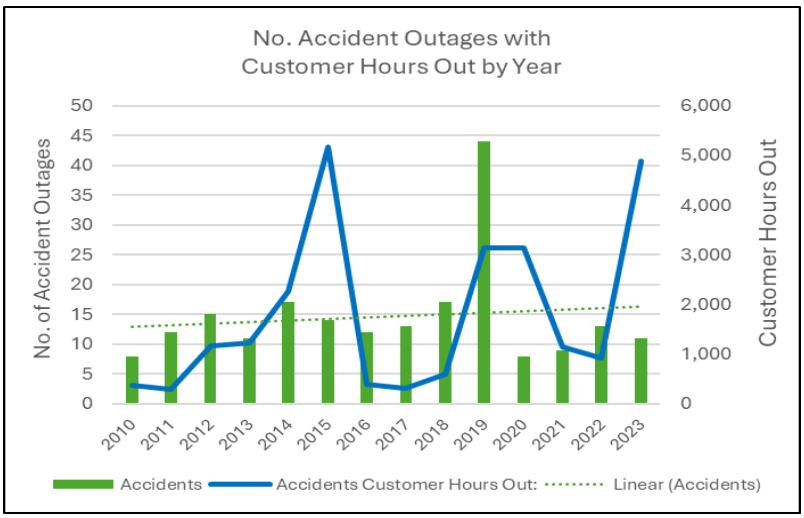
6.1 Power Supplier Outages

At 1% of total outages, power supplier outages ranked 8th. In 2023, WEC experienced 11 outages caused by the GMP transmission system with 10,113 member hours out compared to 15 and 48,517 member hours out in 2022. The three-year average for power supplier outages is 11 and 20,838 member hours out and the 10-year average is 7 and 19,105 member hours out.



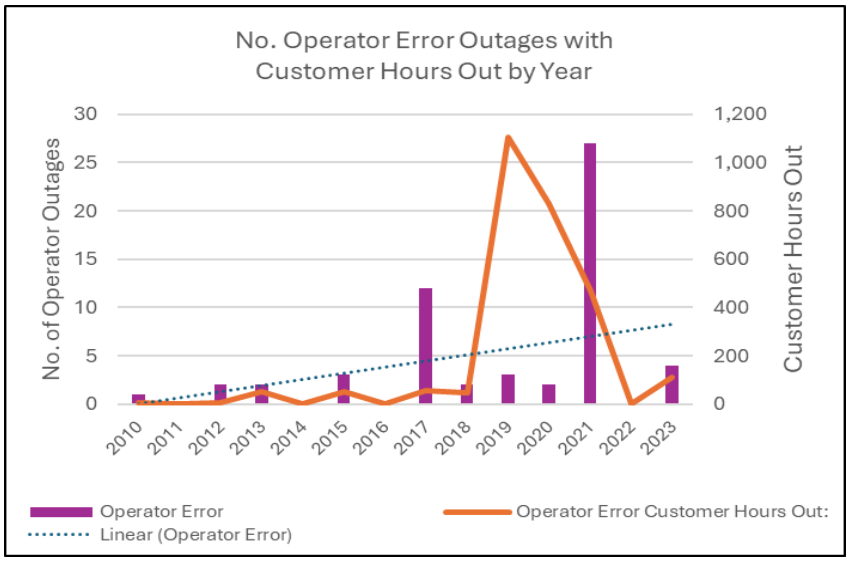
6.1 Accidents

At 1% of total outages, Accident outages ranked 9th with 11 outages and 4,879 member hours out compared to 13 Accident outages and 917 member hours out in 2022. The three-year average for Accident outages is 11 and 2,314 member hours out and the 10-year average is 16 and 2,193 member hours out.



6.9 Operator Error

At 1% of total outages and ranked 10th (last), Operator Error outages accounted for 4 outages in 2023 with 110 member hours out compared to no outages in 2022. The three-year average for Operator Error outages is 10 and 193 member hours out and the 10-year average is 5 and 267 member hours out.



7. Action Plan:

Over the last 25 years WEC has been adhering to USDA Rural Utility Services (RUS) construction standards that help harden the distribution system from the effects of increased storm severity. These practices are funded through the RUS approved Construction Work Plan (CWP) process. The four-year CWP is focused on continued improvement and enhanced reliability of WEC's transmission and distribution system.

Over the last ten years 100% of WEC's pole plant has been inspected and WEC continues to inspect 10% of the plant each year as required by RUS standards. WEC has also recently conducted an inspection of all primary underground installations to ensure they meet RUS and NESC requirements and present no inherent safety or reliability issues. The results of these inspections are used to assess the current condition of WEC's pole plant to maximize their life cycle value. The inspection data is crucial in determining pole condition and the results are fully integrated into the WEC's four-year CWP. During the 2019-22 CWP work period, WEC replaced and/or installed a total of 1,071 poles. Also in 2022, WEC moved away from using Class 3 pole sizes and started replacing poles with a stronger, thicker Class 2 pole to provide added protection against falling trees.

In 2023, WEC's consulting engineering group completed a system wide study to develop a ten-year long-range plan (LRP) to determine the immediate and long-term distribution system requirements through the year 2033. The study reviewed all of WEC's distribution substations, distribution lines and transmission lines and evaluations included thermal, voltage, reverse power, reactive compensation, short circuit, asset condition, reliability and operational considerations based on historical load and load growth projections over the next ten years. The evaluations determined a list of short and long-term recommendations that WEC will incorporate into its new 2024-2027 CWP and subsequent CWPs through 2034.

The new 2024-2027 CWP calls for approximately 75% of the dollars being spent on reconstruction and upgrades on circuits in WEC's service territory. The CWP also outlines system-hardening improvements including, but not limited to, the following: replacement of small and aged conductors, installation of capacitors to reduce line loss, the replacement of deteriorated poles, the addition of mid-span poles to reduce conductor span lengths and the reconstruction of approximately 14 miles of line.

Upgrades and system enhancements in the new 2024-2027 CWP include a complete AMI system replacement, installation of Transmission Ground Fault Over Voltage (TGFOV) protection at six substations, installation and/or upgrades of 24 new reclosers, installation and/or replacement of approximately 750 distribution transformers, installation of new voltage regulators and capacitors, upgrades at two substations and the complete replacement of two other substations.

In addition to the above CWP projects, fourteen line rehabilitation projects were identified and added to the new plan, two of which will extend three-phase conductors

on two feeders beyond their current end points to help with phase balancing, voltage control and outage management by further segmenting long, single-phase lines. A third three-phase project was created from the December 2022 winter storm that was eligible as a FEMA event. FEMA will provide mitigation funding for this project, where an off-road section of this three-phase line was heavily damaged during that storm.

The mitigation plan will replace 46 old class 4, 5, and 6 poles with taller class 2 poles, relocate an off-road section of the line to the road and replaces the older, smaller conductors with the stronger Cable Spacer System. The Cable Spacer System's compact design shrinks the strike zone from falling trees and uses a support messenger to support the insulated conductors. This system is better suited to keeping the conductors in the air and energized when struck by a falling tree. It will be used for all applicable three-phase upgrade projects in the future for added reliability. WEC also reviews all single-phase upgrade projects to determine if they should be upgraded in place or moved to the road or if it should be converted to underground.

WEC continues the practice of conducting annual inspections of its entire 34.5 kV and 46 kV transmission lines in the spring and fall of each year. An infrared hot spot scan of equipment and equipment connections within the substations is also completed. During the 2019-22 CWP period, WEC completed upgrades on the Graniteville to Jackson Corners 34.5 kV transmission line and installed a new 34.5 kV switch at the Mt. Knox substation. WEC also completed 65% of the upgrades on the South Walden 34.5 kV transmission line during the last CWP work period. In the upcoming 2024-2027 CWP, WEC plans on completing the upgrades on the South Walden 34.5 kV line and adding a new recloser at the GMP/WEC tap location.

For the last five years and again for 2024, WEC's Board of Directors has approved significant funding for ROW clearing. The funding will be used to target clearing those lines directly affected by wet snow loading and danger trees. During 2023, ROW clearing crews maintained approximately 67 miles of distribution line and 1.16 miles of transmission line. A total of 4,326 danger trees were cut during ROW operations.

In 2023, WEC also conducted a study of tree outages over the 2017-2022 six-year period to determine which substations and distribution circuits were the worst performers. Individual circuits were evaluated down to the fuse level to identify those sections of line with a higher frequency of outages. WEC plans on utilizing the results of this study and combining this information with new emerging technologies and other system information to develop a new cutting plan in 2024.

Emerald Ash Borer (a continued threat to service reliability): In 2018, the Emerald Ash Borer (EAB) was detected in Orange County which is the heart of WEC's service territory. The EAB is an insect of Asiatic origin that bores into the Ash tree and lays eggs. The resulting larvae feed off the soft tissue of the tree below the bark effectively girdling the tree and cutting off the flow of water and nutrients to the tree's canopy, killing the tree. Based on experience in other states, the EAB is expected to devastate most Ash trees located within any infected area. Historically, utilities have purposely left

the Ash tree to populate along and adjacent to electric line corridors as it was a hardy and resilient species. Unfortunately, the Ash trees once infected with the EAB are expected to be dead within 2 to 4 years and hence become a significant threat to electric lines and therefore service reliability. Ash trees are prioritized by WEC ROW clearing crews while performing maintenance cutting in WEC rights-of-way.

The 2024 ROW clearing budget will fund a targeted distribution system trim cycle of just over eight years and a transmission trim cycle of approximately six years. The additional funding provided over the last 4 budget years was mostly allocated to WEC's three phase main line feeders and danger tree removal on transmission, three phase and single phase main - line circuits. The additional trimming did provide significantly improved reliability to those lines.

Outage Management: In 2023 WEC made several changes internally to the way outages are managed. Working with our OMS software vendor WEC changed the way our online outage map displays outage information. Members can now see if their general location is affected by an outage or is part of a larger outage. By hovering over the outage point on the map, information regarding the outage i.e., when reported, when crews are assigned, cause and estimated restoration time, can be displayed. Also in 2023, WEC deployed tablets to our line crews who now have the ability to view all outage information including any information regarding the outage called in by members.

Storm Response: WEC monitors the weather on a daily basis and when notification of an approaching severe weather event is received from the VELCO weather forecasters, WEC participates in the VELCO emergency prep conference calls for these events. WEC personnel are then put on alert ahead of the pending situation and preparations are made ahead of the event to coordinate deployment of resources and restoration. WEC also utilizes the NEPPA Mutual Aid program for Major Storm restoration and depending on the type and amount of damage that occurs, WEC will request any needed resources from NEPPA, WEC Line Contractors and other Vermont utilities to expedite restoration.

The 2023 Reliability Report is being submitted to the Board via ePUC.

Respectfully submitted,

Dave Kresock
Director of Operations & Engineering