Sample Utility

2021 ANNUAL BENCHMARKING REPORT | **eRELIABILITY TRACKER**

DEED PUBLIC POWER
RESEARCH & DEVELOPMENT
American Public Power Association

AMERICAN PUBLIC POWER ASSOCIATION
Powering Strong Communities

I. About this Report

This report focuses on distribution system reliability across the country and is customized to each utility that participates in the American Public Power Association's eReliability Tracker service. APPA created the eReliability Tracker Annual Report to assist utilities in their efforts to understand and analyze their electric system. In 2012, APPA developed the eReliability Tracker thanks to a grant from the Demonstration of Energy & Efficiency Developments (DEED) program.

This report reflects data in the eReliability Tracker from January 1, 2021 to December 31, 2021. If you do not have a full year of data in the system, then this analysis might not properly reflect your utility's statistics. The report only includes data recorded as of February 19, 2022.

Reliability reflects both historic and ongoing engineering investment decisions within a utility. Proper use of reliability metrics ensures that a utility is performing its intended function and is providing service in a consistent and effective manner.

While the primary use of reliability statistics is for self-evaluation, you can use these statistics to compare your utility with similar utilities. However, differences such as electrical network configuration, ambient environment, weather conditions, and number of customers served typically limit most utility-to-utility comparisons. Due to the diverse range of utilities that use the eReliability Tracker, this report endeavors to improve comparative analyses by grouping utilities by size and region.

Since this report contains data for all utilities that use the eReliability Tracker, it is important to consider how a particularly large or small utility can affect the rest of the data. To ease the issues associated with comparability, each utility's reliability statistics are weighted based on customer count when aggregated. This means that all utilities are equally weighted, and all individual statistics are developed on a per customer basis.

The aggregate statistics displayed in this report are calculated from 270 utilities that verified their 2021 outage data. Utilities that experienced no outages in 2021, or did not upload any data, will have NULL, nan, or "0" values in their report for utility-specific data and were not included in the aggregate analysis. Also note that log-normal data with a z-score greater than 3.25 will be considered for inclusion and may be excluded if it significantly distorts the aggregate statistics.

Utility Classifications

This report separates utilities into groups according to geographic region and the number of customers served. Table 1 shows the range of customer sizes for utilities that use the eReliability Tracker by five distinct customer size class groups of approximately 104 utilities per group.

Your utility belongs to customer size class 4 and region 2.

Table 1. Customer size range per customer size class

Customer Size Class	Customer Size Range
Class 1	[0, 1511)
Class 2	[1511, 3224)
Class 3	[3224, 7135)
Class 4	[7135, 14329)
Class 5	[14329, 499542)

Each utility is also grouped with all other participating utilities within their region. Figure 1 shows the number of utilities using the eReliability Tracker in each region and Figure 2 shows the states and territories included in each region.
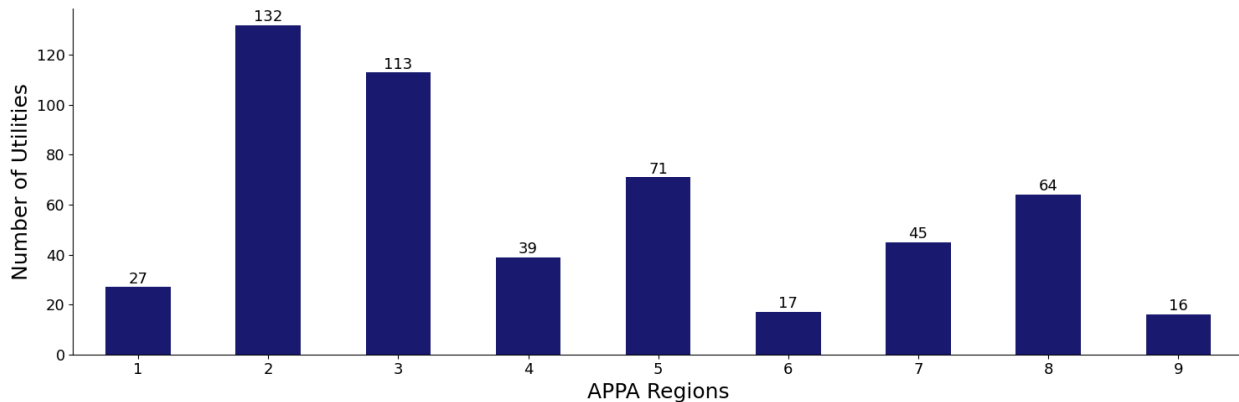
Figure 1. Number of utilities subscribed to the eReliability Tracker by region
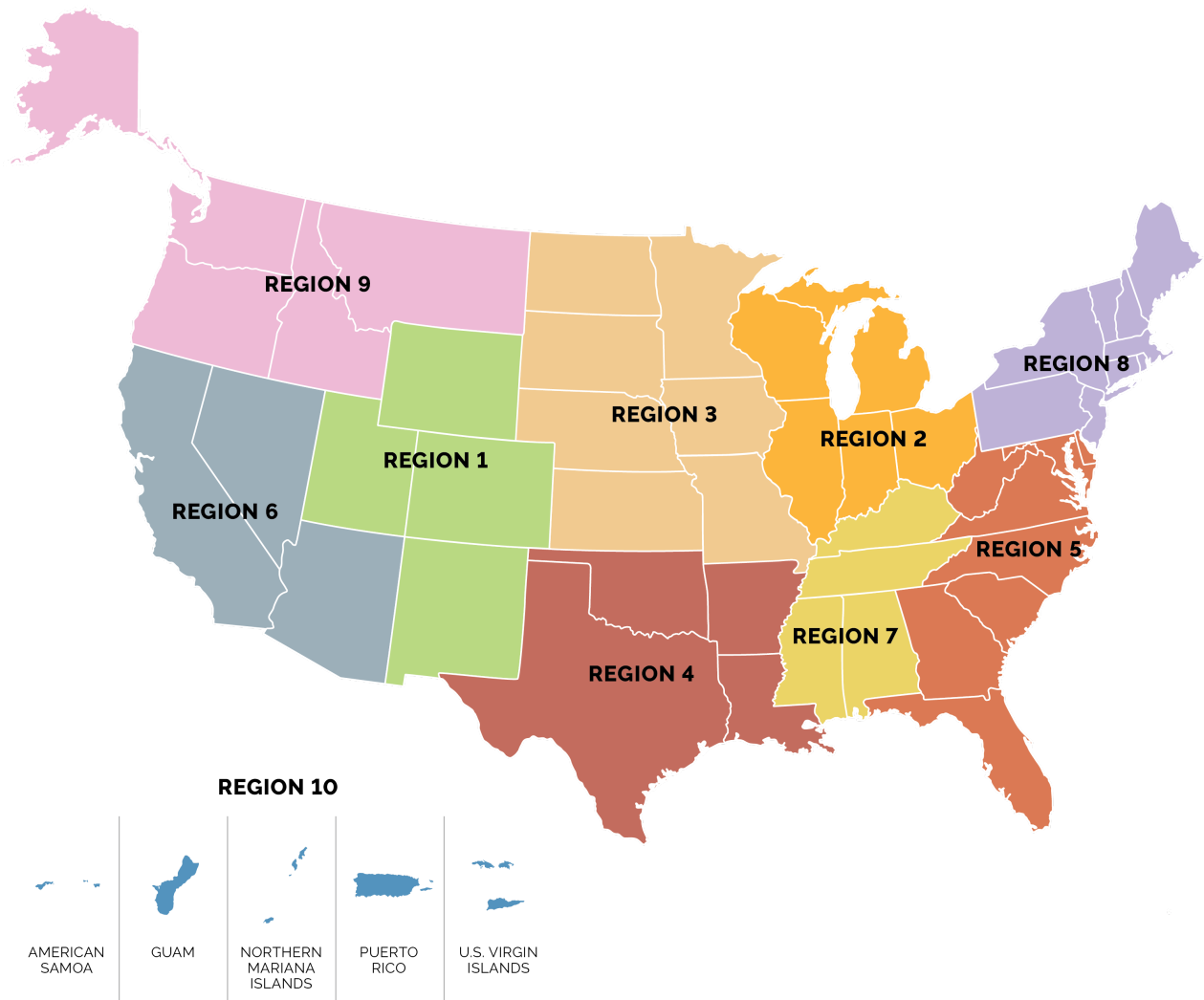
Figure 2. Regions

II. IEEE Statistics

When it comes to reliability metrics, the industry standard metrics are defined in the Institute for Electrical and Electronics Engineers' Guide for Electric Power Distribution Reliability Indices, or IEEE 1366 guidelines. For each utility, the eReliability Tracker performs IEEE 1366 calculations for System Average Interruption Duration Index (SAIDI), System Average Interruption Frequency Index (SAIFI), Customer Average Interruption Duration Index (CAIDI), Momentary Average Interruption Frequency Index (MAIFI) and Average Service Availability Index (ASAI).

It is important to note how major events (MEs) are calculated and used in this report. An example of a ME includes severe weather, such as a tornado or hurricane, that leads to unusually long outages in comparison to your distribution system's typical outage. This report uses **APPA's ME threshold**, which is a calculation based directly on the SAIDI for specific outage events, rather than daily SAIDI. APPA's ME threshold allows a utility to remove outages that exceed the IEEE 2.5 beta threshold for outage events, which considers up to 10 years of the utility's outage history. In the eReliability Tracker, if a utility does not have at least 36 outage events prior to the year being analyzed, then no threshold is calculated. If this is the case for your utility, then you will have a NULL value in the field below and the calculations without MEs in the SAIDI, SAIFI, CAIDI, and ASAI sections of this report will be the same as the calculations with MEs for your utility. More outage history will provide a better threshold for your utility.

Your utility's APPA major event threshold is 3.72 minutes.

For each of the reliability indices, this report displays your utility's metrics alongside other comparative groups. The first table within each of the following subsections allows you to better understand the performance of your electric system relative to other utilities nationwide and to those within your same region or size class. The second table breaks down the national data into quartile ranges, a minimum value, and a maximum value.

All indices, except MAIFI, are calculated for outages with and without MEs; furthermore, the data are broken down to show calculations for scheduled and unscheduled outages. Note that scheduled and unscheduled calculations include MEs. Also note that wherever MEs are excluded, the exclusion is based on the APPA's ME threshold for your system.

II.1. System Average Interruption Duration Index (SAIDI)

SAIDI is defined as the average interruption duration (in minutes) for customers served by the utility during a specific time frame.

Since SAIDI is a sustained interruption index, only outages lasting longer than five minutes are included in the calculations. SAIDI is calculated by dividing the sum of all customer minutes of interruption [1] within the specified time frame by the average number of customers served during that period. For example, a utility with 100 customer minutes of interruption and 100 customers would have a SAIDI of 1.

Note that in the tables below, scheduled and unscheduled calculations include MEs. Also note that wherever MEs are excluded, the exclusion is based on the APPA's ME threshold for your system.

Table 2. Average SAIDI with and without MEs in minutes

	All	No MEs	Unscheduled	Scheduled
Your utility	61.4	61.4	61.4	NULL
Utilities that use the eReliability Tracker	111.1	44.19	97.22	23.38
Utilities in your region	55.79	33.9	51.29	7.65
Utilities in your customer size class	77.82	33.14	76.09	2.81

Table 3. Summary SAIDI data from the eReliability Tracker

	All	No MEs	Unscheduled	Scheduled
Minimum Value	0	0	0	0
First Quartile	16.95	10.15	15.06	0.25
Median Value	46.29	22.89	44.29	1.4
Third Quartile	108.87	49.55	98.49	4.42
Maximum Value	1793.88	926.72	1548.04	1606.86
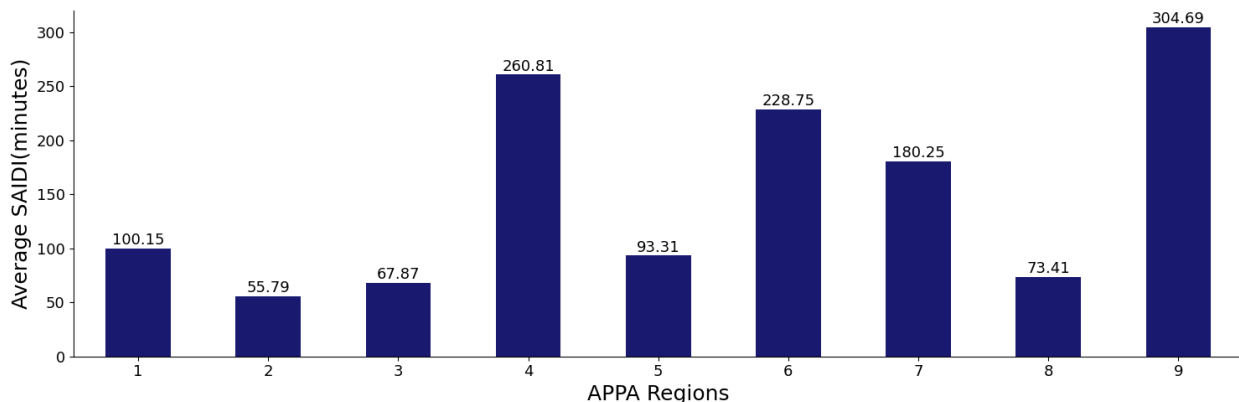
Figure 3. Average SAIDI for all utilities that use the eReliability Tracker by region

1. Customer minutes of interruption is calculated by multiplying total customers interrupted and total minutes of interruption. ↵

II.2. System Average Interruption Frequency Index (SAIFI)

SAIFI is defined as the average number of instances a customer on the utility system will experience an interruption during a specific period.

Since SAIFI is a sustained interruption index, only outages lasting longer than five minutes are included in the calculations. SAIFI is calculated by dividing the total number of customer interruptions by the average number of customers served during that period. For example, a utility with 150 customer interruptions and 200 customers would have a SAIFI of 0.75 interruptions per customer.

Note that in the tables below, scheduled and unscheduled calculations include MEs. Also note that wherever MEs are excluded, the exclusion is based on the APPA's ME threshold for your system.

Table 4. Average SAIFI with and without MEs in interruptions

	All	No MEs	Unscheduled	Scheduled
Your utility	0.9	0.9	0.9	NULL
Utilities that use the eReliability Tracker	0.84	0.53	0.78	0.1
Utilities in your region	0.65	0.46	0.6	0.09
Utilities in your customer size class	0.73	0.41	0.7	0.04

Table 5. Summary SAIFI data from the eReliability Tracker

	All	No MEs	Unscheduled	Scheduled
Minimum Value	0	0	0	0
First Quartile	0.23	0.13	0.21	0
Median Value	0.53	0.31	0.52	0.01
Third Quartile	1.15	0.71	1.12	0.05
Maximum Value	5.14	4.17	4.47	4.02
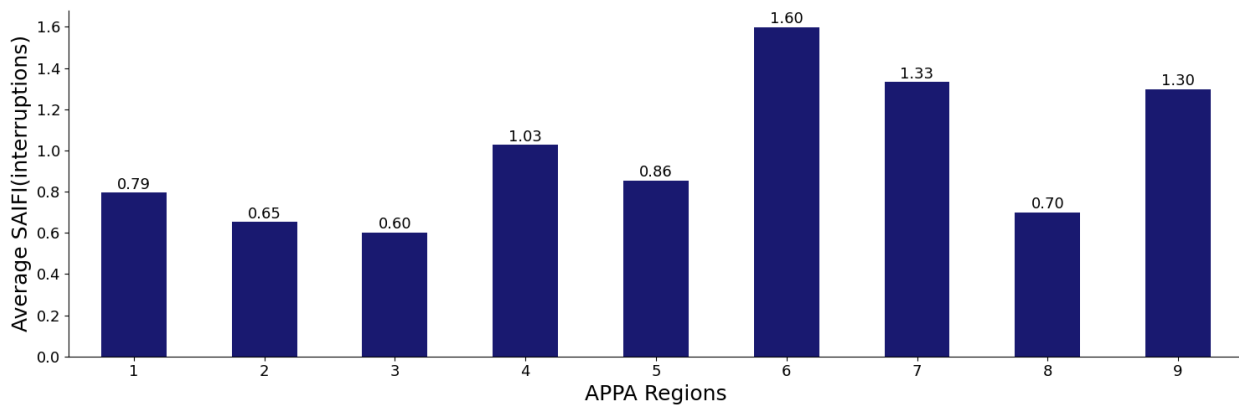
Figure 4. Average SAIFI for all utilities that use the eReliability Tracker by region

II.3. Customer Average Interruption Duration Index (CAIDI)

CAIDI is defined as the average duration (in minutes) of an interruption experienced by customers during a specific time frame.

Since CAIDI is a sustained interruption index, only outages lasting longer than five minutes are included in the calculations. CAIDI is calculated by dividing the sum of all customer minutes of interruption by the number of customers that experienced one or more interruptions during that period. This metric reflects the average customer experience (minutes of duration) during an outage.

Note that in the tables below, scheduled and unscheduled calculations include MEs. Also note that wherever MEs are excluded, the exclusion is based on the APPA's ME threshold for your system.

Table 6. Average CAIDI with and without MEs in minutes

	All	No MEs	Unscheduled	Scheduled
Your utility	61.59	61.59	61.59	NULL
Utilities that use the eReliability Tracker	115.19	84	113.06	128.91
Utilities in your region	112.71	85.84	113.71	99.7
Utilities in your customer size class	107.16	87.17	108.15	118.02

Table 7. Summary CAIDI data from the eReliability Tracker

	All	No MEs	Unscheduled	Scheduled
Minimum Value	0	0	0	0
First Quartile	61	55.72	60.62	51.99
Median Value	86.26	71.59	86.42	84.9
Third Quartile	117.39	95.14	116.52	141.87
Maximum Value	1322.8	438.68	1350.23	1377.2
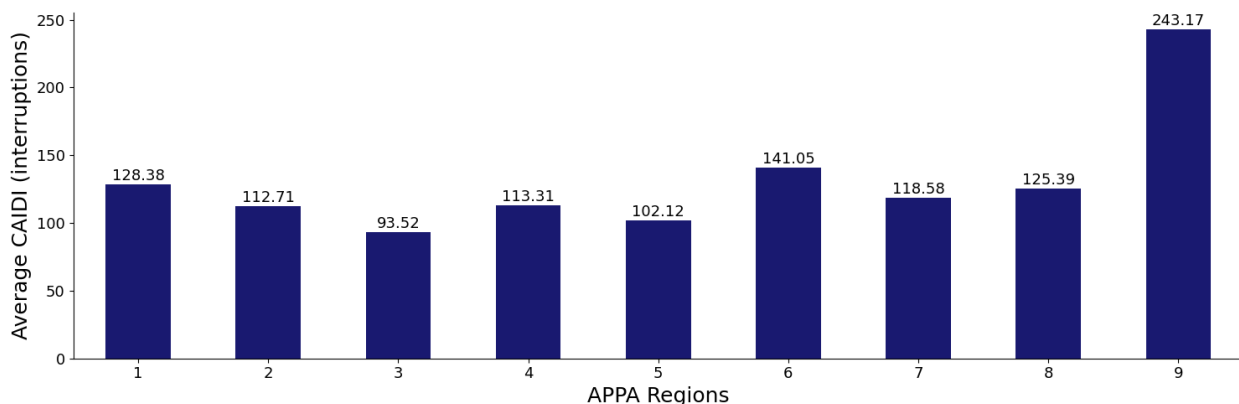
Figure 5. Average CAIDI for all utilities that use the eReliability Tracker by region

II.4. Momentary Average Interruption Frequency Index (MAIFI)

MAIFI is defined as the average number of times a customer on the utility system will experience a momentary interruption.

In this report, an outage with a duration of five minutes or less is classified as momentary. MAIFI is calculated by dividing the total number of momentary customer interruptions by the total number of customers served by the utility. For example, a utility with 20 momentary customer interruptions and 100 customers would have a MAIFI of 0.20.

Momentary outages can be more difficult to track and utilities without an automated outage mangament system might not log these interruptions; therefore, some utilities have a MAIFI of zero.

Table 8. Average MAIFI

	MAIFI (interruptions)
Your utility	1.4
Utilities that use the eReliability Tracker	0.79
Utilities in your region	0.99
Utilities in your customer size class	0.45

Table 9. Summary MAIFI data from the eReliability Tracker

	MAIFI (interruptions)
Minimum Value	0
First Quartile	0.01
Median Value	0.09
Third Quartile	0.59
Maximum Value	19.4
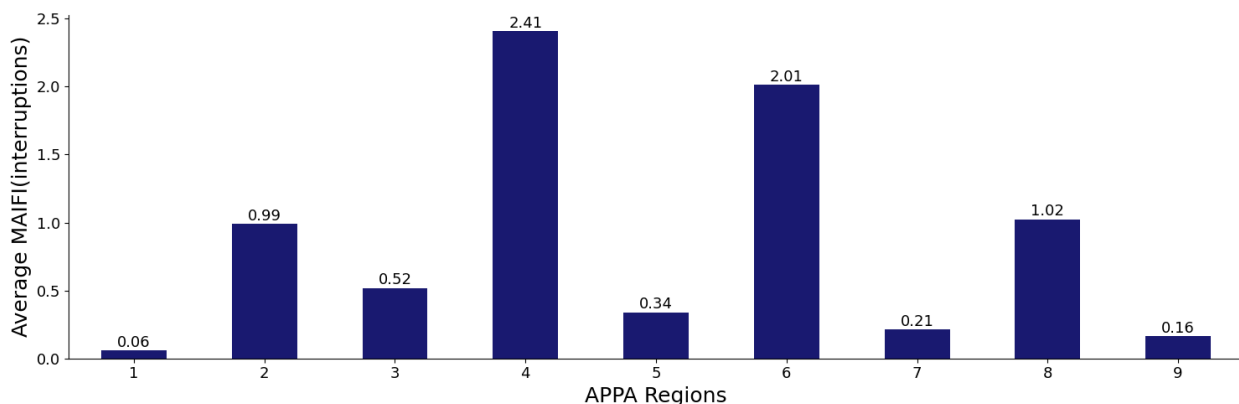
Figure 6. Average MAIFI for all utilities that use the eReliability Tracker by region

II.5. Average Service Availability Index (ASAI)

ASAI is a measure of the average availability of the sub-transmission and distribution systems that serve customers.

This load-based index represents the percentage availability of electric service to customers within the period analyzed. It is calculated by dividing the total hours in which service is available to customers by the total hours that service is demanded by the customers. For example, an ASAI of 99.99% means that electric service was available for 99.99% of the time during the given period. Note that the higher your ASAI value, the better the performance.

In the tables below, scheduled and unscheduled calculations include MEs. Also note that wherever MEs are excluded, the exclusion is based on the APPA's ME threshold for your system.

Table 10. Average ASAI with and without MEs in %

	All	No MEs	Unscheduled	Scheduled
Your utility	99.997	99.997	99.997	NULL
Utilities that use the eReliability Tracker	99.9789	99.9916	99.9815	99.9955
Utilities in your region	99.9889	99.9935	99.9897	99.9985
Utilities in your customer size class	99.9852	99.9937	99.9856	99.9994

Table 11. Summary ASAI data from the eReliability Tracker

	All	No MEs	Unscheduled	Scheduled
Maximum Value	100	100	100	100
First Quartile	99.9967	99.998	99.9971	99.9999
Median Value	99.9912	99.9956	99.9915	99.9997
Third Quartile	99.9792	99.9907	99.9812	99.9992
Minimum Value	99.6586	99.8246	99.7054	99.6942
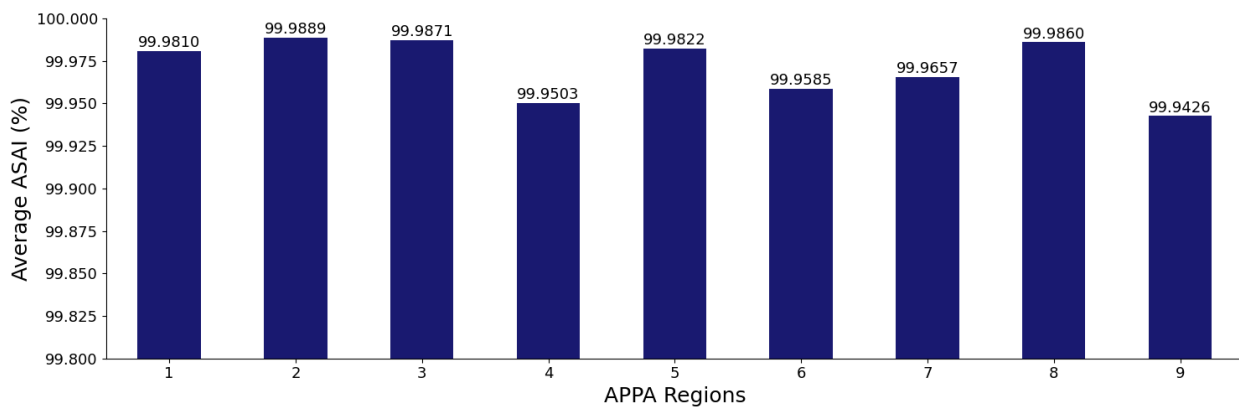
Figure 7. Average ASAI for all utilities that use the eReliability Tracker by region

II.6. Energy Information Administration (EIA) Form 861 Data

Form EIA-861 collects annual information on electric power industry participants involved in the generation, transmission, distribution, and sale of electric energy in the United States and its territories.

In 2014, EIA began publishing reliability statistics in Form EIA-861; therefore, APPA included these statistics in this report for informational purposes. Please note that the following data includes 175 investor-owned, 454 rural cooperative, and 319 public power utilities that were large enough to be required to fill out the full EIA-861 form, and does not include utilities that completed the EIA 861-S form (for smaller entities). Note that the 319 participating public power utilities include entities classified by EIA as municipal, political subdivision, and state. In addition, since the collection and release of EIA form data lags by a year, the data provided here is based on 2020 data that was published October 7, 2021. Therefore, we suggest you only use the aggregate statistics contained herein as an informational tool for further comparison of reliability statistics.

In Form EIA-861, an entity provides SAIDI and SAIFI including and excluding Major Event (ME) days in accordance with the IEEE 1366-2003 or IEEE 1366-2012 standard.

Although EIA collected other reliability-related data, the tables below only include SAIDI and SAIFI data including and excluding Major Evnet (ME) days. You can download the full set of data at: http://www.eia.gov/electricity/data/eia861/

Table 12. Summary SAIDI data from Form EIA-861, 2020

	All	**No MEs**
Average	391.57	135.78
Minimum Value	3.93	0
First Quartile	86.21	56.2
Median Value	178	99.32
Third Quartile	363.35	169.65
Maximum Value	7699.56	1353.2

Table 13. Summary SAIFI data from Form EIA-861, 2020

	All	**No MEs**
Average	1.62	1.22
Minimum Value	0.04	0
First Quartile	0.8	0.63
Median Value	1.34	1
Third Quartile	2.1	1.6
Maximum Value	12.93	7.26

II.7. Analysis of Miles of Line and Interruptions

Analyzing metrics on interruptions by miles of line can help utilities explore the relationship between outages, line exposure, and customer density. This analysis separates utilities into groups of similar average customer density (customers served per mile). As seen in Table 15, utilities that use the eReliability Tracker were split into five customer density groups of approximately 79 utilities each. Note that customer density classes include utilities that either provided their miles of line data to S&P Global Platts or recorded their data in the eReliability Tracker. By using the miles of line-related metrics shown in Table 14 and Table 15, you can benchmark your utility's reliability against system characteristics along with the customer normalized metrics included in the rest of the report. These system topography-related metrics can be helpful in understanding, for example, utility reliability against weather and animal-related outages relative to similarly dense and exposed utilities.

Your utility's total miles of line: 156

Your utility's overhead miles of line: 65

Your utility's underground miles of line: 91

Table 14. Total miles of line and interruptions

	Customers Interrupted per Mile	Interruptions per Mile	Minutes of Interruption per Mile
Your utility	45.5	0.28	18.82
Utilities that use the eReliability Tracker	55.57	0.6	197.81
Utilities in your region	49.91	0.61	62.39

Your utility's average customer density (customers per mile): 62.9

Your utility belongs to customer density class 4.

Table 15. Total miles of line analysis by customer density class

Customer Density Class (Customers per Mile)	Customer Density Range	Average Customers Interrupted per Mile	Average Interruptions per Mile	Average Minutes of Interruption per Mile
Class 1	0 - 26	12.8	0.26	130.92
Class 2	26 - 42	18.82	0.3	71.62
Class 3	42 - 57	25.52	0.44	344.9
Class 4	57 - 78	60.66	0.43	61.95
Class 5	78 - 1660	87.43	0.7	104.97

III. Outage Causes

Equipment failure, extreme weather events, wildlife, and vegetation are some of the most common causes of electric system outages.The following pie chart shows the percentages of the primary causes of outages for all utilities using the eReliability Tracker in 2021.
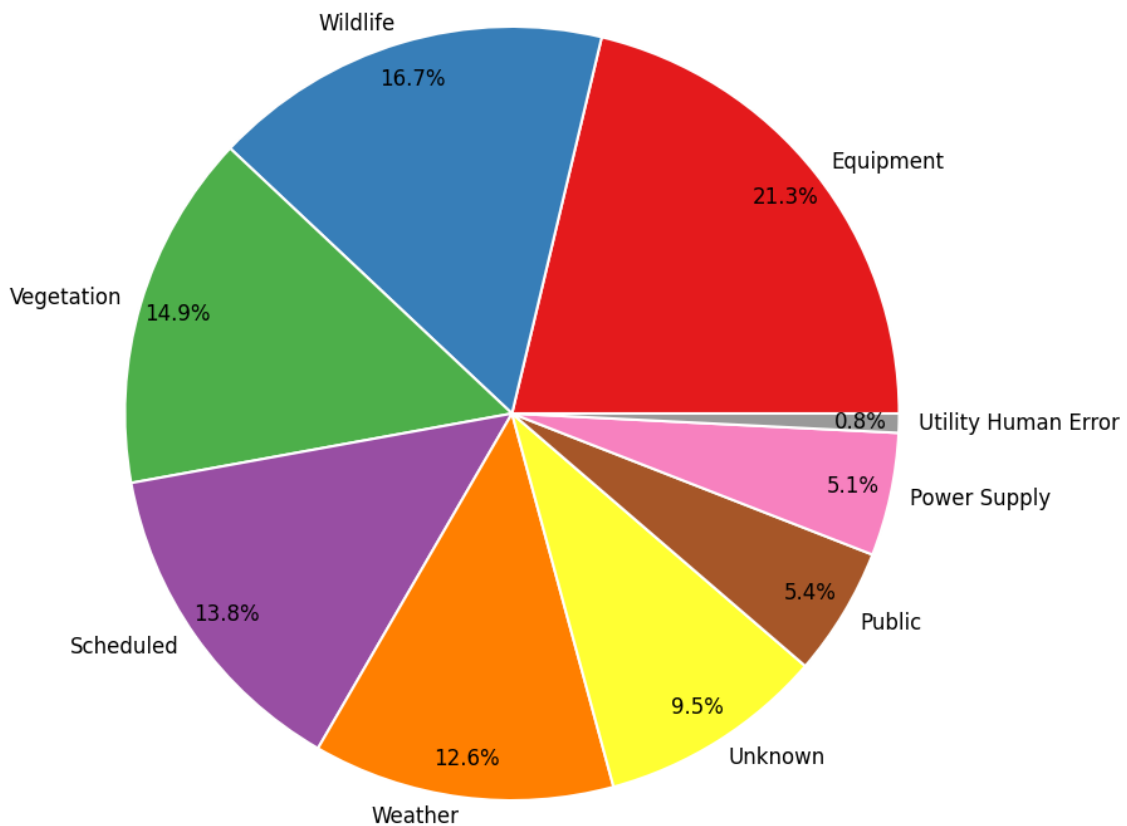
Figure 8. Primary causes of outages for all utilities that use the eReliability Tracker

Certain factors, such as regional weather and animal/vegetation patterns, can make some causes more prevalent for a specific group of utilities. The following section of this report includes graphs depicting common causes of outages for your utility, all utilities in your region, and all utilities using the eReliability Tracker.

Charts containing aggregate information are customer-weighted to account for differences in utility size for a better analytical comparison. For example, a particularly large utility may have a large number of outages compared to a small utility. To avoid skewing the data toward large utilities, the number of cause occurrences is divided by customer size to account for the differences. In Figures 9

-14, the data represent the number of occurrences for each group of 1,000 customers. A customer-weighted occurrence rate of "1" means one outage from that outage cause occurred per 1,000 customers on average in 2021.

Note that the sustained outage cause analysis is more comprehensive than the momentary outage cause analysis due to a larger and more robust sample size for sustained outages. Regardless, tracking both sustained and momentary outages helps utilities understand and reduce outages. To successfully use the outage information tracked by your utility, it is imperative to classify and record outages in detail. The more information provided per outage, the more conclusive and practical your analyses will be.

III.1. Sustained Outage Causes

In general, sustained outages are the most commonly tracked outage type. In analyses of sustained outages, utilities tend to exclude scheduled outages, partial power, customer-related problems, and qualifying major events from their reliability indices calculations. While this is a valid method for reporting, these outages should be included for internal review to make utility-level decisions. In this section, we evaluate common causes of sustained outages for your utility, corresponding region, and for all utilities that use the eReliability Tracker. It is important to note that in this report, sustained outages are classified as outages that last longer than five minutes, as defined by IEEE 1366.
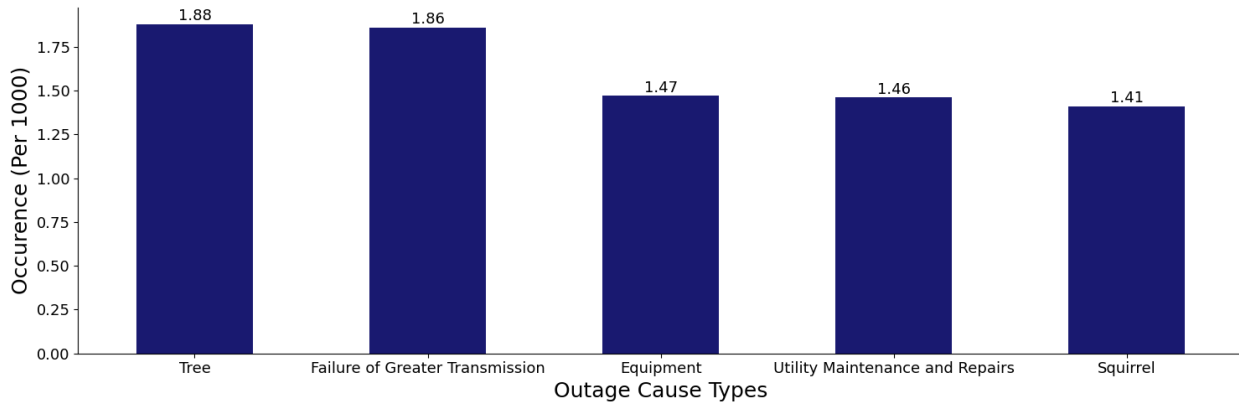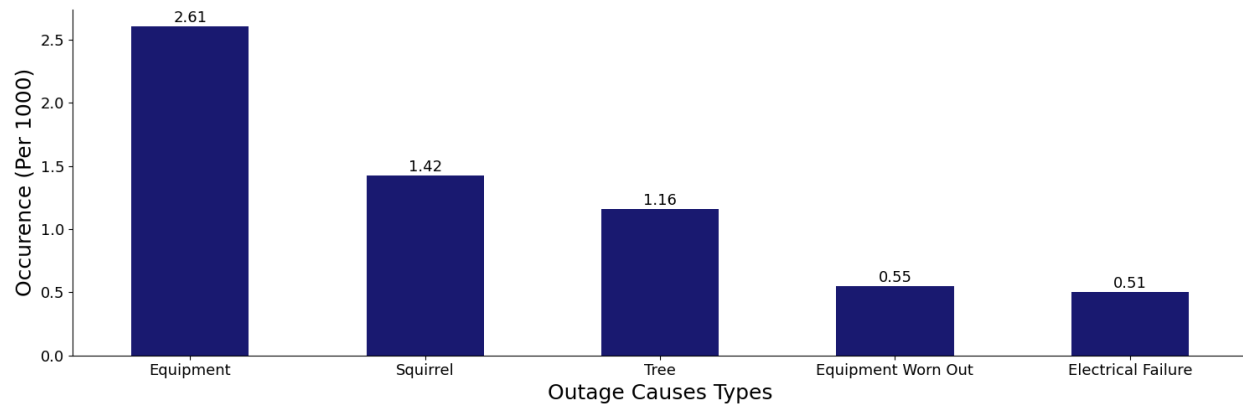

Figure 9. Top five causes of sustained outages for all utilities that use the eReliability Tracker
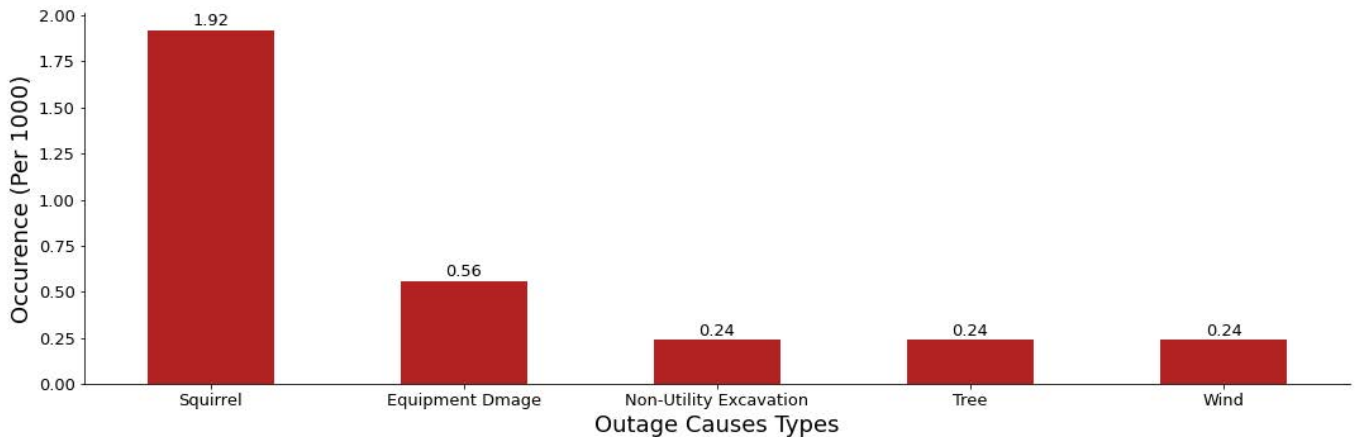
Figure 10. Top five causes of sustained outages for your utility [1]

1. For each utility, the number of occurrences for each cause is divided by that utility's customer size (in 1,000s) to create an occurrence rate that can be compared across different utility sizes. ↵

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**Figure 11.** Top five causes of sustained outages in your region

III.2. Momentary Outage Causes

The ability to track momentary outages can be difficult or unavailable on some systems, but due to the hazard they pose for electronic equipment, it is important to track and analyze momentary causes. In this section, we evaluate common causes of momentary outages for your utility, region, and customer size class as well as common causes for all utilities that use the eReliability Tracker. Please note that only outages lasting less than five minutes are classified as momentary, as defined by IEEE 1366. In Figures 12 – 14, for each utility, the number of occurrences for each cause is divided by that utility's customer size (in thousands) to create an occurrence rate that can be compared across different utility sizes.
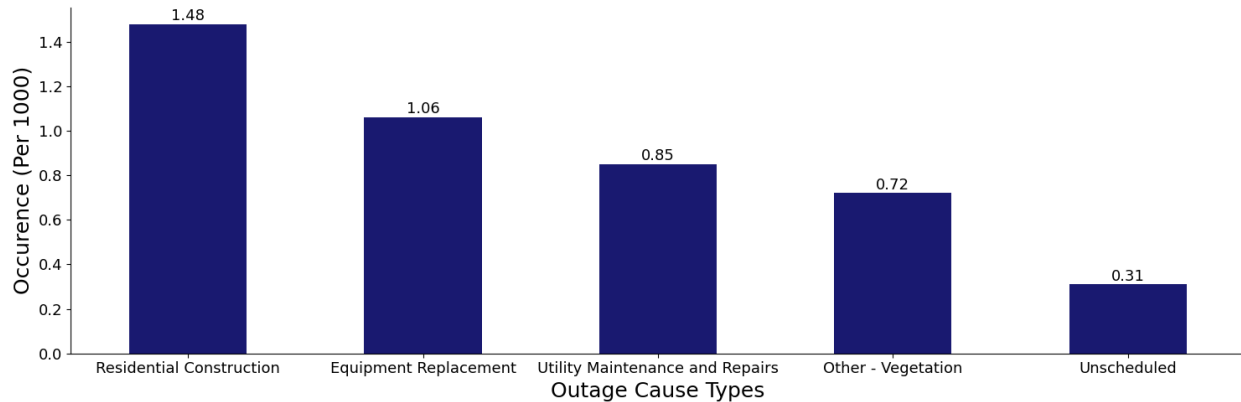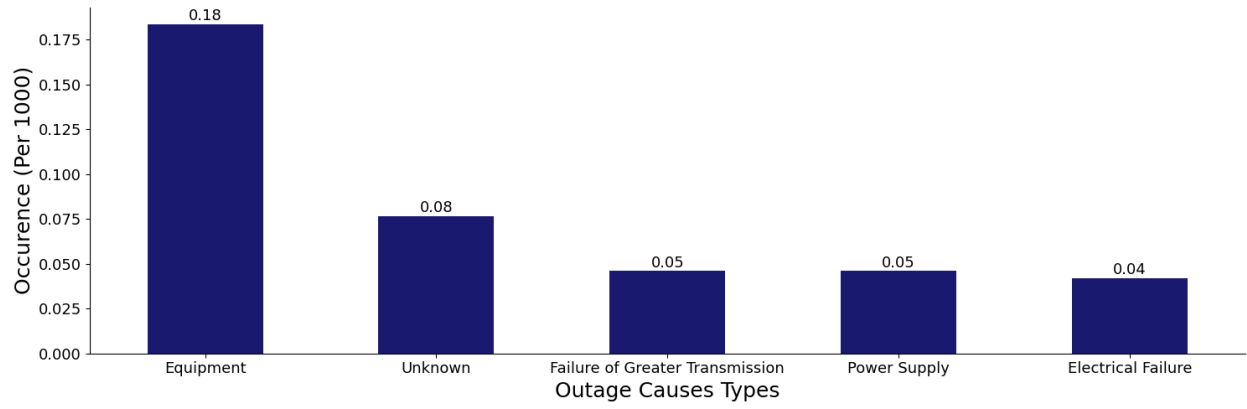

Figure 12. Top five causes of momentary outages for all utilities that use the eReliability Tracker
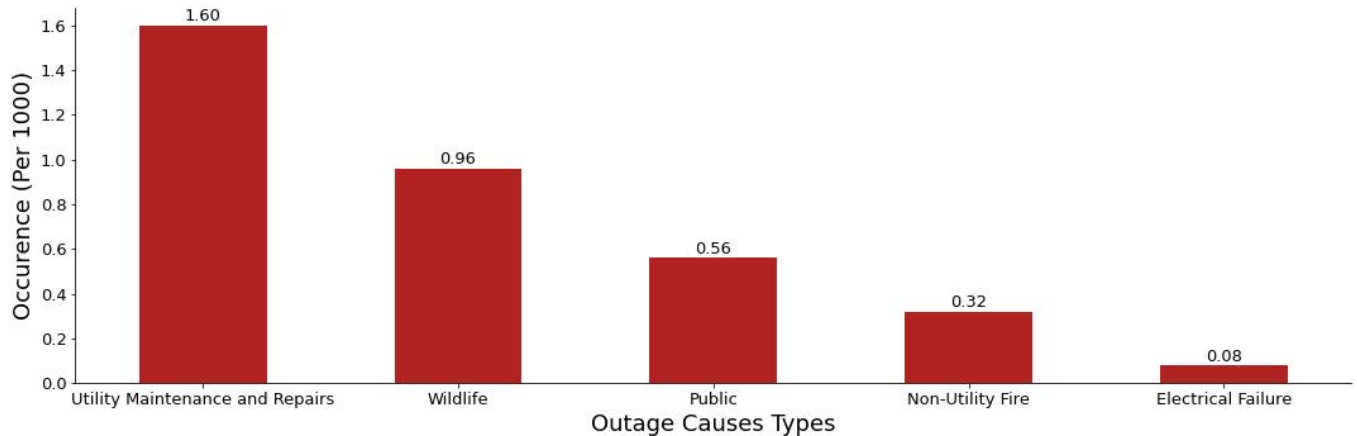
Figure 13. Top five causes of momentary outages for your utility [1]

1. If your utility has less than eight momentary outages recorded in the eReliability Tracker, this graph will be blank. ↵

Figure 14. Top five causes of momentary outages in your region

Thank you for your active participation in the eReliability Tracker service, and we hope this report is useful to your utility in analyzing your system. If you have any questions regarding the material provided in this report, please contact:

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For more information on reliability, visit https://publicpower.org/reliability.

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