Avista Utilities

Electric Service Reliability 2019

April 2020

Table of Contents

Table of Figures

Table of Tables

Avista's Electric Service Reliability Report for 2019

Introduction

Background

Avista's Electric Service Reliability Report documents the annual reliability performance of our electric system for the prior reporting year, which is filed each year with the Washington Utilities and Transportation Commission ("WUTC" or "Commission").[1] This report contains results of the Company's electric service in 2019.

For this annual report our definition of "electric system" has always referred to our overall network[2] of transmission lines, substations, and the distribution lines, or "feeders," that carry electricity to every home and business in our Washington and Idaho service area. "Service reliability" refers to the "uptime"[3] our customers experience for the year. Interruptions in service to our customers (service outages) reduce the uptime they experience. Like all electric utilities, Avista tracks and reports-out on various measures of the number of times in the year our customers experience a service outage and the length of time of these outages (outage duration). In accordance with the Commission's rules,[4] the Company established a baseline year (2005) for each of its reliability measures and then annually compares the results for each reporting year with the baseline statistics and results for the most-recent seven-year period. In addition to reporting reliability statistics, Avista must also report any changes to the methods used to collect and report the results, identify the geographic areas of greatest reliability concern on the Company's electric system, and explain our plans to improve reliability performance in those areas. Finally, Avista reports the number of complaints from its customers related to power quality and service reliability. The detailed reporting requirements are listed under definitions and electric system reliability reporting requirements, provided in Appendix A. Avista files its annual electric service reliability report with the Commission by April 30th each year.

[1] Pursuant to Washington Administrative Code (WAC) 480-100-398.
[2] Entire electric system, irrespective of state jurisdiction.
[3] Uptime is a measure of the time our electric system is available and in service for our customers during the year. A customer who experiences no service outages during the year, would have a service uptime of 100%.
[4] WAC 480-100-393.

Providing Our Customers Reliable Electric Service

Avista is focused on maintaining a high degree of reliability as an important aspect of the quality of our service,[5] particularly as our society becomes ever more reliant upon electronic technologies. The Company's objective has been to *generally uphold our current level of reliability*, which we believe is acceptable to our customers. Providing a level of system reliability that is adequate for

our customers represents a complex balance of customer expectations, cost, and performance. Because it is expensive to achieve every new increment of system reliability, and because these investments must be sustained over a period of many years to achieve objectives measured at the level of the overall system, it is important to ensure that we are prudently investing only the amount of money it takes to achieve an acceptable level of performance. Our customers' satisfaction with their service reliability is also heavily dependent on factors other than the actual reliability of our physical system. For example, their perceptions of the priority Avista places on avoiding outages and quickly restoring service when outages occur, as well as the quality and timeliness of information we provide them during an outage, have much greater bearing on their satisfaction than our actual reliability performance.[6] Avista believes the current reliability performance of our system, along with our customer care and communications, achieves an effective balance, and because of this, represents a cost-effective value for our customers. This assessment is evidenced by our high level of customer satisfaction with their overall service from Avista (which includes aspects such as electric reliability), our customers' satisfaction with their power quality and reliability,[7] by the low number of complaints we receive each year that are related to reliability issues, by our performance being in a reasonable range for the electric utility industry, and our results generally aligning with results for Avista in the Commission's Reliability Benchmarking Study.

Purpose of this Report

As noted above, this report describes results of the Company's annual monitoring of several key reliability indices, or statistics, metrics, or measures. Primary indices are industry standard measures developed by the Institute of Electrical and Electronics Engineers (IEEE), which are important in promoting standardized and comparable reporting across the utility industry. In addition to these IEEE indices the Company also monitors and uses in its analyses several other reliability measures, all of which are briefly described below.

- ✓ **System Average Interruption Frequency Index** – often referred to by its acronym "SAIFI," is the average number of sustained interruptions (or outages) per customer for the year. This index value, developed by the IEEE, is calculated by dividing the total number of outages on the system each year by the average total number of customers on the system

[5] Electric customers regularly report that service reliability is the most important aspect of the service they receive from their electric provider (example: JD Power reports that power quality and reliability accounts for 28% of the overall satisfaction electric customers report for their utility service).

[6] Assessing Residential Customer Satisfaction for Large Electric Utilities. L. Douglas Smith, et al., University of Missouri St. Louis, Department of Economics Working Paper #1007, May 2015.

[7] As measured in the annual customer satisfaction survey conducted by J.D. Power.

for that year. Dividing the value by the total number of customers “normalizes” the number of outages for comparison with other utilities.

- ✓ **System Average Interruption Duration Index** – often referred to by its acronym “SAIDI,” is the average duration (or length) of sustained interruptions per customer for the year. This index value, developed by the IEEE, is calculated by dividing the total number of customer outage hours (number of customers experiencing an outage multiplied by the duration of the outage) experienced on the system for the year by the average total number of customers on the system for that year. Dividing the value by the total number of customers “normalizes” the number of outages for comparison with other utilities.

- ✓ **Customer Average Interruption Duration index** – often referred to by its acronym “CAIDI,” is the average duration of sustained interruptions for those customers who actually experienced a service outage that year. This index value, developed by the IEEE, is calculated by dividing the total number of customer outage hours experienced on the system for the year by the total number of customers who experienced an outage that year. Since this measure reflects the duration of outages for customers experiencing those outages, it is often used to represent the utility’s average outage restoration time.

- ✓ **Average Outage Duration** – this measure is used by Avista to describe the average duration of outages on the system. Since this average number of hours per outage is not divided by any number of customers or any other value, it is not an index value.

- ✓ **Average Number of Customers per Outage Event** – this measure is used by Avista to describe the average number of customers that were impacted by all of the outages on the system during the year. This value is calculated by totaling all of the customers impacted by outage events for the year, and dividing by the number of outage events for the year. This measures the effectiveness of our efforts to minimize the impact of individual outage events on our customers.

- ✓ **Number of Outage Events** – this measure is simply the number of outage events on our system each year that result in a sustained outage for our customers. Since the number of outage events is not divided by any other number it is not an index value.

- ✓ **Total Customer Outage Hours** – this measure is simply the total number of customer outage hours that were experienced by the customers on our system for the year. For each event, the number of customers experiencing the sustained outage is multiplied by the duration of the outage to yield the customer outage hours for each event. Summing all of the individual events’ customer outage hours over a year yields the total customer outage hours. Since this total number of customer hours is not divided by any other number it is not an index value.

In addition to these primary reliability metrics, Avista also tracks the following measures:

- ✓ **Momentary Average Interruption Frequency Index** – often referred to by its acronym "MAIFI" this index is the average number of momentary interruptions (outages) per customer for the year. It is calculated the same way as SAIFI but uses the number of momentary outages instead of the number of sustained outages. By definition, momentary outages are of a duration less than five minutes.
- ✓ **Customer Experiencing Multiple Interruptions** – often referred to by its acronym "CEMI," this metric is the number of customers who experience greater than an identified or set number of interruptions for the year.

The standard reliability statistics and the methods of their calculation are discussed in greater detail in Appendix B of this report.

The Company is also required to report on any changes it has made in the prior year in the manner of collecting reliability data or in calculating values for each reliability index. A brief record of such changes the Company has made historically is provided in Appendix C of this report. As part of this reporting, Avista must also compare its annual reliability performance to a set of baseline reliability statistics, which were established in 2005.[8] All of the data included in this report, as noted above, is based on "system data," this is, representing our entire electric service territory in Washington and Idaho.

Results for Avista's Electric System Reliability in 2019

System Results

Results for several of these reliability measures for 2019 are provided in the table below. In addition to the current-year results we have also listed the prior year result, the five-year average for each measure, and the 2005 baseline value.

*Table 1. Avista Reliability Results for Key Measures in 2019**

Reliability Measure	2018 Result	2019 Results	Previous 5-Year Average (2014-2018)	2005 Baseline
System Average Interruption Frequency Index (SAIFI)	0.81	0.94	0.97	0.97
System Average Interruption Duration Index (SAIDI - Minutes)	126	136	149	108
Customer Average Interruption Duration Index (CAIDI - Hours)	2.60	2.42	2.56	1.87

*Excludes outage results for qualifying major event days.

[8] WAC 480-100-393(3)(b).

Major Event Days

Avista tracks and reports reliability issues associated with major events,[9] and in the table, below, lists the major event days on its system in 2019. A historic record of major event days on our system is provided in Appendix E of this report.

Table 2. Major Events[10] and Major Event Days[11] Experienced on Avista's Electric System in 2019

Major Event Day(s)	SAIDI (hours)	Event Cause
2019 Major Event Day Threshold	9.55	
July 23, 2019	26.64	Weather – Wind
October 9, 2019	45.06	Weather – Wind

System Average Interruption Frequency Index (SAIFI)

Historic Performance – The figure below shows the system average interruption frequency index on the Company's system for the seven-year period 2013 – 2019, including the linear trend.[12] Overall, the trend is improving somewhat even with the significant deviation upward in 2017, and the slight increase from 2018 to 2019. As noted last year, the number of outages for 2017 was in the highest quartile of results measured on the Company's system since 2005. By contrast, the number of outages on our system in 2018 was the lowest number recorded since we began reporting results in 2005. These "swings" in performance results demonstrate that randomly-varying factors beyond the control of the Company are the predominant drivers of our annual service reliability.

[9] Major Events and Major Event Days as used in this report are defined by the IEEE Guide for Electric Power Distribution Reliability Indices, IEEE P1366-2012. Avista's definition and use of the terms 'major events,' 'major event days' are taken from this IEEE Guide. The Company will use the process defined in IEEE P1366 to calculate the threshold value of T_{MED} and to determine MED's. All indices will be reported both including and excluding MED's. The comparisons of service reliability to the baseline statistics in subsequent years will be made using the indices calculated without MED's.

[10] Major Event – Designates an event that exceeds reasonable design and or operation limits of the electric power system. A Major Event includes at least one Major Event Day (MED).

[11] Major Event Day – A day in which the daily system SAIDI exceeds a threshold value, T_{MED}. For the purposes of calculating daily system SAIDI, any interruption that spans multiple calendar days is accrued to the day on which the interruption began. Statistically, days having a daily system SAIDI greater than T_{MED} are days on which the energy delivery system experienced stresses beyond that normally expected (such as severe weather). Activities that occur on major event days should be separately analyzed and reported.

[12] Excluding outages associated with Major Event Days.

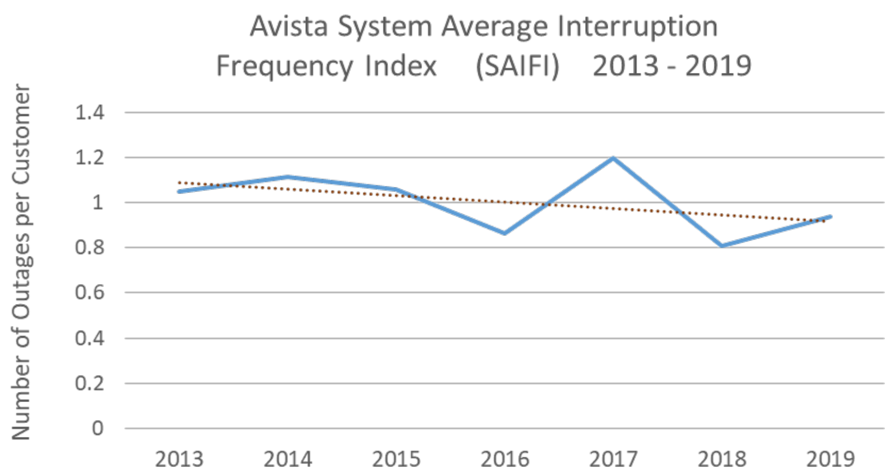

Figure 1. System Average Interruption Frequency Index (SAIFI) on Avista's Electric System 2013 – 2019

System Average Interruption Duration Index (SAIDI)

Historic Performance – The figure below shows the system average interruption duration index on the Company's electric system for the seven-year period from 2013 – 2019, including the linear trend.[13] The average duration of outages for all customers in 2017 was well above the prior years' results, and was the second-highest value measured on the Company's system since 2005. The average duration for all customers in 2018 was the lowest in this, and the prior seven-year period. The relatively low value reported in 2019, combined with the low value in 2018, has resulted in a shift of the linear trend in prior years from increasing slightly, to a new trend of decreasing, or improving slightly.

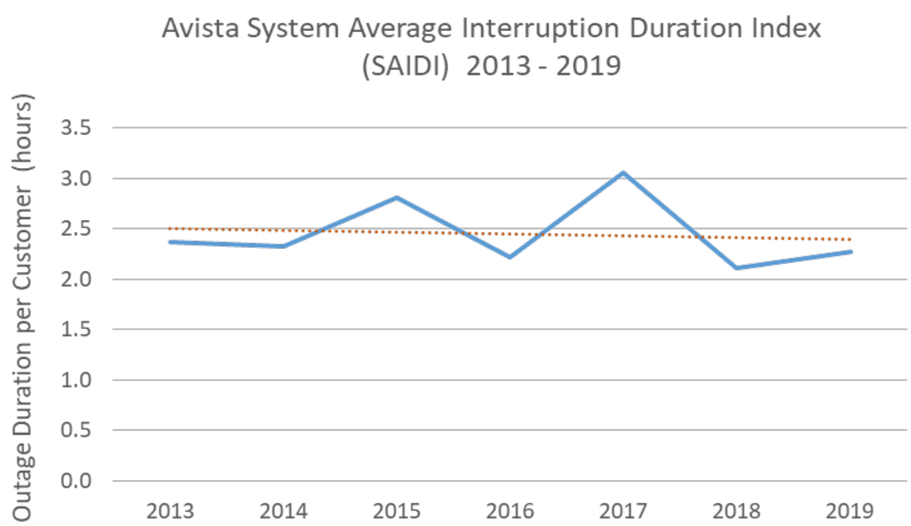

Figure 2. System Average Interruption Duration Index (SAIDI) on Avista's Electric System 2013 – 2019

[13] Excluding Major Event Days.

Customer Average Interruption Duration Index (CAIDI)

Historic Performance – The figure below shows the customer average outage restoration time on the Company's system for the seven-year period from 2013 – 2019, including the linear trend.[14] The relatively similar results reported since 2016, coupled with historically-lower results dropping out of this seven-year reporting period, have served to dampen what had been in prior years a robust increase in the linear trend. While the current trend still reflects a slight deterioration in reliability performance, the increase of 13% over this seven-year period is substantially reduced from the increase of 29% reported in the seven-year period for 2018.

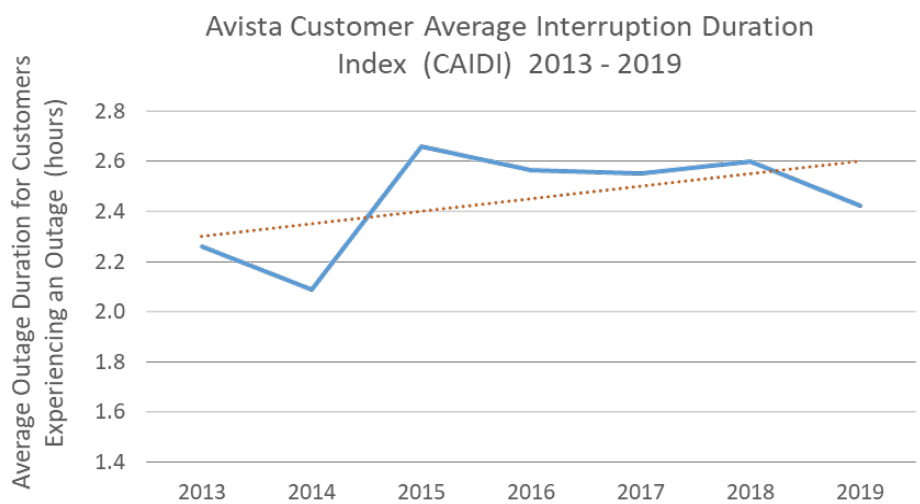

Figure 3. Customer Average Interruption Duration Index (CAIDI) on Avista's Electric System 2013 – 2019

Average Outage Duration

Results for 2018 –The figure below shows the average outage duration on Avista's system for the seven-year period 2013 – 2019, including the linear trend.[15]

[14] Excluding Major Event Days.
[15] Excluding Major Event Days.

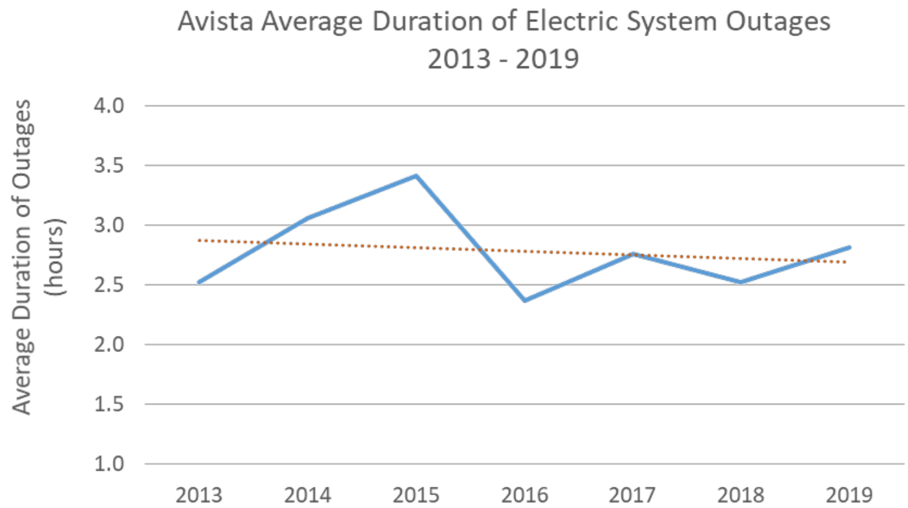

Figure 4. Average Outage Duration on Avista's Electric System 2013 – 2019

The trend reflects a modest decrease in the annual average duration of outage events on our system, even with the slight increase from 2018 to 2019. At first glance, this trend appears to conflict with the trend for customer average restoration time (CAIDI), previously discussed. This measure differs from those in that it measures only the average of outage duration times and does not include the total number of customers or number of customers associated with the outages, and therefore is not an index value.[16]

Average Number of Affected Customers per Outage Event

Results for 2019 –The figure below shows the average number of affected customers per outage event on Avista's electric system for the seven-year period 2013 – 2019, including the linear trend.[17] The trend shows a marked decrease in the average number of customers affected per outage event on our system, even with the slight increase in the average reported for 2019. This continued reduction is the result of the Company's efforts to improve fuse coordination on feeders and laterals, install midline reclosers on feeders of all types, and implement feeder automation and communications with Fault Detection Isolation and Restoration (FDIR) and other Distribution Management System capabilities.

[16] Avista believes this trend in reduced outage duration is likely the result of the increasing number of outage events associated with maintenance and upgrades on the Company's system. These "planned" outages typically involve a small number of customers and are relatively short in duration, such that they serve to reduce the overall average duration for outages of all causes.
[17] Excluding Major Event Days.

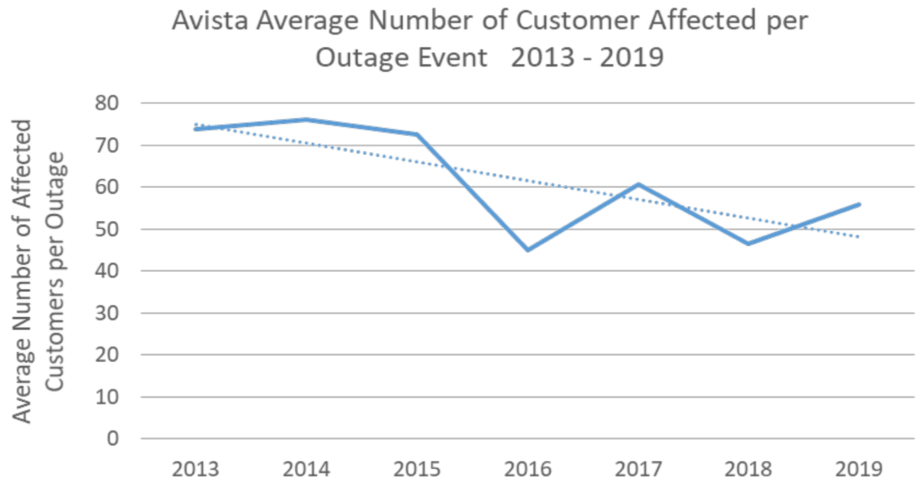

Figure 5. Average Number of Customers Affected per Outage Event on Avista's Electric System 2013 - 2019

Number of Outage Events

Results for 2019 –The figure below shows the number of outage events on Avista's system for the seven-year period 2013 – 2019, including the linear trend.[18] The result for 2018 was the first decline in recent years, and the number for 2019 was nearly identical. The linear trend for this period is a consistent and modest increase in the annual number of outage events occurring on our electric system. As in recent prior years, one of the leading factors driving an increase in the number of outage events is the amount of planned maintenance and construction work being performed on our system.

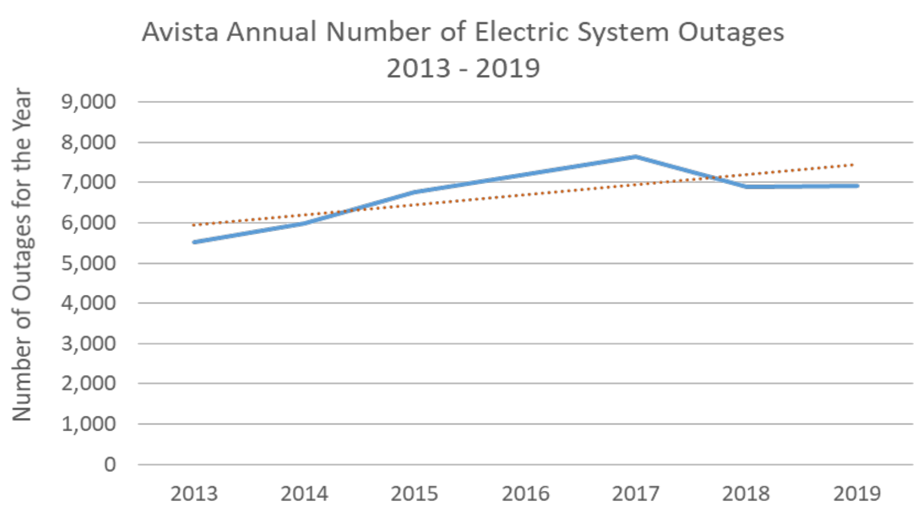

Figure 6. Annual Number of Outage Events on Avista's Electric System 2013 - 2019

[18] Excluding Major Event Days.

Customer Outage Hours

Results for 2019 – The figure below shows the number of customer outage hours on Avista's system for the seven-year period 2013 – 2019, including the linear trend.[19] With the lower reported results for 2018 and 2019, the overall trend for this seven-year reporting period is virtually flat. The formulas for calculation of the number of outages (SAIDI) and outage restoration time (CAIDI) share the same numerator, which is the number of customer outage hours. Two factors affect the customer outage hours, the number of outages and the duration of these outages. Both of these factors are discussed briefly in the sections below.

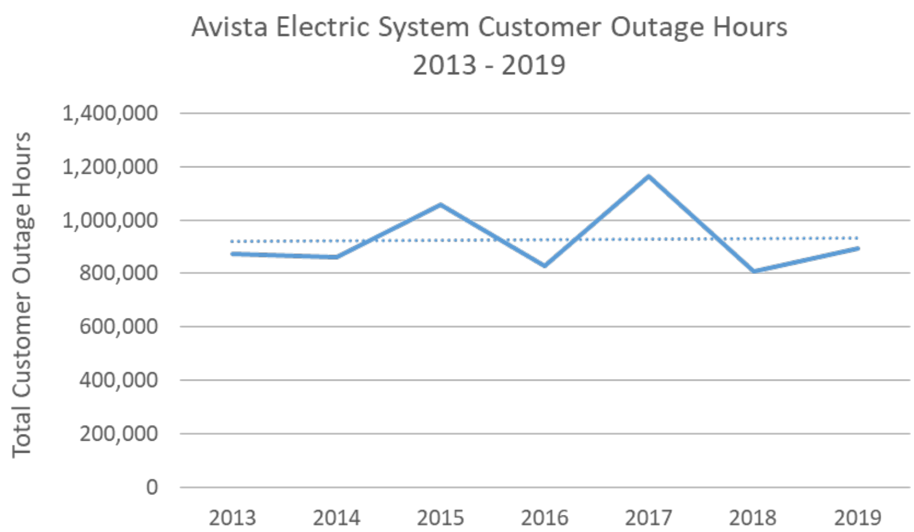

Figure 7. Total Customer Outage Hours on Avista's Electric System 2013 - 2019

Analysis of System Reliability Measures by Feeder Classification

Classification of Feeders by Customer Density

Results for 2019 – In further evaluating the reliability measures discussed above, Avista compared the statistics for feeders based on their classification as "urban," "suburban" and "rural," as shown in Table 3, below.[20]

[19] Excluding Major Event Days.
[20] Avista's feeder classification is based on customer density per feeder mile: Urban is > 150 customers per mile; Suburban is 50 to 150 customers per mile, and Rural is < 50 customers per mile.

Table 3. High Level Comparison of Avista's Urban, Suburban and Rural Feeders and Contribution to Outage Events and Customer Outage Hours. [21]

Feeder Classification	Percentage of Total Customers	Total Power Consumption (%)	Contribution to Customer Outage Hours (%)	Contribution to Number of Outage Events (%)
Urban	12.0	7.6	3.0	6.0
Suburban	52.0	45.6	25.0	36.0
Rural	36.0	46.7	72.0	58.0

In this summary we see that suburban customers dominate by number, but that rural customers stand out from those served on urban and suburban feeders in some important ways:

- ✓ Consumption of electricity on a per customer basis is highest on rural feeders.
- ✓ The number of outage events on rural feeders is disproportionately greater than for urban and suburban feeders.
- ✓ Correspondingly, customer outage hours on rural feeders accounts for more than 70% of the system total.

In the section above, we presented key reliability statistics measured at the system level, which are now reported by feeder classification in the following discussion.

System Average Outage Frequency Index (SAIFI) by Feeder Type

The system-level trend for this reliability measure, as shown above in Figure 1, reflects an improvement in reliability performance over the seven-year period. The figure below shows the strongest improving trend is for rural feeders, followed by a slight improving trend for suburban feeders, and generally stable performance for urban feeders.

[21] Results for this table are based on number of customers and electricity consumption in 2019, and their contribution to customer outage hours and number of outage events for the current seven-year period.

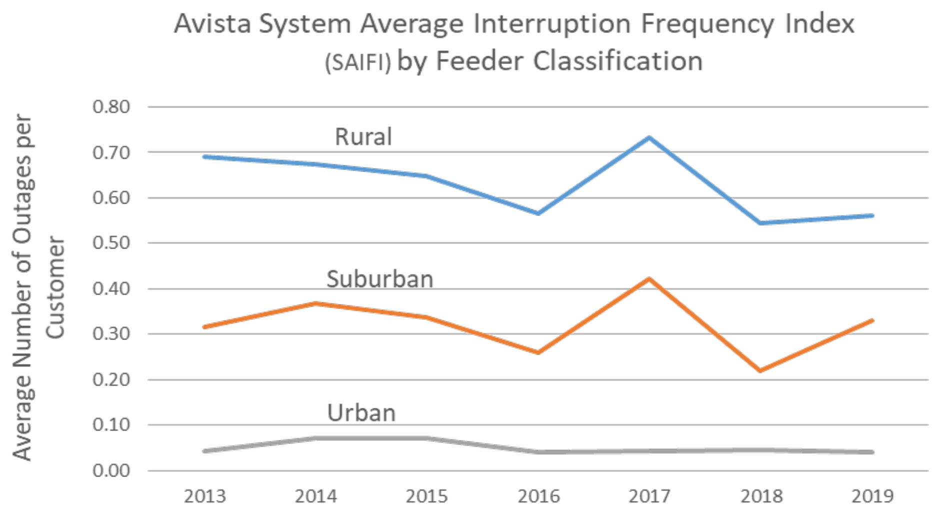

Figure 8. System Average Outage Frequency Index (SAIFI) by Feeder Classification, 2013 - 2019

System Average Outage Duration Index (SAIDI) by Feeder Type

The system-level trend for this reliability measure, as shown above in Figure 2, reflects a slight improvement in reliability performance over the seven-year period, a shift from the trends of slightly worsening performance reported in prior years. The continued reduction in outage duration for rural feeders since 2017 is largely responsible for this changing system-level trend. Results by feeder classification shown in the figure below indicates a relatively-flat trend for outage duration for rural feeders, again, a substantial shift from an increasing trend reported in prior years. The trend is slightly improving for suburban feeders, and is generally stable for urban feeders. In prior reporting years the increasing outage duration on rural feeders was driving an increase in outage duration at the overall system-level.

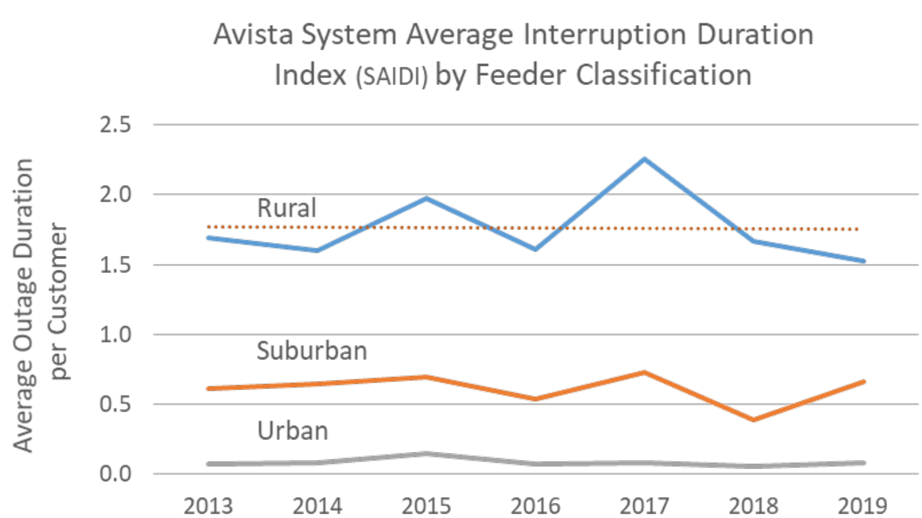

Figure 9. System Average Interruption Duration Index (SAIDI) by Feeder Classification, 2013 - 2019

Customer Average Interruption Duration Index (CAIDI) by Feeder Type

The system-level trend for this reliability measure, as shown above in Figure 3, reflects a fairly strong increase in outage restoration time for our customers who experience an outage. This is the case even with the stable to lower results reported for 2018 and 2019. Reported by feeder classification in the figure below, this index shows a very-slightly increasing trend for urban feeders, stable for suburban, and a pronounced increasing trend for rural feeders. The trend for rural feeders is less pronounced in the current seven-year average where the trend increase is approximately 20%; by contrast, the percentage increase reported for the seven-year average last year was 39%. These results show a continuing pattern, however, where the contribution of outage events on rural feeders is largely driving the overall system performance toward a modest deterioration in reliability for this index.

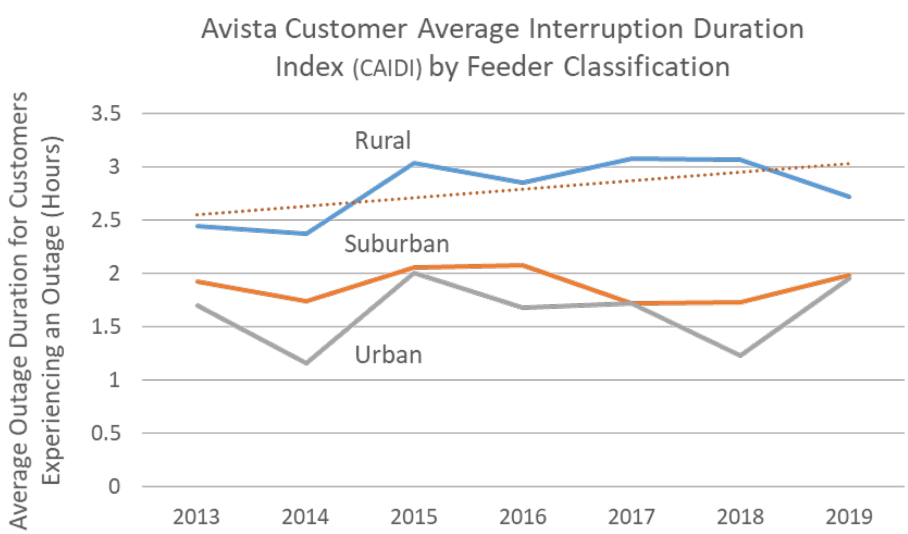

Figure 10. Customer Average Interruption Duration Index (CAIDI) by Feeder Classification, 2013 - 2019

Average Outage Duration Time by Feeder Type

While the system average annual outage duration is trending downward overall, as shown above in Figure 4, the results by feeder classification (below) show that the system trend is being driven most strongly by rural feeders. Average outage duration is trending downward slightly for customers served on suburban feeders, which is a reversal in trend from the seven-year period reported last year. Outage duration on urban feeders continues to trend slightly upward.

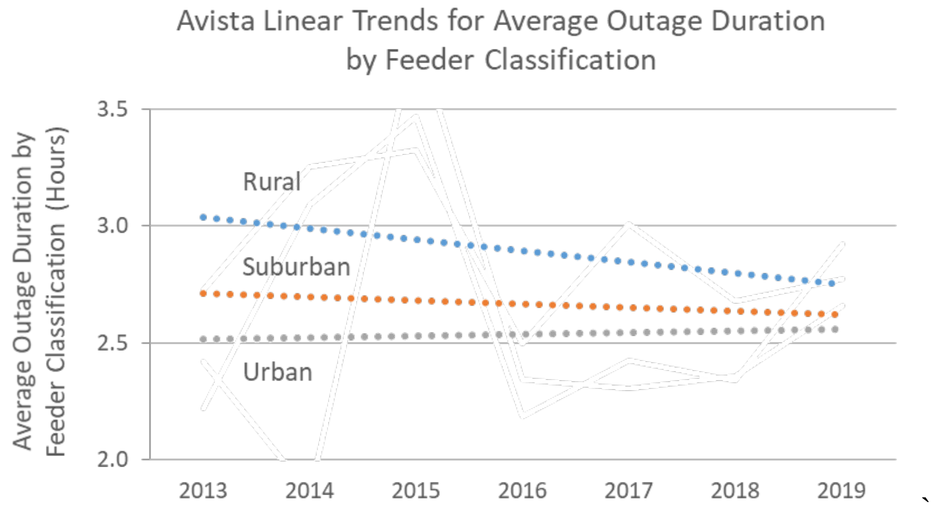

Figure 11. Linear Trend for Average Outage Duration by Feeder Classification on Avista's Electric System, 2013 - 2019

Average Number of Affected Customers per Outage Event by Feeder Type

The system average number of affected customers continues trending downward overall, as shown above in Figure 5, and the figure below shows a relatively consistent trend for urban, suburban and rural feeders on the Company's system. This pattern, as noted above, reflects the Company's multiple efforts to reduce the impact of sustained outage events on customers across its system.

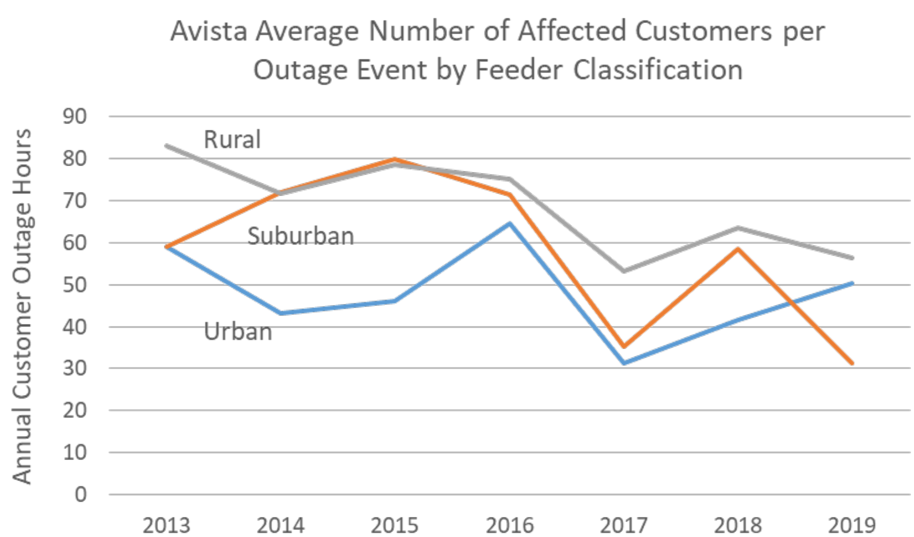

Figure 12. Average Number of Affected Customers per Outage Event by Feeder Classification, 2013 - 2019

Number of Outage Events by Feeder Type

In Figure 6, above, for number of outage events on the Company's electric system, the results showed a sustained increase in the linear trend over the seven-year period. Breaking down these events by feeder classification, however, shows the disparity in annual outages among feeder types. The number of outage events on our urban feeders is essentially flat over the period, while the upward trends for suburban and rural feeders are similar in slope. The results also show the much greater contribution of outage events associated with our rural feeders, which account for approximately half of all sustained outages.

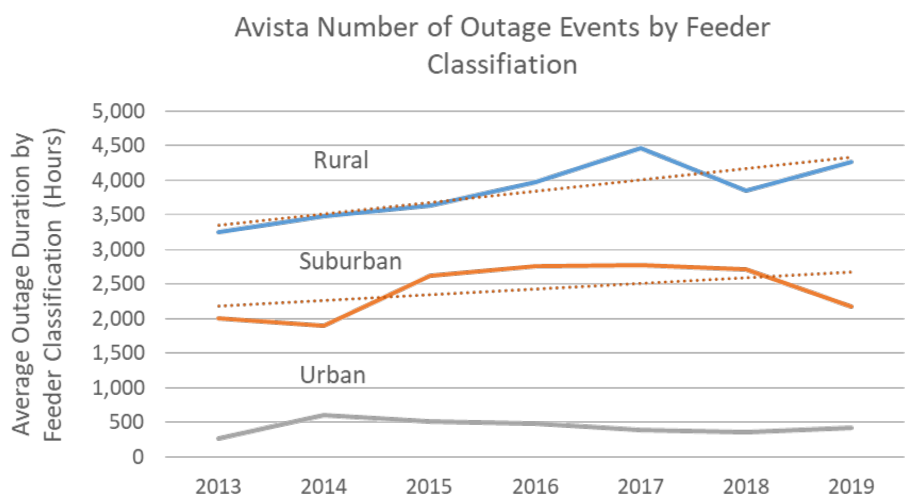

Figure 13. Number of Outage Events on Avista's Electric System by Feeder Classification, 2013 - 2019

Customer Outage Hours by Feeder Type

Figure 7, above, shows the total number of customer outage hours trending about flat on the Company's electric system over the current seven-year period. Looking at the contribution of outage hours by feeder classification shows a slight continuing increase for rural feeders, a very slight decrease for suburban feeders, and a continued flat trend for urban feeders.

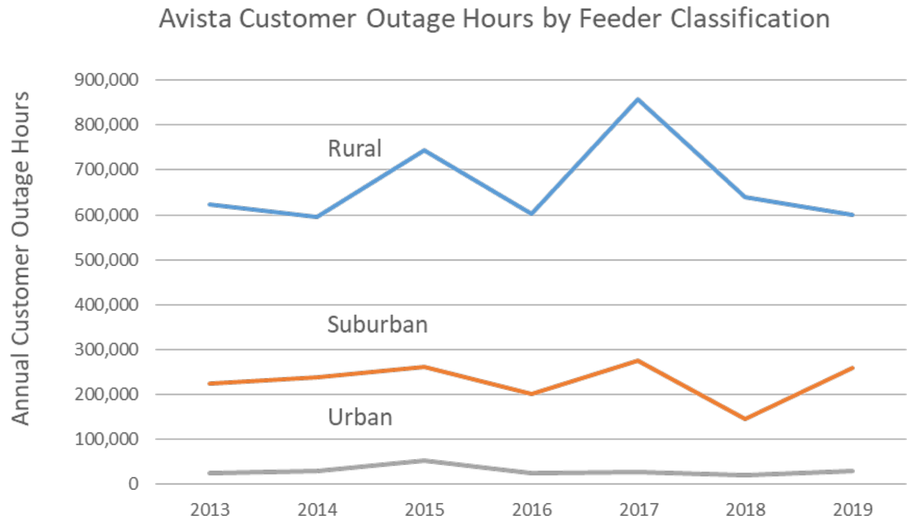

Figure 14. Customer Outage Hours on Avista's Electric System by Feeder Classification, 2013 - 2019

The figure also reflects, as referred to above, the magnitude of the contribution of outage hours for rural feeders, which accounted for over 72% of total outage hours in the current seven-year period. While the results of prior reporting showed a growing difference between urban and suburban (as a group) and the rural feeders over time, that difference in the trends has moderated in this period (while the substantial difference remains).

Overall Service Reliability by Feeder Type

Service Reliability on Urban Feeders

The Company's urban feeders serve approximately 12% of our electric customers and generally provide very-high levels of service reliability, having only 3% of the total customer outage hours and 6% of total outage events. Of the seven key measures tracked in this report, four are in a "very low" range for Avista's reliability results, and three in a "moderate" range. All measures are either very stable, generally stable or improving.

Table 4. Key Reliability Trends for Avista's Urban Feeders, 2013 – 2019

Reliability Measure	Range	Trend
System Average Interruption Frequency Index (SAIFI)	Very Low	Stable
System Average Interruption Duration Index (SAIDI)	Very Low	Stable
Customer Average Interruption Index (CAIDI)	Moderate	Stable
Average Duration of Outages	Moderate	Stable
Average Number of Affected Customers per Outage	Moderate	Decreasing
Number of Outage Events per Year	Very Low	Stable
Total Customer Outage Hours	Very Low	Stable

The one key measure that has a very slight upward trend is the average duration of outages, which has improved somewhat from the trend in the prior seven-year period.

Service Reliability on Suburban Feeders

The Company's suburban feeders serve approximately 52% of our electric customers and, like our urban feeders, generally provide very high levels of service reliability. Suburban feeders experience approximately 37% of total outage events, but account for only 24% of the total customer outage hours.

Table 5. Key Reliability Trends for Avista's Suburban Feeders, 2013 – 2019

Reliability Measure	Level	Trend
System Average Interruption Frequency Index (SAIFI)	Moderate	Stable
System Average Interruption Duration Index (SAIDI)	Low	Stable
Customer Average Interruption Index (CAIDI)	Moderate	Stable
Average Duration of Outages	Moderate	Stable
Average Number of Affected Customers per Outage	Moderate	Increasing
Number of Outage Events per Year	Moderate	Stable
Total Customer Outage Hours	Low	Stable

Of the seven key measures in the table below, all are in the range of low to moderate in Avista's range of reliability performance. Six of these measures are trending stable, while the average number of affected customers per outage is trending negatively. The average duration of outages on these feeders and the total customer outage hours have stabilized from the prior reporting period.

Service Reliability on Rural Feeders

Avista's rural feeders serve approximately 36% of our electric customers, however, they experience 58% of the total outage events, and 72% of the total customer outage hours. Reliability performance on these rural feeders, ***while reasonable for the remote conditions served***, is in the upper or "high" end of the range of Avista's reliability results. One of the measures, average number of affected customers, is generally in the same range as that for urban and suburban feeders. Five of the seven measures are stable or improving, with the performance of two continuing to worsen slightly. This compares favorably with last results from the prior seven-year period, where four of the key measures were trending negatively. As noted above, the magnitude of the difference in outage events and customer outage hours between urban and suburban feeders (as a group) and the rural feeders is tending to drive Avista's system-level results for these measures.

Table 6. Key Reliability Trends for Avista's Urban Feeders, 2013 – 2019

Reliability Measure	Level	Trend
System Average Interruption Frequency Index (SAIFI)	High	Decreasing
System Average Interruption Duration Index (SAIDI)	High	Stable
Customer Average Interruption Index (CAIDI)	High	Increasing
Average Duration of Outages	High	Decreasing
Average Number of Affected Customers per Outage	Moderate	Decreasing
Number of Outage Events per Year	High	Increasing
Total Customer Outage Hours	High	Stable

Though the average duration of outages is decreasing on our rural feeders, the system and customer average interruption duration indices are increasing due to the increasing number of outage events experienced on these feeders. Likewise, the total customer outage hours are trending upward because the increase in the number of outage events is outpacing the downward trending number of customers impacted per outage event.

Service Reliability of Avista's Rural Feeders

Customer Outage Hours

In the prior reporting period, the Company's rural feeders added an average of just over 20,000 customer outage hours each year to our system total (or 140,000 additional hours for the seven-year period). For the current period, 2013 – 2019, this negative trend has slowed to a more gradual increase of approximately 40,000 cumulative hours. The table below shows the average rates of change for the top 12 factors, the net of which has contributed to this annual average increase in customer outage hours.

Table 7. Average Annual Change in Customer Outage Hours by Reason and Sub-Reason for Avista's Rural Feeders, 2013 - 2019

Outage Cause Category	**Average Annual Rate of Change (Hours/Year)**
Company Maintenance / Upgrade	9,281
Public Caused	6,295

Tree Caused	5,982
Undetermined Cause	5,135
Pole Fire	2,048
Animal Caused	635
Underground Equipment Failure	478
Miscellaneous Caused	163
Company Operations	126
Overhead Equipment Failure	-398
Substation Equipment Failure	-1,091
Weather Caused	-8,581

The reasonably good news from this assessment is that the leading cause of increased outage events and customer outage hours is Avista's own work to improve the condition of these feeders. In this same vein, investments made in the system are having the effect of slightly reducing the customer outage hours associated with overhead and substation equipment failures. Fortuitously, customer outage hours associated with weather caused outage events were also reduced by a significant measure, likely due in some small part to the maintenance/upgrade work being performed by the Company on its rural feeders.

Beyond Company maintenance/upgrade activities, other leading causes of the increase in total customer outage hours included public caused, such as "car hit pole" incidents, tree-caused outages, outages of undetermined cause, and pole fires. The top twelve contributing reasons (and sub-reasons) to customer outage hours on our rural feeders are shown in the figure below.

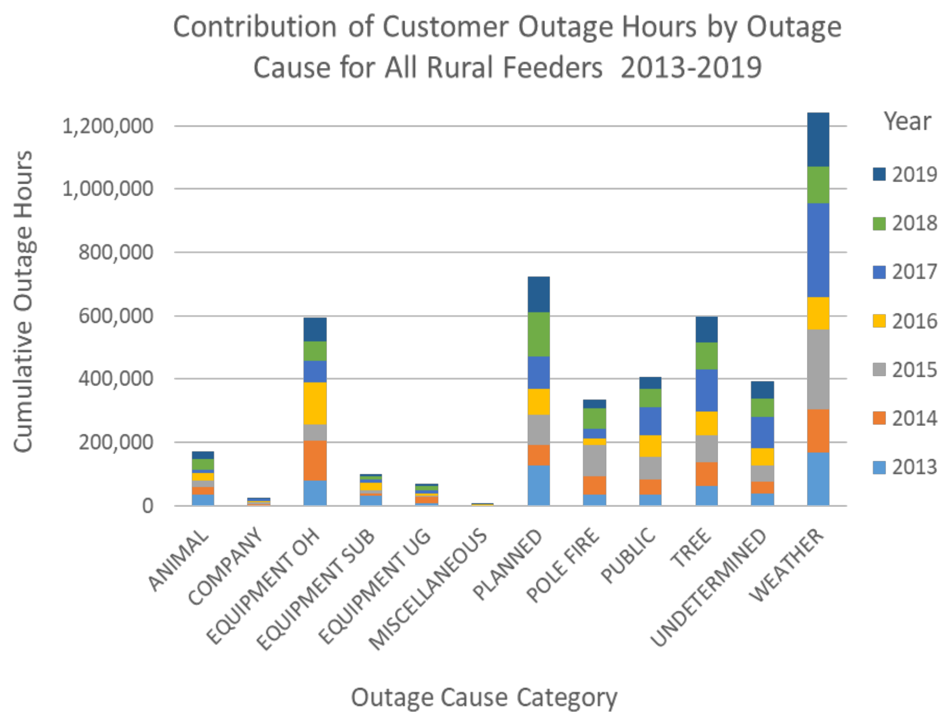

Figure 15. Contribution to Customer Outage Hours by Outage Cause on Avista's Rural Feeders, 2013 – 2019

As is typical on Avista's system, weather-related outages were the leading contributor to customer outage hours on our rural feeders, contributing over 1.2 million hours over the seven-year period. The second leading cause is Avista's maintenance/upgrade activities, which contributed over 700,000 outage hours, an increase of approximately 100,000 hours from last year. In order of contribution from other causes were outages caused by tree fell, overhead equipment failure, public (such as car hit pole), undetermined cause, pole fire, and animal-caused outages.

Feeders with Greatest Service Reliability Challenges

For the purposes of this limited discussion, we identified the top ten feeders on our system that have faced the greatest reliability challenge in the current reporting period, based on five of the reliability measures discussed above, plus the category of five year trend in outage events. The individual feeders are listed by the code abbreviations Avista uses as a naming convention for feeders in its system (e.g. STM633 refers to feeder number 633, originating from the St. Maries substation).

Table 8. Top Ten Most-Challenging Feeders by Reliability Measure

System Average Interruption Frequency Index (SAIFI)	System Average Interruption Duration Index (SAIDI)	Customer Average Interruption Duration Index (CAIDI)	Total Customer Outage Hours	Annual Number of Outage Events	Five-Year Trend in Outage Events
STM633	CLV34F1	CLV34F1	CLV34F1	ARD12F2	CLV34F1
CLV34F1	GIF34F1	GIF34F1	GIF34F1	BLU321	KET12F2

GIF34F1	STM633	STM633	STM633	CHW12F2	SOT523
GRV1273	GRV1273	GRV1273	GRV1273	CHW12F3	DER651
SPI12F1	GIF34F2	GIF34F2	GIF34F2	CLV34F1	GRV1273
STM631	ORI12F3	ORI12F3	ORI12F3	GIF34F1	ORO1281
BLU321	SPI12F1	SPI12F1	SPI12F1	KET12F2	EFM12F1
GIF34F2	STM631	STM631	STM631	MLN12F1	LIB12F3
ORI12F3	BLU321	BLU321	BLU321	ORI12F3	SAG741
SAG741	WEI1289	WEI1289	WEI1289	RAT233	OLD721

The pattern immediately evident is the relative consistency of the individual feeders on the list for the first four measures (SAIFI, SAIDI, CAIDI, and Customer Outage Hours). Since the increase in outage events on rural feeders has been a key contributor to customer outage hours, we also listed the most challenging feeders for that reliability measure. Evaluating feeders by this measure resulted in the addition of six new feeders to list compared with the four prior measures. Sorting the rural feeders by the five-year trend in outage events introduces six new feeders to the list (feeders that were not previously listed for any of the other reliability measures in the table).

Looking specifically at the measure for customer outage hours, Avista calculated the cumulative outage hours (2013 – 2019) for the top ten most challenging feeders by outage reason or cause, shown in the figure below.

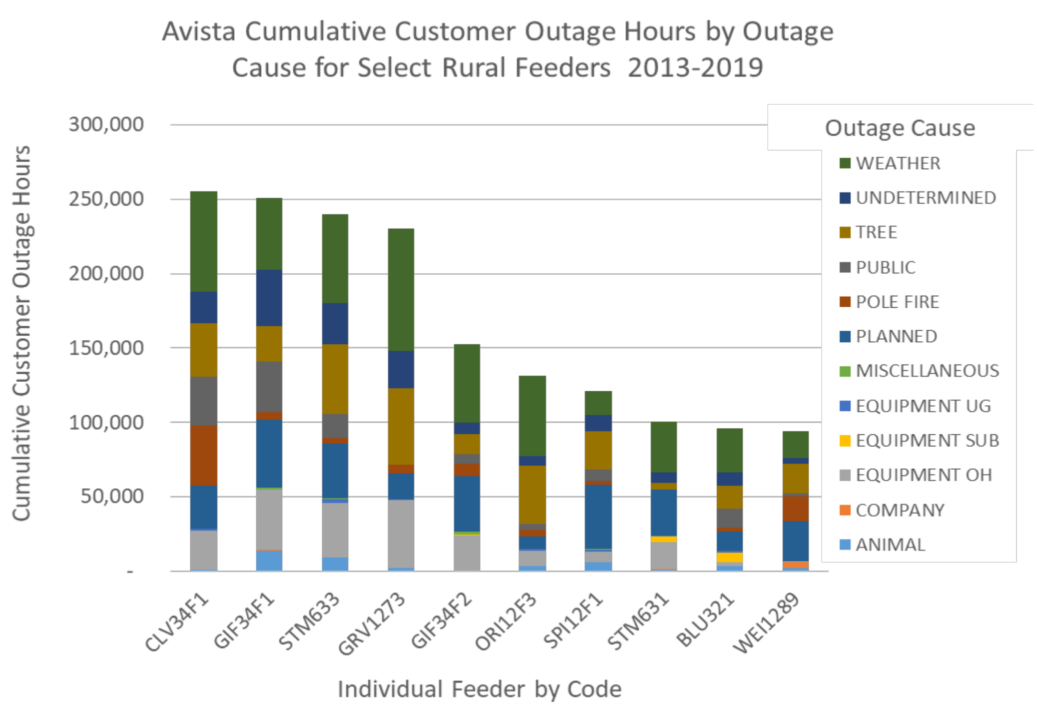

Figure 16. Cumulative Outage Hours by Feeder and Outage Cause, 2013 – 2019

Depending on the reliability objectives being pursued, and the reliability measure determined to be important, this type of analysis could be useful for identifying what types of measures could be implemented in order to improve targeted performance.

Summary of Investments in Rural Feeders in 2019

Avista engineering and operations staff, apart from our ongoing Asset Maintenance programs[22] are continuously evaluating opportunities to maintain the overall performance of the Company's rural feeders. These include specific investments that have the benefit of improving the service reliability of poorly-performing circuits. Among these programs are Grid Modernization, Failed Plant and Operations, Feeder Tie and Reconductor, Feeder Minor Rebuild, etc. A brief summary of these program investments made in 2019 is provided in the table below.[23]

Table 9. Brief Summary of Feeder Investments in 2019

Feeder	Key Objectives	Work Performed	Investment
MRT13632	Asset condition based replacements, thermal capacity increase.	Replaced 8-100 year old PILC cable, installed cable splices at 20 locations to tie cable into the existing network.	$300,000
WAS781	Improve service reliability on the feeder served by radial transmission.	Converted single phase to three phase and interconnected with Franklin County PUD to create a backup feed in the event of a substation, feeder or transmission outage. Also replaced end of life poles, installed a regulator bank and a Viper recloser at the interconnection point.	$350,000
GIF34F1	Improve service reliability for customers downstream of an area with frequent outages.	Installed a Viper recloser approximately 11.5 miles south of the Hunters substation.	$67,000
ORI12F3	Performance and capacity improvements and asset condition replacements.	Reconductoring approximately 3.5 miles in a multi-year project to improve voltage and loading issues, and to replace end of life assets based on condition.	$113,000
SLK12F2	Improve reliability in high-impact outage area and remediate voltage and fuse coordination issues.	Rerouted existing overhead circuit to VMC, installed new poles and conductor. Performed load rebalancing to correct low voltage, and implemented an improved fuse coordination strategy to reduce outage impacts.	$196,000

[22] Avista's Asset Maintenance programs include Wood Pole Management, Vegetation Management, Street Lighting, and Overhead Transformer Changeout.
[23] Investment amounts presented to the nearest $thousand.

SEA12F6	Tie in new feeder to substation to improve capacity and reliability.	Created a feeder tie in the overhead station requiring several sections of new conductor and structures. Reliablity improved through added capacity and reduced exposure to feeder length.	$14,000
MEA12F3	Add feeder capacity and improve reliability.	Constructed new section of primary underground circuit and transferred exising load from adjacent feeders. Reliability improved through greater capacity and reduced exposure to feeder length.	$209,000
LEON611	Overhead to underground conversion to improve reliability.	Rebuilt a feeder lateral by converting an aged section of overhead conductor to underground cable to improve reliability on this feeder.	$13,000
COT2402	Improve reliability through improved fuse coordination and automation.	Replaced existing fusing with a midline, 3 Phase Kyle recloser.	$26,000
CRG1261	Replace end of life cable based on asset condition and improve reliability.	Existing and deteriorated underground cable on the circuit replaced with new cable.	$43,000
ORO1281	Improve safety, reliability and feeder capacity.	Existing and deteriorated overhead circuit, including issues with non-standard framing, was rebuilt and reconductored.	$34,000
DER651	Improve service reliability through automation.	Existing fusing on the feeder was replaced with a midline TripSaver recloser, to reduce the impact of outages for customers on the feeder.	$3,000
NLW-LMR	Improve reliability on North Lewiston Substation.	This was the first stage of installing a new circuit tie between North Lewiston Substation and the Lewiston Mill Road Substation. The North Lewiston Substation has no other existing ties to other substations.	$399,000
BLU322	Wood Pole inspection and rebuild based on asset condition.	Application of Avista's ongoing Wood Pole Management Program to inspect, reinforce and replace or the extend the life of assets based on condition.	$68,000
RAT233	Grid Modernization feeder rebuild to achieve multiple objectives.	Application of Avista's ongoing Grid Modernization Program to replace assets based on end of life, manage capacity issues and long term O&M costs, and to improve service reliability.	$1,180,000

STM633	Ehancements for new service connections, and to enhance service reliability.	Added a three-phase loop to the feeder, including about 7,500 feet of overhead line reconductored, poles replaced based on condition, and 1,200 feet of new underground circuit. While, the primary need was for new customer connects, the design also improves service reliability for about 320 customers served on the feeder.	$518,000
WAL543	Replacement of underground cable based on asset condition.	Approximately 1/2 mile of three-phase underground cable was replaced on Pritchard Creek, based on the need for end-of-life assets. This will benefit service reliability for customers served from this section of the feeder.	$75,000

Appendices

Appendix A - Definitions

"Baseline reliability statistic" – Avista will compare its reliability statistics to the year 2005.

"Commission Complaint" – When a customer is not satisfied with the Company as it relates to Electric Reliability and files a complaint directly with the Commission.

"Customer Complaint" - When a customer is not satisfied with the Company as it relates to Electric Reliability and makes a complaint directly to a Company representative.

"Electric Service Reliability" - The continuity of electric service experienced by retail customers.

"*Electric System Reliability Reporting Requirements*" – The minimum reporting requirements are as follows:

> *(1) The report must be consistent with the electric service reliability monitoring and reporting plan filed under WAC 480-100-393. As set forth in the plan, in an identified year, baseline reliability statistics must be established and reported. In subsequent years, new reliability statistics must be compared to the baseline reliability statistics and to reliability statistics from all intervening years. The utility must maintain historical reliability information necessary to show trends for a minimum of seven years.*
>
> *(2) The report must address any changes that the utility may make in the collection of data and calculation of reliability information after initial baselines are set. The utility must explain why the changes occurred and explain how the change is expected to affect comparisons of the newer and older information. Additionally, to the extent practical, the utility must quantify the effect of such changes on the comparability of new reliability statistics to baseline reliability statistics.*
>
> *(3) The report must identify the utility's geographic areas of greatest reliability concern, explain their causes, and explain how the utility plans to address them.*
>
> *(4) The report must identify the total number of customer complaints about reliability and power quality made to the utility during the year, and must distinguish between complaints about sustained interruptions and power quality. The report must also identify complaints that were made about major events.*

"Full-system" - All equipment and lines necessary to serve retail customers whether for the purpose of generation, transmission, distribution or individual service.

"Interruption Cause Code" – Used to describe the cause of an interruption (i.e., animal, tree, public, etc…).

"Major Event" – Designates an event that exceeds reasonable design and or operation limits of the electric power system. A Major Event includes at least one Major Event Day (MED).

"Major Event Day" – A day in which the daily system SAIDI exceeds a threshold value, T_{MED}. For the purposes of calculating daily system SAIDI, any interruption that spans multiple calendar days is accrued to the day on which the interruption began. Statistically, days having a daily system SAIDI greater than T_{MED} are days on which the energy delivery system experienced stresses beyond that normally expected (such as severe weather). Activities that occur on major event days should be separately analyzed and reported.

"Momentary Event Interruption" – An interruption(s) of duration 5 minutes or less. Each event consists of one trip and one reclose operation that occur within 5 minutes. For example, if an interrupting device operates three times and then holds, this would be counted as three events with the number of customers affected as three times the Ni.

"Power Quality" – Characteristics of electricity, primarily voltage and frequency, that must meet certain specifications for safe, adequate and efficient operations.

"*Reliability Statistic"* – Standard Statistics measures and calculation methods are per the IEEE Standard 1366-2003 (or latest version) Titled "IEEE Guide for Electric Power Distribution Reliability Indices". Same as Reliability Indices.

"Sustained Interruption" - An interruption lasting longer than 5 minutes.

Appendix B - Index Calculations

SAIFI – System Average Interruption Frequency Index

- The average number of sustained interruptions per customer
- = The number of customers which had ***sustained interruptions*** / Total number of customers served
- = $\frac{\sum N_i}{N_T}$

$MAIFI_E$ – Momentary Average Interruption Event Frequency Index

- The average number of momentary interruption events per customer
- = The number of customers which had ***momentary interruption events*** / Total number of customers served
- = $\frac{\sum ID_E N_i}{N_T}$
- MAIFI can be calculated by one of two methods. Using the number of momentary interruptions or the number momentary events. This report calculates $MAIFI_E$ using momentary events. The event includes all momentary interruptions occurring within 5 minutes of the first interruption. For example, when an automatic interrupting device opens and then recloses two, or three times before it remains closed, it is considered a single event.

SAIDI – System Average Interruption Duration Index

- ✓ Average sustained outage time per customer
- = Outage duration multiplied by the customers effected for all ***sustained interruptions*** / Total number of customers served
- = $\frac{\sum r_i N_i}{N_T}$

CAIDI – Customer Average Interruption Duration Index

- Average restoration time
- = Outage duration multiplied by the customers effected for all ***sustained interruptions*** / The number of customers which had ***sustained interruptions***
- = $\frac{\sum r_i N_i}{\sum N_i}$

Quantities

i = An interruption event;

r_i *= Restoration time for each interruption event;*

T = Total;

ID_E *= Number of interrupting device events;*

N_i = Number of interrupted customers for each interruption event during the reporting period;
N_T = Total number of customers served for the area being indexed;

$CEMI_n$ – Customers Experiencing Multiple Sustained Interruptions more than n.

- $CEMI_n$
- = Total Number of Customers that experience more than *n* **sustained interruptions** / Total Number of Customers Served
- = $\frac{CN_{(k>n)}}{N_T}$

$CEMSMI_n$ – Customers experiencing multiple sustained interruption and momentary interruption events.

- CEMSMIn
- = Total Number of Customers experiencing more than *n* **interruptions** / Total Number of Customers Served
- = $\frac{CNT_{(k>n)}}{N_T}$

MED - Major Event Day
A major event day is a day in which the daily system SAIDI exceeds a threshold value. Its purpose is to allow major events to be studied separately from daily operation, and in the process, to better reveal trends in daily operation that would be hidden by the large statistical effect of major events.

T_{MED} is calculated (taken from the IEEE 1366-2003 Standard)
The major event day identification threshold value, T_{MED}, is calculated at the end of each reporting period (typically one year) for use during the next reporting period as follows:

a) Collect values of daily SAIDI for five sequential years ending on the last day of the last complete reporting period. If fewer than five years of historical data are available, use all available historical data until five years of historical data are available.
b) Only those days that have a SAIDI/Day value will be used to calculate the T_{MED} (do not include days that did not have any interruptions).
c) Take the natural logarithm (ln) of each daily SAIDI value in the data set.
d) Find a(Alpha), the average of the logarithms (also known as the log-average) of the data set.
e) Find b(Beta), the standard deviation of the logarithms (also known as the log-standard deviation) of the data set.
f) Compute the major event day threshold, TMED, using equation (25).

$$T_{MED} = e^{(a + 2.5\,b)}$$

g) Any day with daily SAIDI greater than the threshold value TMED that occurs during the subsequent reporting period is classified as a major event day. Activities that occur on days classified as major event days should be separately analyzed and reported.

When an event has reached the threshold to constitute a MED described in subpart (f) above, all outage incidents associated with the MED will be flagged in the Company's Outage Management Tool. As the Company further assesses damage in the field while making repairs, new subsequent outage incidents that were a result of the MED may be created as more accurate information is made available. The subsequent incidents will be flagged and included as part of original outage event and MED.

Avista's Methodology for Calculating CEMI

The IEEE Standard 1366P-2003 provides for two methods to analyze data associated with customers experiencing multiple momentary interruptions and/or sustained interruptions. Avista's Outage Management Tool (OMT) and Geographical Information System (GIS) provide the ability to geospatially associate an outage to individual customer service points. This association allows for graphically showing Customers Experiencing Multiple sustained Interruptions ($CEMI_n$) with Major Event Day data included onto GIS produced areas. Data can be exported to MS Excel to also create graphs representing different values of n. The calculation for $CEMI_n$ and Customers Experiencing Multiple Sustained and Momentary Interruptions $CEMSMI_n$ is provided in Attachment B.

Avista has used the data from the OMT system integrated with the GIS system to geospatially display reliability data for specific conditions. The specific conditions imply looking at the number of sustained interruptions for each service point (meter point). This would be similar to the SAIFI index, but would be related to a certain number of sustained interruptions. Avista includes all sustained interruptions including those classified under Major Event Days. This provides a view of what each customer on a specific feeder experiences on an annual basis. Momentary Interruptions are not included in the $CEMI_n$ index because by IEEE definition only applies to sustained outages. Other Momentary Indices are not included because of the lack of indication at many rural substations and line locations.

Appendix C - Methods and Measures

WAC 480-100-398 (2) requires the Company to report changes made in data collection or calculation of reliability information after initial baselines are set. This section addresses changes that the Company has made to data collection.

Data Collection

Since Avista's Electric Service Reliability Monitoring and Reporting Plan was filed in 2001 (UE-011428), there have been several improvements in the methods used to collect outage data. In late 2001, centralizing the distribution trouble dispatch and data collection function for Avista's entire service territory began. The distribution dispatch office is located in the Spokane main complex. At the end of September 2005, 100% of the Company's feeders, accounting for 100% of the customers, are served from offices that employ central dispatching.

The data collected for 2016 represents the tenth full year of outage data collected through the Outage Management Tool (OMT). For 2016, all data was collected using the "Outage Management Tool" (OMT) based on the Company's Geographic Information System (GIS). The OMT system automates the logging of restoration times and customer counts.

Avista discovered a software coding error that has been within the OMT system since 2002 that caused a small increase in the SAIDI and CAIDI for 2008. Previous years were also evaluated to determine the overall impact to the Avista baseline statistics and at this time Avista is not proposing a change to the baseline numbers. The software error only occurred during very specific outage conditions when a group of customers with an initial outage starting time were "rolled" up into another group of customers that were determined to be part of the first group outage. The second group may have had a later outage starting time. When the first group of customer outage information was rolled up, the original outage starting time was lost and the second group outage starting time was used for both groups of customers instead of using the first outage starting time. The number of customers was counted correctly.

Even as good as the OMT system is at quantifying the number of customers and duration of the outage duration, there still are areas where the data collection is not precise. Determining the exact starting time of an outage is dependent on when a customer calls in, how well the Avista Distribution Dispatcher determines where the outage is and defines the device that has opened to remove the faulted section.

As AMR/AMI metering is implemented in the future and the customer meter provides outage information to the OMT system through an interface, the SAIDI and CAIDI numbers are expected to increase. This is similar to the above discussion.

Use of the OMT system and GIS data has improved the tracking of the numbers of customers without power, allowed for better prioritization of the restoration of service, and the improved dispatching of crews.

Appendix D - Areas of Greatest Concern

Please see Table 8, above, for the Company's current listing of worst performing feeders based on current service reliability results. Figure 15 and Table 9 also provide feeder specific information related to outage causes by reason and sub-reason, as well as total outage events. As Avista notes in the discussion above, because there are a number of approaches for determining "worst" performance, the designation of worst performing feeders should be informed by the reliability objectives the Company is intending to achieve. Avista is currently in the process of developing a new set of electric system reliability performance measures and strategic supporting plan. Accordingly, we anticipate that our report on 2019 service reliability performance will provide new information, analysis and recommendations on worst feeder performance based on these new objectives.

Appendix E - Historic Major Event Days on Avista's System

The following table is provided as an initial review of Major Event Day information. The main premise of the IEEE Major Event Day calculation is that using the 2.5b method should classify 2.3 days each year as MED's. The following table shows the previous major event days, the daily SAIDI value and the relationship of the yearly T_{MED}.

Year	Date	SAIDI	T_{MED}
2004	05-21-2004	7.11	6.35
	08-02-2004	7.36	
	12-08-2004	31.00	
2005	06-21-2005	39.53	4.916
	06-22-2005	9.03	
	08-12-2005	19.60	
2006	01-11-2006	12.10	7.058
	03-09-2006	8.58	
	11-13-2006	30.79	
	12-14-2006	29.26	
	12-15-2006	158.31	
2007	01-06-2007	9.98	8.017
	06-29-2007	32.64	
	07-13-2007	12.79	
	08-31-2007	21.30	
2008	01-27-2008	17.57	9.224
	07-10-2008	36.74	
	08-18-2008	9.49	
2009	None		9.925
2010	5/3/2010	21.04	11.110
	11/16/2010	68.67	
2011	None		10.848
2012	1/19/2012	9.93	9.489
	12/17/2012	14.35	
2013	8/25/2013	24.97	8.956
	8/26/2013	11.78	
	9/15/2013	14.01	
	11/16/2013	11.09	
2014	7/23/14	92.95	8.719
	7/24/14	35.66	
	8/25/14	121.05	
	8/3/14	38.52	
	8/12/14	9.84	
2015	8/29/15	13.42	8.219

	9/30/15	9.99	
	11/17/15	2093.19	
	11/18/15	399.34	
	11/19/15	147.97	
	11/20/15	66.96	
	11/21/15	47.30	
	11/22/15	32.61	
	11/23/15	15.38	
	11/24/15	12.19	
	12/23/15	29.35	
	12/24/15	19.24	
2016	None		10.171
2017			10.189
2018	1/24/18	12.08	10.47
	11/24/18	13.30	

Appendix F - Interruption Cause Codes

Cause code information is provided in this report to give readers a better understanding of outage sources. Further, the Company uses cause information to analyze past outages and, if possible, reduce the frequency and duration of future outages.

Since 2011, Avista has stopped using the subcategory "protected" under the "Animal" category. Almost all birds are considered protected, so there is little differentiation between the "Bird" and "Protected" subcategories. Avista will include additional information in the Remarks section as reported from the field personnel. .

MAIN CATEGORY	SUB CATEGORY	Definition
ANIMAL	Bird Squirrel Underground Other	Outages caused by animal contacts. Specific animal called out in sub category.
PUBLIC COMPANY	Car Hit Pad Car Hit Pole Dig In Fire Tree Other Dig in Other	Underground outage due to car, truck, construction equipment etc. contact with pad transformer, junction enclosure etc... Overhead outage due to car, truck, construction equipment etc. contact with pole, guy, neutral etc. Dig in by a customer, a customer's contractor, or another utility. Outages caused by or required for a house/structure or field/forest fire. Homeowner, tree service, logger etc. fells a tree into the line. Other public caused outages Dig in by company or contract crew. Other company caused outages
EQUIPMENT OH	Arrestors Capacitor Conductor - Pri Conductor - Sec Connector - Pri Connector - Sec Crossarm- rotten Cutout / Fuse Insulator Insulator Pin Other Pole - Rotten Recloser Regulator Switch / Disconnect	Outages caused by equipment failure. Specific equipment called out in sub category. Wildlife guard failed or caused an outage

	Transformer - OH Wildlife Guard	
EQUIPMENT UG	URD Cable - Pri URD Cable- Sec Connector - Sec Elbow Junctions Primary Splice Termination Transformer - UG Other	Outages caused by equipment failure. Specific equipment called out in sub category.
EQUIPMENT SUB	High side fuse Bus Insulator High side PCB High side Swt / Disc Lowside OCB/Recloser Low side Swt / Disc Relay Misoperation Regulator Transformer Other	
MISCELLANEOUS		For causes not specifically listed elsewhere
NOT OUR PROBLEM (*Outages in this category are not included in reported statistics*)	Customer Equipment Other Utility	Customer equipment causing an outage to their service. If a customer causes an outage to another customer this is covered under Public. Outages when another utility's facilities cause an outage on our system.
POLE FIRE		Used when water and contamination causes insulator leakage current and fire. If insulator is leaking due to material failure list under equipment failure. If cracked due to gunfire use customer caused other.

PLANNED TREE UNDETERMINED	Maintenance / Upgrade Forced Tree fell Tree growth Service Weather	Outage, normally prearranged, needed for normal construction work. Outage scheduled to repair outage damage. For outages when a tree falls into distribution primary/secondary or transmission during normal weather. Tree growth causes a tree to contact distribution primary/secondary or transmission during normal weather. For outages when a tree falls or grows into a service. When snow and wind storms causes a tree or branch to fall into, or contact the line. Includes snow loading and unloading. Use when the cause cannot be determined.
WEATHER	Snow / Ice Lightning Wind	Outages caused by snow or ice loading or unloading on a structure or conductor. Use weather tree for snow and ice loading on a tree. Lightning flashovers without equipment damage. Equipment failures reported under the equipment type. Outages when wind causes conductors to blow into each other, another structure, building etc.