



May 18, 2020

The Honorable Chair and Members
of the Hawai'i Public Utilities Commission
Kekuanao'a Building, First Floor
465 South King Street
Honolulu, Hawai'i 96813

Dear Commissioners:

Subject: Hawaiian Electric Annual Service Reliability Reports for 2019

Hawaiian Electric Company, Inc., Hawai'i Electric Light Company, Inc., and Maui Electric Company, Limited¹ respectfully submit a copy of its Annual Service Reliability Report for the year 2019. (See Attachments 1, 2, and 3, respectively.)

Sincerely,

/s/ Kevin M. Katsura

Kevin M. Katsura
Director, Regulatory Non-Rate Proceedings

Enclosures

c: Division of Consumer Advocacy

¹ Hawaiian Electric Company, Inc., Maui Electric Company, Limited, and Hawai'i Electric Light Company, Inc. are each doing business as "Hawaiian Electric" and have jointly registered "Hawaiian Electric" as a trade name with the State of Hawai'i Department of Commerce and Consumer Affairs, as evidenced by Certificate of Registration No. 4235929, dated December 20, 2019.

HAWAIIAN ELECTRIC COMPANY, INC.

ANNUAL SERVICE RELIABILITY REPORT

2019

May 12, 2020

INTRODUCTION

This is Hawaiian Electric Company, Inc.'s 2019 annual service reliability report.

The service reliability indices provided in this report are commonly used in the electric power utility industry as a method of measuring system reliability performance. These include overall availability of electrical service during a given period of time (Average Service Availability Index or ASAI), the average frequency or number of times customers experience a sustained interruption of service during a given period of time (System Average Interruption Frequency Index or SAIFI), the average length of time an interrupted customer is without power during a given period of time (Customer Average Interruption Duration Index or CAIDI), and the average length of time customers are without power during a given period of time (System Average Interruption Duration Index or SAIDI). SAIDI is an indication of overall system reliability because it incorporates the impact of frequency and duration of outages on the total customer base. The Appendix contains definitions, explanations, and equations for the reliability indices.

METHODOLOGY

The reliability indices provided in this report are calculated using the Institute of Electrical and Electronics Engineers (IEEE) Standard 1366TM-2012 methodology. Indices reported on a normalized basis exclude Major Event Days (MEDs). MEDs are defined as days in which the daily system SAIDI exceeds the MED threshold value (T_{MED}). Statistically, days having a daily system SAIDI greater than T_{MED} indicate days on which the energy delivery system experienced stresses beyond that normally expected (such as during severe weather).¹ In calculating daily system SAIDI, any interruption that spans multiple calendar days is accrued to the day on which the interruption began.

RESULTS

The following tables provide reliability index results on unnormalized and normalized bases for generation, transmission, and distribution outages and separately for 1) transmission and distribution outages, 2) utility generation outages, and 3) non-utility generation outages. Results are as of January 8, 2020. Subsequent findings may result in changes to data.

¹ IEEE Std 1366TM-2012: IEEE Guide for Electric Power Distribution Reliability Indices

Annual Service Reliability Indices

The following days in 2019 were determined to be MEDs and are therefore excluded from the normalized indices.

- 2/10/19 due to effects of winter storm/high winds, vegetation, equipment deterioration, and flashover
- 10/30/19 due to vegetation and company personnel error
- 12/25/19 due to high winds and vegetation

Table 1: Generation, Transmission, and Distribution Outages – Unnormalized

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	300,722	302,499	303,732	304,359	304,965	305,627
Customer Interruptions	384,937	578,092	394,758	426,050	404,503	449,341
Customer-Hours Interrupted	537,802	766,068	553,427	703,324	627,251	890,903
SAIDI (minutes)	107.30	151.95	109.33	138.65	123.41	174.90
CAIDI (minutes)	83.83	79.51	84.12	99.05	93.04	118.96
SAIFI (interruptions)	1.280	1.911	1.300	1.400	1.326	1.470
ASAI (percentage)	99.980%	99.971%	99.979%	99.974%	99.977%	99.967%

Table 2: Transmission and Distribution Outages – Unnormalized

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	300,722	302,499	303,732	304,359	304,965	305,627
Customer Interruptions	352,633	437,534	328,474	397,604	404,502	445,204
Customer-Hours Interrupted	522,491	721,807	506,993	699,880	627,238	890,348
SAIDI (minutes)	104.25	143.17	100.15	137.97	123.41	174.79
CAIDI (minutes)	88.90	98.98	92.61	105.61	93.04	119.99
SAIFI (interruptions)	1.173	1.446	1.081	1.306	1.326	1.457
ASAI (percentage)	99.980%	99.973%	99.981%	99.974%	99.977%	99.967%

Table 3: Utility Generation Outages – Unnormalized

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	300,722	302,499	303,732	304,359	304,965	305,627
Customer Interruptions	0	26,914	66,284	17,341	0	3,646
Customer-Hours Interrupted	0	18,772	46,434	1,776	0	425
SAIDI (minutes)	0.00	3.72	9.17	0.35	0.00	0.08
CAIDI (minutes)	0.00	41.85	42.03	6.14	0.00	7.00
SAIFI (interruptions)	0.000	0.089	0.218	0.057	0.000	0.012
ASAI (percentage)	100.000%	99.999%	99.998%	100.000%	100.000%	100.000%

Table 4: Non-Utility Generation Outages – Unnormalized

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	300,722	302,499	303,732	304,359	304,965	305,627
Customer Interruptions	32,304	113,644	0	11,105	1	491
Customer-Hours Interrupted	15,311	25,489	0	1,668	13	130
SAIDI (minutes)	3.05	5.06	0.00	0.33	0.00	0.03
CAIDI (minutes)	28.44	13.46	0.00	9.01	753.00	15.92
SAIFI (interruptions)	0.107	0.376	0.000	0.036	0.000	0.002
ASAI (percentage)	99.999%	99.999%	100.000%	100.000%	100.000%	100.000%

Table 5: Generation, Transmission, and Distribution Outages – Normalized²

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	300,722	302,499	303,732	304,359	304,965	305,627
Customer Interruptions	384,937	439,687	304,466	350,078	382,106	337,799
Customer-Hours Interrupted	537,802	500,853	421,384	489,908	568,968	530,394
SAIDI (minutes)	107.30	99.34	83.24	96.58	111.94	104.13
CAIDI (minutes)	83.83	68.35	83.04	83.97	89.34	94.21
SAIFI (interruptions)	1.280	1.454	1.002	1.150	1.253	1.105
ASAI (percentage)	99.980%	99.981%	99.984%	99.982%	99.979%	99.980%

² Exclusions include:

- 1/2/15 due to high winds and vegetation
- 2/14/15 due to high winds
- 2/19/15 due to high winds
- 7/24/16 due to flooding at Iwilei Substation and surrounding area
- 1/21/17 due to trees/branches and high winds
- 1/22/17 due to high winds
- 2/5/17 due to high winds and vegetation
- 8/24/18 due to effects of Hurricane Lane
- 9/12/18 due to effects of Tropical Storm Olivia and equipment deterioration
- 2/10/19 due to effects of winter storm/high winds, vegetation, equipment deterioration, and flashover
- 10/30/19 due to vegetation and company personnel error
- 12/25/19 due to high winds and vegetation

Table 6: Transmission and Distribution Outages – Normalized²

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	300,722	302,499	303,732	304,359	304,965	305,627
Customer Interruptions	352,633	321,880	304,466	321,632	382,105	333,662
Customer-Hours Interrupted	522,491	460,172	421,384	486,464	568,955	529,838
SAIDI (minutes)	104.25	91.27	83.24	95.90	111.94	104.02
CAIDI (minutes)	88.90	85.78	83.04	90.75	89.34	95.28
SAIFI (interruptions)	1.173	1.064	1.002	1.057	1.253	1.092
ASAI (percentage)	99.980%	99.983%	99.984%	99.982%	99.979%	99.980%

Table 7: Utility Generation Outages – Normalized²

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	300,722	302,499	303,732	304,359	304,965	305,627
Customer Interruptions	0	26,914	0	17,341	0	3,646
Customer-Hours Interrupted	0	18,772	0	1,776	0	425
SAIDI (minutes)	0.00	3.72	0.00	0.35	0.00	0.08
CAIDI (minutes)	0.00	41.85	0.00	6.14	0.00	7.00
SAIFI (interruptions)	0.000	0.089	0.000	0.057	0.000	0.012
ASAI (percentage)	100.000%	99.999%	100.000%	100.000%	100.000%	100.000%

Table 8: Non-Utility Generation Outages – Normalized²

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	300,722	302,499	303,732	304,359	304,965	305,627
Customer Interruptions	32,304	90,893	0	11,105	1	491
Customer-Hours Interrupted	15,311	21,909	0	1,668	13	130
SAIDI (minutes)	3.05	4.35	0.00	0.33	0.00	0.03
CAIDI (minutes)	28.44	14.46	0.00	9.01	753.00	15.92
SAIFI (interruptions)	0.107	0.300	0.000	0.036	0.000	0.002
ASAI (percentage)	99.999%	99.999%	100.000%	100.000%	100.000%	100.000%

The following charts and discussion are based on the annual reliability index results for generation, transmission, and distribution outages on a normalized basis (data from Table 5, above).

Figure 1: Normalized System Average Interruption Duration Index (SAIDI)

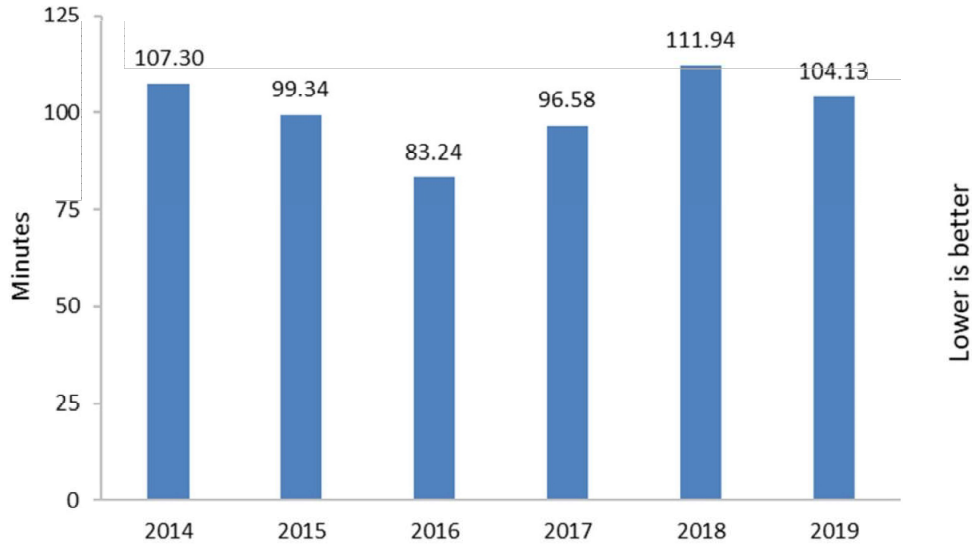


Figure 1 shows the SAIDI values for 2014 to 2019.

The 2019 SAIDI of 104.13 minutes is about a 7% decrease compared to the 2018 SAIDI of 111.94 minutes. The customer hours interrupted was 530,394 hours in 2019 compared to 568,968 hours in 2018.

The following events significantly impacted the 2019 SAIDI results:

1. January 26, 2019 (Saturday) – A wood pole broke due to a motor vehicle accident in Makaha. This resulted in a sustained outage to 5,951 customers for up to 17 hours and 36 minutes and contributed 2.24 minutes to the annual SAIDI.
2. October 11, 2019 (Friday) – A lightning storm affected various parts of O‘ahu. This resulted in a sustained outage to 4,451 customers for up to 99 hours and 59 minutes and contributed 1.87 minutes to the annual SAIDI.
3. October 10, 2019 (Thursday) – A lightning storm affected various parts of O‘ahu. This resulted in a sustained outage to 11,184 customers for up to 7 hours and 9 minutes and contributed 1.85 minutes to the annual SAIDI.

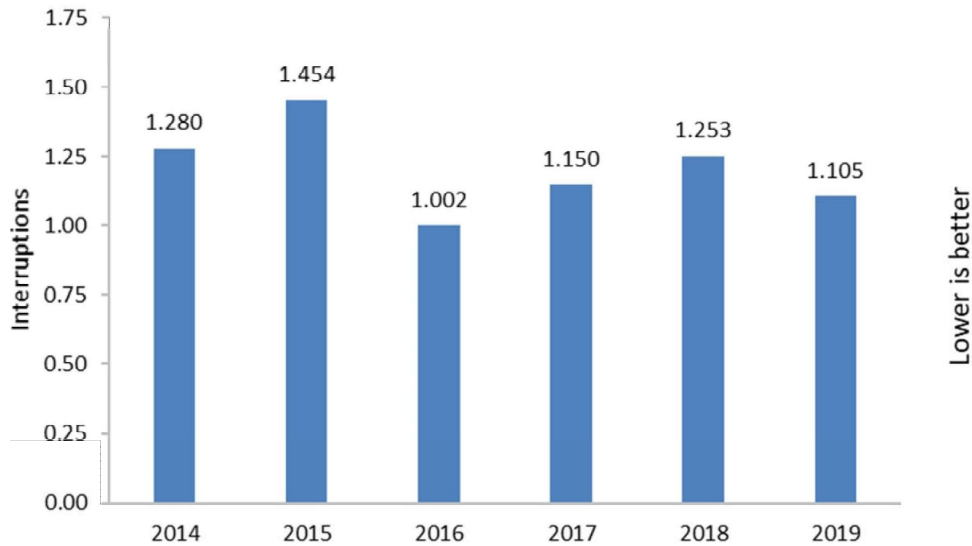
Figure 2: Normalized System Average Interruption Frequency Index (SAIFI)

Figure 2 shows the SAIFI values for 2014 to 2019.

The 2019 SAIFI of 1.105 is about a 12% decrease from the 2018 SAIFI of 1.253. The number of customer interruptions was 337,799 in 2019 compared to 382,106 customer interruptions in 2018.

The following events significantly impacted the 2019 SAIFI results:

1. October 10, 2019 (Thursday) – A lightning storm affected various parts of O‘ahu. This resulted in a sustained outage to 11,184 customers for up to 7 hours and 9 minutes and contributed 0.037 to the annual SAIFI.
2. January 26, 2019 (Saturday) – A wood pole broke due to a motor vehicle accident in Makaha. This resulted in a sustained outage to 5,951 customers for up to 17 hours and 36 minutes and contributed 0.019 to the annual SAIFI.
3. April 26, 2019 (Friday) – A defective air switch flashed over at Pukele substation. This resulted in a sustained outage to 5,517 customers for up to 17 minutes and contributed 0.018 to the annual SAIFI.

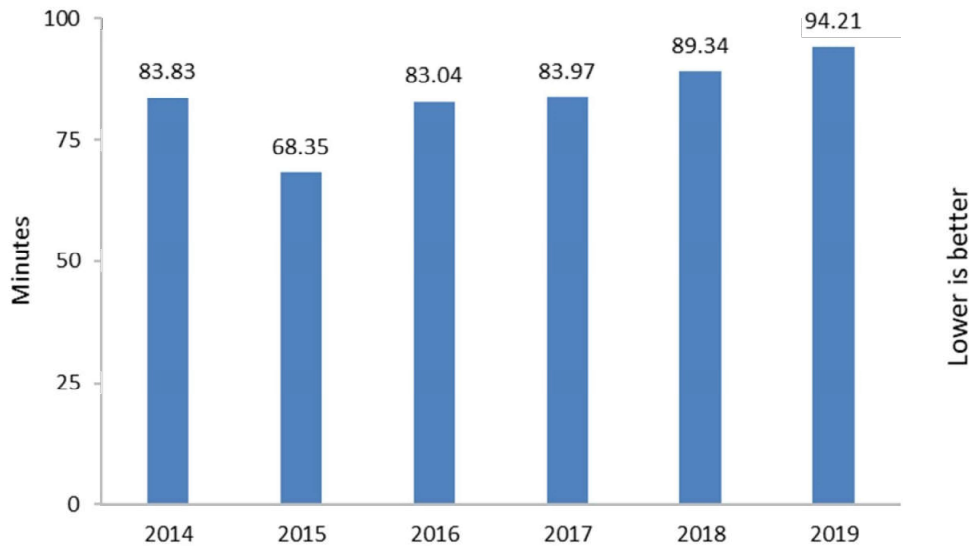
Figure 3: Normalized Customer Average Interruption Duration Index (CAIDI)

Figure 3 shows the CAIDI values for 2014 to 2019.

The 2019 CAIDI of 94.21 minutes is about a 5% increase compared to the 2018 CAIDI of 89.34 minutes.

The following events significantly affected the 2019 CAIDI results:

1. June 25, 2019 (Tuesday) – A lightning storm affected various parts of O‘ahu. This resulted in a sustained outage to 2,631 customers for up to 67 hours and 34 minutes and contributed 0.69 minutes to the annual CAIDI.
2. November 19, 2019 (Tuesday) – A lightning storm affected various parts of O‘ahu. This resulted in a sustained outage to 712 customers for up to 9 hours and 22 minutes and contributed 0.62 minutes to the annual CAIDI.
3. March 13, 2019 (Wednesday) – A defective wood cross-arm broke in Aiea. This resulted in a sustained outage to 1,155 customers for up to 4 hours and 29 minutes and contributed 0.56 minutes to the annual CAIDI.

Figure 4: Normalized Average System Availability Index (ASAI)

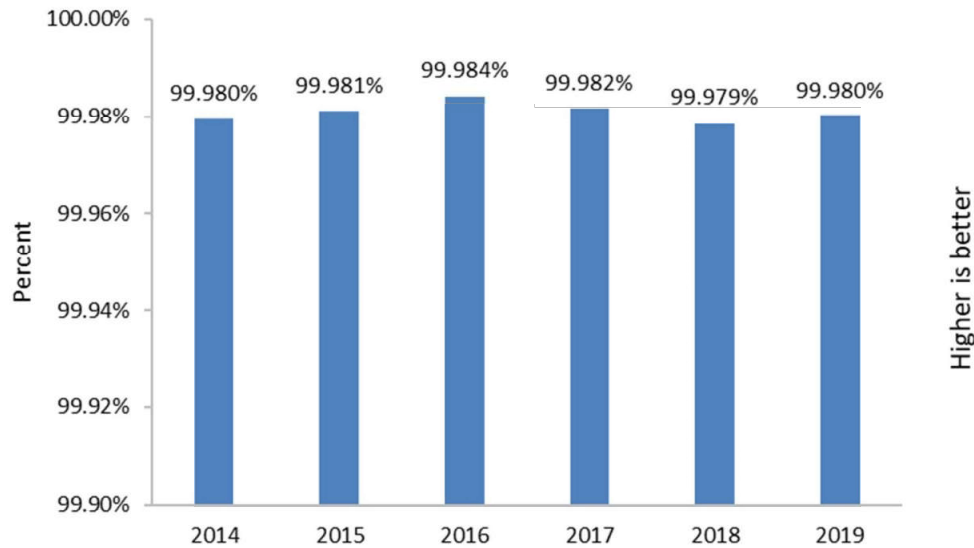
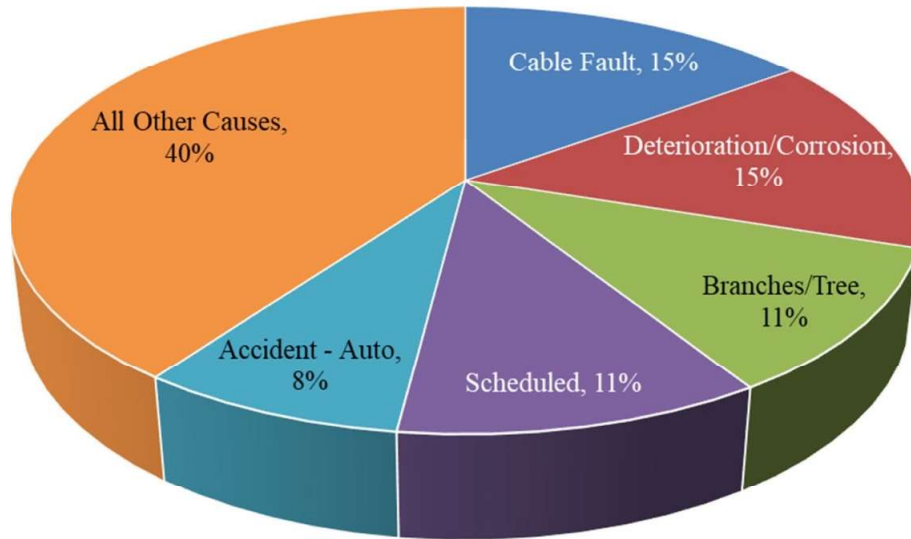


Figure 4 shows the ASAI values for 2014 to 2019.

The 2019 ASAI of 99.980% is a 0.001% increase from the 2018 ASAI of 99.979%. The customer hours interrupted was 530,394 hours in 2019 compared to 568,968 hours in 2018.

Figure 5: Outage Causes for 2019



The top five outage causes by customer hours interrupted, as illustrated in Figure 5, accounted for about 60% of the total customer hours interrupted in 2019. These include:

<u>Outage Cause</u>	<u>Description</u>
1. Cable Fault	Underground cable or cable component failure
2. Deterioration/Corrosion	Failed, broken, or corroded equipment
3. Branches/Tree	Vegetation contacting or falling onto overhead conductors
4. Scheduled	Planned outage to replace/repair equipment
5. Accident – Auto	Motor vehicle collision with company equipment

From 2018 to 2019, the top five outage causes by customer hours interrupted remained the same. Deterioration/Corrosion and Accident – Auto remained the 2nd and 5th top outage causes, respectively. Cable Fault went from 3rd to 1st, Scheduled went from 1st to 4th, and Branches/Tree went from 4th to 3rd.

Hawaiian Electric Company, Inc.
Normalized Sustained Interruption Summary

From: January 1, 2019 To: December 31, 2019

Outage Cause	Customer Hours Interrupted	Customer Interruptions	SAIFI (interruptions)	SAIDI (minutes)	CAIDI (minutes)
Cable Fault	80,039.4	61,769	0.202	15.71	77.75
Deterioration/Corrosion	78,629.7	54,472	0.178	15.44	86.61
Branches/Tree	59,577.2	31,160	0.102	11.70	114.72
Scheduled	56,205.2	14,418	0.047	11.03	233.90
Accident - Auto	39,872.1	21,004	0.069	7.83	113.90
Unknown	34,998.7	23,909	0.078	6.87	87.83
Lightning	27,184.4	12,425	0.041	5.34	131.27
Forced	24,760.3	17,470	0.057	4.86	85.04
Overgrown	24,342.5	12,605	0.041	4.78	115.87
System Change	19,111.2	21,239	0.069	3.75	53.99
High Winds	19,033.3	12,099	0.040	3.74	94.39
Switching	12,710.0	12,622	0.041	2.50	60.42
Transformer - Failure	9,422.5	4,867	0.016	1.85	116.16
Object in Line - Balloon	8,308.6	9,964	0.033	1.63	50.03
Accident - Construction	7,374.1	3,275	0.011	1.45	135.10
Flashover	6,738.4	5,816	0.019	1.32	69.52
Faulty Operation	6,259.2	5,165	0.017	1.23	72.71
Customer - Equipment	5,422.0	3,393	0.011	1.06	95.88
Vandalism	3,378.4	933	0.003	0.66	217.26
Other	1,564.0	1,916	0.006	0.31	48.98
Other Company Personnel	1,562.5	1,445	0.005	0.31	64.88
Object in Line - Animal	1,211.3	927	0.003	0.24	78.40
Overload	1,034.2	777	0.003	0.20	79.86
Transformer - Overload	676.4	311	0.001	0.13	130.50
Object in Line - Foreign Object	429.6	157	0.001	0.08	164.18
Auto UFLS	425.4	3,646	0.012	0.08	7.00
Accident - Other	99.0	1	0.000	0.02	5,937.00
Fire	24.8	14	0.000	0.00	106.21
Customer - Requested	0.0	0	0.000	0.00	0.00
Failure/Defect	0.0	0	0.000	0.00	0.00
Flooding	0.0	0	0.000	0.00	0.00
Heavy Rain	0.0	0	0.000	0.00	0.00
Landslide	0.0	0	0.000	0.00	0.00
Manual Load Shed	0.0	0	0.000	0.00	0.00
Natural Disaster/Tsunami/Earthquake	0.0	0	0.000	0.00	0.00
Object in Line - Man	0.0	0	0.000	0.00	0.00
Total	530,394.1	337,799	1.105	104.13	94.21

Average System Availability =	99.980%
Number of customers for the period =	305,627
24-month annual SAIDI (minutes) average for the period 1/1/2018 - 12/31/2019 =	108.03
24-month average number of customers for the period 1/1/2018 - 12/31/2019 =	305,296

Notes: Outage causes are listed in descending order of SAIDI. Outages due to customer requests are not included in the service reliability indices.

Hawaiian Electric Company, Inc.
Normalized Sustained Interruption Summary

From: January 1, 2019 To: December 31, 2019

	Interruption Count	% of Total	Customer Hours Interrupted	% of Total
<u>Equipment</u>	868	29.3%	182,799.8	34.5%
Cable Fault	517	17.4%	80,039.4	15.1%
Deterioration/Corrosion	229	7.7%	78,629.7	14.8%
Transformer - Failure	62	2.1%	9,422.5	1.8%
Flashover	13	0.4%	6,738.4	1.3%
Faulty Operation	19	0.6%	6,259.2	1.2%
Overload	5	0.2%	1,034.2	0.2%
Transformer - Overload	23	0.8%	676.4	0.1%
Failure/Defect	0	0.0%	0.0	0.0%
<u>Error</u>	27	0.9%	14,272.5	2.7%
Switching	18	0.6%	12,710.0	2.4%
Other Company Personnel	9	0.3%	1,562.5	0.3%
<u>Generation</u>	2	0.1%	425.4	0.1%
Auto UFLS	2	0.1%	425.4	0.1%
Manual Load Shed	0	0.0%	0.0	0.0%
Other	0	0.0%	0.0	0.0%
<u>Maintenance</u>	1,398	47.1%	100,076.7	18.9%
Scheduled	1,123	37.9%	56,205.2	10.6%
Forced	243	8.2%	24,760.3	4.7%
System Change	32	1.1%	19,111.2	3.6%
<u>Other</u>	5	0.2%	1,564.0	0.3%
Other	5	0.2%	1,564.0	0.3%
<u>Public (Non-Utility)</u>	139	4.7%	66,119.8	12.5%
Accident - Auto	32	1.1%	39,872.1	7.5%
Object in Line - Balloon	12	0.4%	8,308.6	1.6%
Accident - Construction	19	0.6%	7,374.1	1.4%
Customer - Equipment	34	1.1%	5,422.0	1.0%
Vandalism	2	0.1%	3,378.4	0.6%
Object in Line - Animal	35	1.2%	1,211.3	0.2%
Object in Line - Foreign Object	2	0.1%	429.6	0.1%
Accident - Other	1	0.0%	99.0	0.0%
Fire	2	0.1%	24.8	0.0%
Customer - Requested	0	0.0%	0.0	0.0%
Object in Line - Man	0	0.0%	0.0	0.0%
<u>Unknown</u>	226	7.6%	34,998.7	6.6%
Unknown	226	7.6%	34,998.7	6.6%
<u>Vegetation</u>	184	6.2%	83,919.7	15.8%
Branches/Tree	117	3.9%	59,577.2	11.2%
Overgrown	67	2.3%	24,342.5	4.6%
<u>Weather</u>	117	3.9%	46,217.7	8.7%
Lightning	95	3.2%	27,184.4	5.1%
High Winds	22	0.7%	19,033.3	3.6%
Flooding	0	0.0%	0.0	0.0%
Heavy Rain	0	0.0%	0.0	0.0%
Landslide	0	0.0%	0.0	0.0%
Natural Disaster/Tsunami/Earthquake	0	0.0%	0.0	0.0%
Total	2,966		530,394.1	

Note: Outages due to customer requests are not included in the service reliability indices.

DEFINITION OF TERMS

CUSTOMER INTERRUPTION

One interruption of one customer.

INTERRUPTION

The loss of service to one or more customers as a result of one or more component outages.

INTERRUPTION DURATION

The time period from the initiation of an interruption until service has been restored to the affected customers.

MOMENTARY INTERRUPTION

An interruption having a duration of five minutes or less, typically limited to the period required to restore service by an interrupting device.

OUTAGE

The loss of ability of a component to deliver power. An outage may or may not cause an interruption of service to customers, depending on the system configuration.

SUSTAINED INTERRUPTION

Any interruption not classified as a momentary interruption. That is, any interruption that lasts more than five minutes.

Note: Interruptions to customers at their request are not included.

Reliability indices are based on the standards defined by the Institute of Electrical and Electronics Engineers (IEEE). Four indices that convey a meaningful representation of the level of reliability are as follows:

RELIABILITY INDICES

AVERAGE SERVICE AVAILABILITY INDEX (ASAI)

ASAI indicates the fraction of time that the average customer received service during a predefined period of time. Customer hours service demand is determined by multiplying the total number of customers served by the number of hours in the period.

$$ASAI = \frac{\sum \text{Customer Hours Service Availability}}{\sum \text{Customer Hours Service Demand}} \times 100\%$$

CUSTOMER AVERAGE INTERRUPTION DURATION INDEX (CAIDI)

CAIDI indicates the average time required to restore service during a predefined period of time.

$$CAIDI = \frac{\sum(\text{Duration of Interruption} \times \text{No. of Sustained Customer Interruptions})}{\sum \text{No. of Sustained Customer Interruptions}} = \frac{SAIDI}{SAIFI}$$

SYSTEM AVERAGE INTERRUPTION DURATION INDEX (SAIDI)

SAIDI indicates the total sustained interruption duration for the average customer during a predefined period of time. It is commonly measured in minutes or hours of interruption.

$$SAIDI = \frac{\sum(\text{Duration of Interruption} \times \text{No. of Sustained Customer Interruptions})}{\text{Total No. of Customers Served}}$$

SYSTEM AVERAGE INTERRUPTION FREQUENCY INDEX (SAIFI)

SAIFI indicates how often the average customer experiences a sustained interruption during a predefined period of time.

$$SAIFI = \frac{\sum \text{No. of Sustained Customer Interruptions}}{\text{Total No. of Customers Served}}$$

HAWAI‘I ELECTRIC LIGHT COMPANY, INC.

ANNUAL SERVICE RELIABILITY REPORT 2019

May 12, 2020

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The service reliability indices provided in this report are commonly used in the electric power utility industry as a method of measuring system reliability performance. These include overall availability of electrical service during a given period of time (Average Service Availability Index or ASAI), the average frequency or number of times customers experience a sustained interruption of service during a given period of time (System Average Interruption Frequency Index or SAIFI), the average length of time an interrupted customer is without power during a given period of time (Customer Average Interruption Duration Index or CAIDI), and the average length of time customers are without power during a given period of time (System Average Interruption Duration Index or SAIDI). SAIDI is an indication of overall system reliability because it incorporates the impact of frequency and duration of outages on the total customer base. The Appendix contains definitions, explanations, and equations for the reliability indices.

METHODOLOGY

The reliability indices provided in this report are calculated using the Institute of Electrical and Electronics Engineers (IEEE) Standard 1366TM-2012 methodology. Indices reported on a normalized basis exclude Major Event Days (MEDs). MEDs are defined as days in which the daily system SAIDI exceeds the MED threshold value (T_{MED}). Statistically, days having a daily system SAIDI greater than T_{MED} indicate days on which the energy delivery system experienced stresses beyond that normally expected (such as during severe weather).¹ In calculating daily system SAIDI, any interruption that spans multiple calendar days is accrued to the day on which the interruption began.

RESULTS

The following tables provide reliability index results on unnormalized and normalized bases for generation, transmission, and distribution outages and separately for 1) transmission and distribution outages, 2) utility generation outages, and 3) non-utility generation outages. Results are as of January 8, 2020. Subsequent findings may result in changes to data.

¹ IEEE Std 1366TM-2012: IEEE Guide for Electric Power Distribution Reliability Indices.

Annual Service Reliability Indices

The following days in 2019 were determined to be MEDs and are therefore excluded from the normalized indices.

- 2/10/19 due to effects of winter storm/high winds
- 7/8/19 due to remnants of Tropical Storm Barbara

Table 1: Generation, Transmission, and Distribution Outages – Unnormalized

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	82,872	83,622	84,367	85,041	85,408	86,068
Customer Interruptions	324,546	345,143	196,249	151,681	216,840	263,410
Customer-Hours Interrupted	1,316,984	661,703	247,641	263,828	328,406	362,225
SAIDI (minutes)	953.50	474.78	176.12	186.14	230.71	252.52
CAIDI (minutes)	243.48	115.03	75.71	104.36	90.87	82.51
SAIFI (interruptions)	3.916	4.127	2.326	1.784	2.539	3.060
ASAI (percentage)	99.819%	99.910%	99.967%	99.965%	99.956%	99.952%

Table 2: Transmission and Distribution Outages – Unnormalized

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	82,872	83,622	84,367	85,041	85,408	86,068
Customer Interruptions	206,679	261,025	118,879	120,857	137,897	230,102
Customer-Hours Interrupted	1,294,614	644,887	227,989	259,368	297,702	357,482
SAIDI (minutes)	937.31	462.72	162.14	182.99	209.14	249.21
CAIDI (minutes)	375.83	148.24	115.07	128.76	129.53	93.21
SAIFI (interruptions)	2.494	3.121	1.409	1.421	1.615	2.673
ASAI (percentage)	99.822%	99.912%	99.969%	99.965%	99.960%	99.953%

Table 3: Utility Generation Outages – Unnormalized

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	82,872	83,622	84,367	85,041	85,408	86,068
Customer Interruptions	80,034	76,909	58,077	22,253	28,948	14,302
Customer-Hours Interrupted	13,347	16,017	16,766	2,728	16,346	1,782
SAIDI (minutes)	9.66	11.49	11.92	1.92	11.48	1.24
CAIDI (minutes)	10.01	12.50	17.32	7.36	33.88	7.48
SAIFI (interruptions)	0.966	0.920	0.688	0.262	0.339	0.166
ASAI (percentage)	99.998%	99.998%	99.998%	100.000%	99.998%	100.000%

Table 4: Non-Utility Generation Outages – Unnormalized

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	82,872	83,622	84,367	85,041	85,408	86,068
Customer Interruptions	37,833	7,209	19,293	8,571	49,995	19,006
Customer-Hours Interrupted	9,023	799	2,886	1,731	14,357	2,961
SAIDI (minutes)	6.53	0.57	2.05	1.22	10.09	2.06
CAIDI (minutes)	14.31	6.65	8.97	12.12	17.23	9.35
SAIFI (interruptions)	0.457	0.086	0.229	0.101	0.585	0.221
ASAI (percentage)	99.999%	100.000%	100.000%	100.000%	99.998%	100.000%

Table 5: Generation, Transmission, and Distribution Outages – Normalized²

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	82,872	83,622	84,367	85,041	85,408	86,068
Customer Interruptions	225,903	192,196	185,013	128,861	216,840	160,467
Customer-Hours Interrupted	238,159	214,740	204,049	191,415	328,406	236,484
SAIDI (minutes)	172.43	154.08	145.12	135.05	230.71	164.86
CAIDI (minutes)	63.26	67.04	66.17	89.13	90.87	88.42
SAIFI (interruptions)	2.726	2.298	2.193	1.515	2.539	1.864
ASAI (percentage)	99.967%	99.971%	99.972%	99.974%	99.956%	99.969%

² Exclusions include:

- 1/22/14 due to high winds and vegetation
- 8/7/14 due to effects of Hurricane Iselle
- 8/8/14 due to effects of Hurricane Iselle
- 8/16/14 due to effects of Hurricane Iselle
- 12/24/14 due to underfrequency load shed due to Independent Power Producer equipment trip and motor vehicle accident
- 1/2/15 due to high winds
- 1/3/15 due to high winds
- 2/14/15 due to high winds
- 7/23/16 due to effects of Tropical Storm Darby
- 9/21/17 due to scheduled substation maintenance
- 12/5/17 due to high winds
- 2/10/19 due to effects of winter storm/high winds
- 7/8/19 due to remnants of Tropical Storm Barbara

Table 6: Transmission and Distribution Outages – Normalized²

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	82,872	83,622	84,367	85,041	85,408	86,068
Customer Interruptions	136,032	108,078	107,643	98,037	137,897	127,159
Customer-Hours Interrupted	223,795	197,925	184,397	186,955	297,702	231,741
SAIDI (minutes)	162.03	142.01	131.14	131.90	209.14	161.55
CAIDI (minutes)	98.71	109.88	102.78	114.42	129.53	109.35
SAIFI (interruptions)	1.641	1.292	1.276	1.153	1.615	1.477
ASAI (percentage)	99.969%	99.973%	99.975%	99.975%	99.960%	99.969%

Table 7: Utility Generation Outages – Normalized²

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	82,872	83,622	84,367	85,041	85,408	86,068
Customer Interruptions	80,034	76,909	58,077	22,253	28,948	14,302
Customer-Hours Interrupted	13,347	16,017	16,766	2,728	16,346	1,782
SAIDI (minutes)	9.66	11.49	11.92	1.92	11.48	1.24
CAIDI (minutes)	10.01	12.50	17.32	7.36	33.88	7.48
SAIFI (interruptions)	0.966	0.920	0.688	0.262	0.339	0.166
ASAI (percentage)	99.998%	99.998%	99.998%	100.000%	99.998%	100.000%

Table 8: Non-Utility Generation Outages – Normalized²

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	82,872	83,622	84,367	85,041	85,408	86,068
Customer Interruptions	9,837	7,209	19,293	8,571	49,995	19,006
Customer-Hours Interrupted	1,017	799	2,886	1,731	14,357	2,961
SAIDI (minutes)	0.74	0.57	2.05	1.22	10.09	2.06
CAIDI (minutes)	6.20	6.65	8.97	12.12	17.23	9.35
SAIFI (interruptions)	0.119	0.086	0.229	0.101	0.585	0.221
ASAI (percentage)	100.000%	100.000%	100.000%	100.000%	99.998%	100.000%

The following charts and discussion are based on the annual reliability index results for generation, transmission, and distribution outages on a normalized basis (data from Table 5, above).

Figure 1: Normalized System Average Interruption Duration Index (SAIDI)

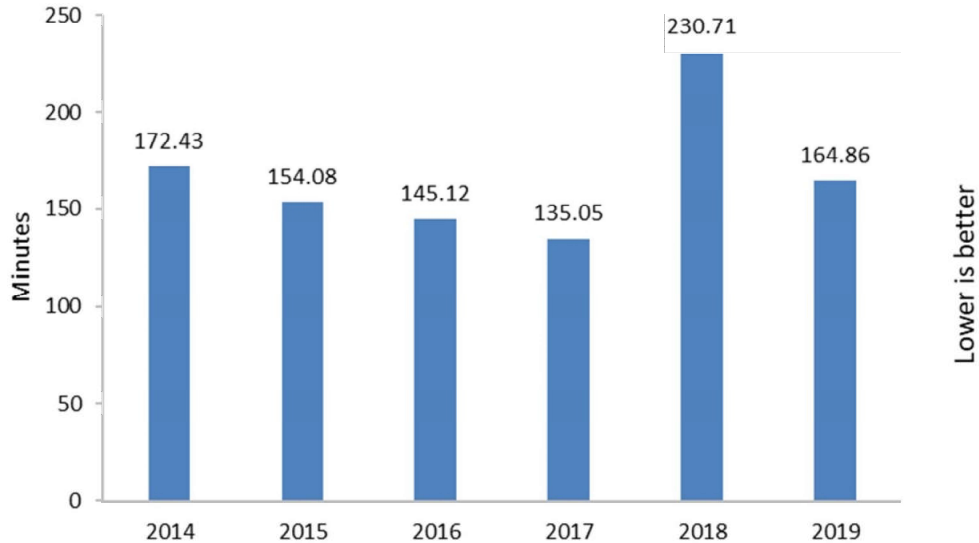


Figure 1 shows the SAIDI values for 2014 to 2019.

The 2019 SAIDI of 164.86 minutes is about a 29% decrease compared to the 2018 SAIDI of 230.71 minutes. The customer hours interrupted was 236,484 hours in 2019 compared to 328,406 hours in 2018.

The following events significantly impacted the 2019 SAIDI results:

1. March 19, 2019 (Tuesday) – A jumper failed/melted along Highway 130 to the area normally served by equipment lost due to the 2018 volcanic eruptions. This resulted in a sustained outage to 4,257 customers for up to 5 hours and 14 minutes and contributed 15.05 minutes to the annual SAIDI.
2. October 24, 2019 (Thursday) – A scheduled outage to perform maintenance and upgrade transmission poles in the North Kohala area. This resulted in a sustained outage to 2,133 customers for up to 8 hours and 19 minutes and contributed 12.19 minutes to the annual SAIDI.
3. August 17, 2019 (Saturday) – Previously unknown equipment deterioration and vegetation issues, in an area difficult to access, resulted in multiple outages that affected customers along the Hamakua Coast. This resulted in a sustained outage to 5,970 customers for up to 5 hours and 53 minutes and contributed 6.64 minutes to the annual SAIDI.

Figure 2: Normalized System Average Interruption Frequency Index (SAIFI)

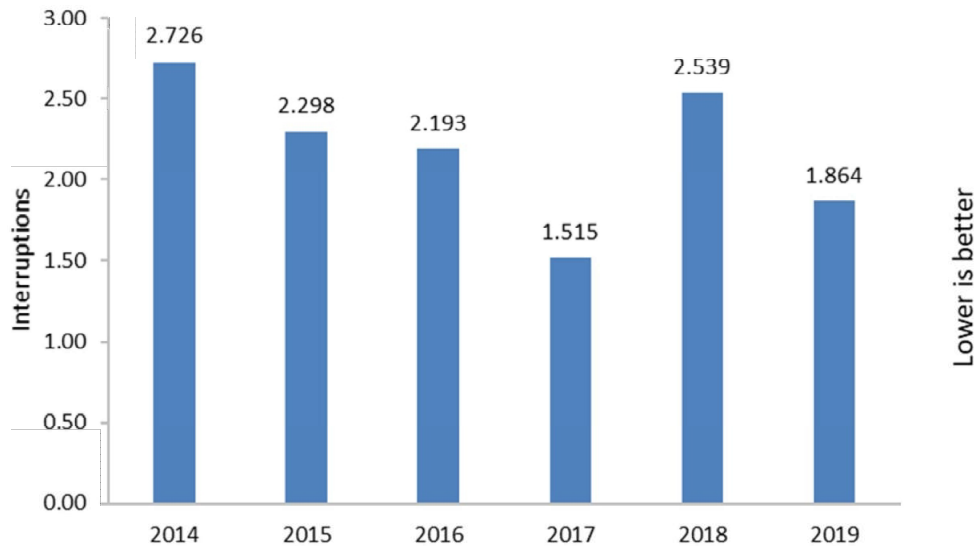


Figure 2 shows the SAIFI values for 2014 to 2019.

The 2019 SAIFI of 1.864 is about a 27% decrease from the 2018 SAIFI of 2.539. The number of customer interruptions was 160,467 in 2019 compared to 216,840 interruptions in 2018.

The following events significantly impacted the 2019 SAIFI results:

1. November 19, 2019 (Tuesday) – Under-frequency load shed when Kamaoa Wind Farm tripped off-line due to a defective current transformer. This resulted in a sustained outage to 11,293 customers for up to 10 minutes and contributed 0.131 to the annual SAIFI.
2. October 8, 2019 (Tuesday) – Under-frequency load shed when Keahole CT5 tripped off-line. This resulted in a sustained outage to 7,968 customers for up to 11 minutes and contributed 0.093 to the annual SAIFI.
3. February 16, 2019 (Saturday) – Under-frequency load shed due to lost steam unit at Hamakua Energy Partners. This resulted in a sustained outage to 7,713 customers for up to 28 minutes and contributed 0.090 to the annual SAIFI.

Figure 3: Normalized Customer Average Interruption Duration Index (CAIDI)

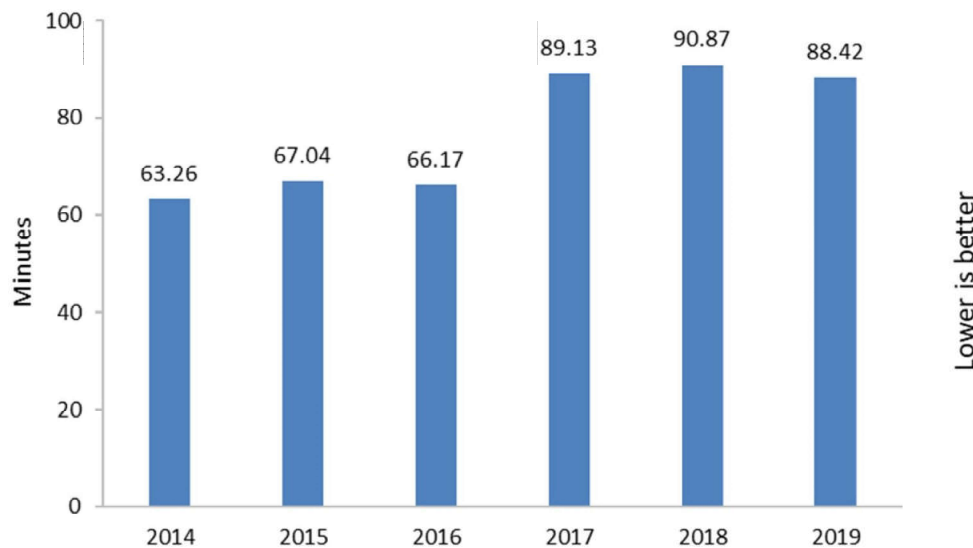


Figure 3 shows the CAIDI values for 2014 to 2019.

The 2019 CAIDI was 88.42 minutes, about a 3% decrease compared to the 2018 CAIDI of 90.87 minutes.

The following events significantly impacted the 2019 CAIDI results:

1. March 19, 2019 (Tuesday) – A jumper failed/melted along Highway 130 to the area normally served by equipment lost due to the 2018 volcanic eruptions. This resulted in a sustained outage to 4,257 customers for up to 5 hours and 14 minutes and contributed 5.88 minutes to the annual CAIDI.
2. October 24, 2019 (Thursday) – A scheduled outage to perform maintenance and upgrade transmission poles in the North Kohala area. This resulted in a sustained outage to 2,133 customers for up to 8 hours and 19 minutes and contributed 5.44 minutes to the annual CAIDI.
3. December 21, 2019 (Saturday) – High winds resulted in various weather-related outages across Hawai'i Island. This resulted in a sustained outage to 2,063 customers for up to 13 hours and 2 minutes and contributed 1.37 minutes to the annual CAIDI.

Figure 4: Normalized Average System Availability Index (ASAI)

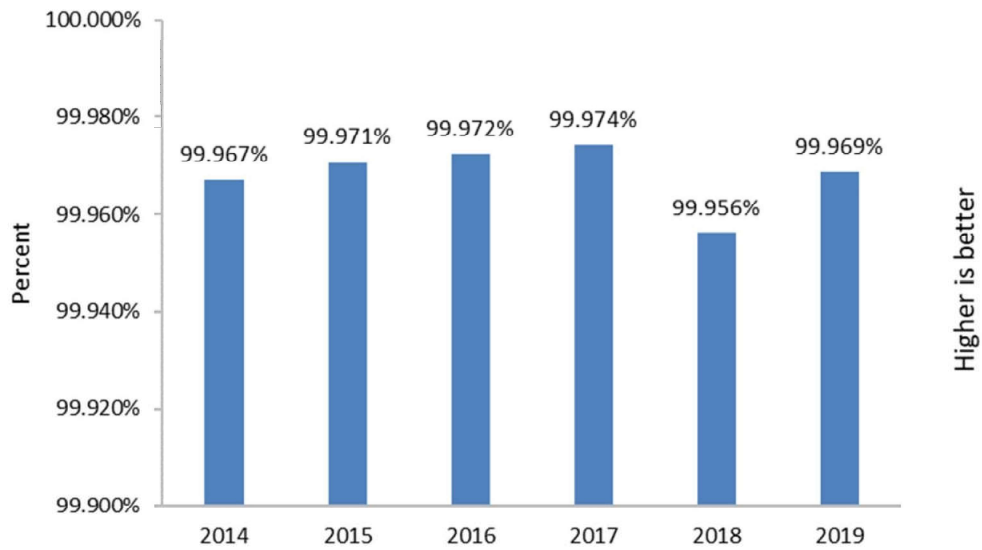
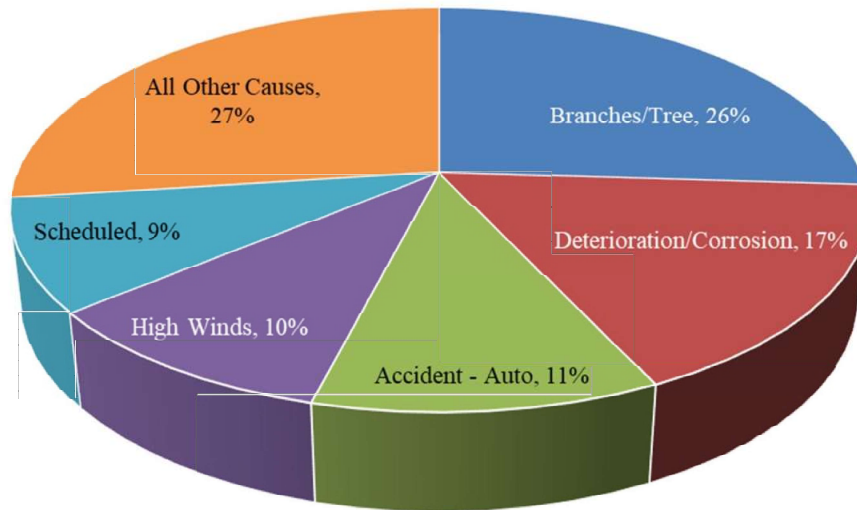


Figure 4 shows the ASAI values for 2014 to 2019.

The 2019 ASAI of 99.969% was a .013% increase from the 2018 ASAI of 99.956%. The customer hours interrupted was 236,484 hours in 2019 compared to 328,406 hours in 2018.

Figure 5: Outage Causes for 2019



The top five outage causes by customer hours interrupted, as illustrated in Figure 5, accounted for about 73% of the total customer hours interrupted in 2019. These include:

<u>Outage Cause</u>	<u>Description</u>
1. Branches/Tree	Vegetation contacting or falling onto overhead conductors
2. Deterioration/Corrosion	Failed, broken, or corroded equipment
3. Accident – Auto	Motor vehicle collision with company equipment
4. High Winds	Outages due to high/gusty winds
5. Scheduled	Planned outages to replace/repair equipment

From 2018 to 2019, Branches/Tree remained the top outage cause. The Deterioration/Corrosion and Scheduled causes are new to the list as the 2nd and 5th top outage causes, respectively. High Winds went from 2nd to 4th and Accident – Auto went from 4th to 3rd.

Hawai'i Electric Light Company, Inc.
Normalized Sustained Interruption Summary

From: January 1, 2019 To: December 31, 2019

Outage Cause	Customer Hours Interrupted	Customer Interruptions	SAIFI (interruptions)	SAIDI (minutes)	CAIDI (minutes)
Branches/Tree	61,926.3	36,542	0.425	43.17	101.68
Deterioration/Corrosion	39,687.5	17,929	0.208	27.67	132.82
Accident - Auto	25,977.9	16,320	0.190	18.11	95.51
High Winds	24,016.0	15,107	0.176	16.74	95.38
Scheduled	22,250.7	3,596	0.042	15.51	371.26
Cable Fault	16,435.4	9,734	0.113	11.46	101.31
Unknown	14,600.9	8,900	0.103	10.18	98.43
Overgrown	7,888.3	6,003	0.070	5.50	78.84
Natural Disaster/Tsunami/Earthquake	6,735.3	3,300	0.038	4.70	122.46
Auto UFLS	4,743.1	33,308	0.387	3.31	8.54
Forced	2,899.6	2,485	0.029	2.02	70.01
Failure/Defect	2,831.0	450	0.005	1.97	377.47
Lightning	1,487.0	917	0.011	1.04	97.29
Accident - Other	1,127.8	265	0.003	0.79	255.34
System Change	1,112.1	293	0.003	0.78	227.73
Transformer - Failure	838.8	286	0.003	0.58	175.98
Accident - Construction	654.7	174	0.002	0.46	225.77
Object in Line - Animal	593.9	231	0.003	0.41	154.25
Faulty Operation	459.0	3,994	0.046	0.32	6.90
Other Company Personnel	88.1	471	0.005	0.06	11.22
Object in Line - Balloon	58.4	116	0.001	0.04	30.19
Heavy Rain	26.8	7	0.000	0.02	230.00
Other	25.4	29	0.000	0.02	52.59
Fire	18.5	8	0.000	0.01	139.00
Customer - Equipment	1.7	2	0.000	0.00	51.00
Customer - Requested	0.0	0	0.000	0.00	0.00
Flashover	0.0	0	0.000	0.00	0.00
Flooding	0.0	0	0.000	0.00	0.00
Landslide	0.0	0	0.000	0.00	0.00
Manual Load Shed	0.0	0	0.000	0.00	0.00
Object in Line - Foreign Object	0.0	0	0.000	0.00	0.00
Object in Line - Man	0.0	0	0.000	0.00	0.00
Overload	0.0	0	0.000	0.00	0.00
Switching	0.0	0	0.000	0.00	0.00
Transformer - Overload	0.0	0	0.000	0.00	0.00
Vandalism	0.0	0	0.000	0.00	0.00
Total	236,484.1	160,467	1.864	164.86	88.42

Average System Availability = 99.969%
 Number of customers for the period = 86,068
 24-month annual SAIDI (minutes) average for the period 1/1/2018 - 12/31/2019 = 197.78
 24-month average number of customers for the period 1/1/2018 - 12/31/2019 = 85,738

Notes: Outage causes are listed in descending order of SAIDI. Outages due to customer requests are not included in the service reliability indices.

Hawai'i Electric Light Company, Inc.
Normalized Sustained Interruption Summary
 From: January 1, 2019 To: December 31, 2019

	Interruption Count	% of Total	Customer Hours Interrupted	% of Total
<u>Equipment</u>	170	17.5%	60,251.6	25.5%
Deterioration/Corrosion	91	9.3%	39,687.5	16.8%
Cable Fault	40	4.1%	16,435.4	6.9%
Failure/Defect	2	0.2%	2,831.0	1.2%
Transformer - Failure	36	3.7%	838.8	0.4%
Faulty Operation	1	0.1%	459.0	0.2%
Flashover	0	0.0%	0.0	0.0%
Overload	0	0.0%	0.0	0.0%
Transformer - Overload	0	0.0%	0.0	0.0%
<u>Error</u>	5	0.5%	88.1	0.0%
Other Company Personnel	5	0.5%	88.1	0.0%
Switching	0	0.0%	0.0	0.0%
<u>Generation</u>	4	0.4%	4,743.1	2.0%
Auto UFLS	4	0.4%	4,743.1	2.0%
Manual Load Shed	0	0.0%	0.0	0.0%
Other	0	0.0%	0.0	0.0%
<u>Maintenance</u>	222	22.8%	26,262.4	11.1%
Scheduled	164	16.8%	22,250.7	9.4%
Forced	52	5.3%	2,899.6	1.2%
System Change	6	0.6%	1,112.1	0.5%
<u>Other</u>	1	0.1%	25.4	0.0%
Other	1	0.1%	25.4	0.0%
<u>Public (Non-Utility)</u>	64	6.6%	28,432.8	12.0%
Accident - Auto	29	3.0%	25,977.9	11.0%
Accident - Other	3	0.3%	1,127.8	0.5%
Accident - Construction	6	0.6%	654.7	0.3%
Object in Line - Animal	18	1.8%	593.9	0.3%
Object in Line - Balloon	3	0.3%	58.4	0.0%
Fire	3	0.3%	18.5	0.0%
Customer - Equipment	2	0.2%	1.7	0.0%
Customer - Requested	0	0.0%	0.0	0.0%
Object in Line - Foreign Object	0	0.0%	0.0	0.0%
Object in Line - Man	0	0.0%	0.0	0.0%
Vandalism	0	0.0%	0.0	0.0%
<u>Unknown</u>	53	5.4%	14,600.9	6.2%
Unknown	53	5.4%	14,600.9	6.2%
<u>Vegetation</u>	338	34.7%	69,814.6	29.5%
Branches/Tree	272	27.9%	61,926.3	26.2%
Overgrown	66	6.8%	7,888.3	3.3%
<u>Weather</u>	117	12.0%	32,265.0	13.6%
High Winds	87	8.9%	24,016.0	10.2%
Natural Disaster/Tsunami/Earthquake	1	0.1%	6,735.3	2.8%
Lightning	28	2.9%	1,487.0	0.6%
Heavy Rain	1	0.1%	26.8	0.0%
Flooding	0	0.0%	0.0	0.0%
Landslide	0	0.0%	0.0	0.0%
Total	974		236,484.1	

Note: Outages due to customer requests are not included in the service reliability indices.

DEFINITION OF TERMS

CUSTOMER INTERRUPTION

One interruption of one customer.

INTERRUPTION

The loss of service to one or more customers as a result of one or more component outages.

INTERRUPTION DURATION

The time period from the initiation of an interruption until service has been restored to the affected customers.

MOMENTARY INTERRUPTION

An interruption having a duration of five minutes or less, typically limited to the period required to restore service by an interrupting device.

OUTAGE

The loss of ability of a component to deliver power. An outage may or may not cause an interruption of service to customers, depending on the system configuration.

SUSTAINED INTERRUPTION

Any interruption not classified as a momentary interruption. That is, any interruption that lasts more than five minutes.

Note: Interruptions to customers at their request are not included.

Reliability indices are based on the standards defined by the Institute of Electrical and Electronics Engineers (IEEE). Four indices that convey a meaningful representation of the level of reliability are as follows:

RELIABILITY INDICES

AVERAGE SERVICE AVAILABILITY INDEX (ASAI)

ASAI indicates the fraction of time that the average customer received service during a predefined period of time. Customer hours service demand is determined by multiplying the total number of customers served by the number of hours in the period.

$$ASAI = \frac{\sum \text{Customer Hours Service Availability}}{\sum \text{Customer Hours Service Demand}} \times 100\%$$

CUSTOMER AVERAGE INTERRUPTION DURATION INDEX (CAIDI)

CAIDI indicates the average time required to restore service during a predefined period of time.

$$CAIDI = \frac{\sum(\text{Duration of Interruption} \times \text{No. of Sustained Customer Interruptions})}{\sum \text{No. of Sustained Customer Interruptions}} = \frac{SAIDI}{SAIFI}$$

SYSTEM AVERAGE INTERRUPTION DURATION INDEX (SAIDI)

SAIDI indicates the total sustained interruption duration for the average customer during a predefined period of time. It is commonly measured in minutes or hours of interruption.

$$SAIDI = \frac{\sum(\text{Duration of Interruption} \times \text{No. of Sustained Customer Interruptions})}{\text{Total No. of Customers Served}}$$

SYSTEM AVERAGE INTERRUPTION FREQUENCY INDEX (SAIFI)

SAIFI indicates how often the average customer experiences a sustained interruption during a predefined period of time.

$$SAIFI = \frac{\sum \text{No. of Sustained Customer Interruptions}}{\text{Total No. of Customers Served}}$$

MAUI ELECTRIC COMPANY, LIMITED

ANNUAL SERVICE RELIABILITY REPORT

2019

May 12, 2020

INTRODUCTION

This is Maui Electric Company, Limited's 2019 annual service reliability report.

The service reliability indices provided in this report are commonly used in the electric power utility industry as a method of measuring system reliability performance. These include overall availability of electrical service during a given period of time (Average Service Availability Index or ASAI), the average frequency or number of times customers experience a sustained interruption of service during a given period of time (System Average Interruption Frequency Index or SAIFI), the average length of time an interrupted customer is without power during a given period of time (Customer Average Interruption Duration Index or CAIDI), and the average length of time customers are without power during a given period of time (System Average Interruption Duration Index or SAIDI). SAIDI is an indication of overall system reliability because it incorporates the impact of frequency and duration of outages on the total customer base. The Appendix contains definitions, explanations, and equations for the reliability indices.

METHODOLOGY

The reliability indices provided in this report are calculated using the Institute of Electrical and Electronics Engineers (IEEE) Standard 1366TM-2012 methodology. Indices reported on a normalized basis exclude Major Event Days (MEDs). MEDs are defined as days in which the daily system SAIDI exceeds the MED threshold value (T_{MED}). Statistically, days having a daily system SAIDI greater than T_{MED} indicate days on which the energy delivery system experienced stresses beyond that normally expected (such as during severe weather).¹ In calculating daily system SAIDI, any interruption that spans multiple calendar days is accrued to the day on which the interruption began.

RESULTS

The following tables provide reliability index results on unnormalized and normalized bases for generation, transmission, and distribution outages and separately for 1) transmission and distribution outages, 2) utility generation outages, and 3) non-utility generation outages. Results are as of January 20, 2020. Subsequent findings may result in changes to data.

¹ IEEE Std 1366TM-2012: IEEE Guide for Electric Power Distribution Reliability Indices

Annual Service Reliability Indices

The following days in 2019 were determined to be MEDs and are therefore excluded from the normalized indices.

- 2/10/19 due to effects of winter storm/high winds, vegetation, and flashover (Maui only)
- 2/12/19 due to effects of winter storm/high winds (Maui only)
- 11/22/19 due to high winds (Maui only)

Table 1: Generation, Transmission, and Distribution Outages – All Islands, Unnormalized

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	69,825	70,303	70,745	71,049	71,671	72,265
Customer Interruptions	175,649	213,736	141,555	248,291	241,217	195,561
Customer-Hours Interrupted	219,072	533,523	220,337	984,239	569,222	348,169
SAIDI (minutes)	188.25	455.33	186.87	831.18	476.53	289.08
CAIDI (minutes)	74.83	149.77	93.39	237.84	141.59	106.82
SAIFI (interruptions)	2.516	3.040	2.001	3.495	3.366	2.706
ASAI (percentage)	99.964%	99.913%	99.965%	99.842%	99.909%	99.945%

Table 2: Transmission and Distribution Outages – All Islands, Unnormalized

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	69,825	70,303	70,745	71,049	71,671	72,265
Customer Interruptions	151,460	185,384	134,247	244,444	173,292	185,205
Customer-Hours Interrupted	198,364	515,672	213,140	979,851	527,947	342,971
SAIDI (minutes)	170.45	440.10	180.77	827.48	441.98	284.76
CAIDI (minutes)	78.58	166.90	95.26	240.51	182.79	111.11
SAIFI (interruptions)	2.169	2.637	1.898	3.441	2.418	2.563
ASAI (percentage)	99.968%	99.916%	99.966%	99.843%	99.916%	99.946%

Table 3: Utility Generation Outages – All Islands, Unnormalized

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	69,825	70,303	70,745	71,049	71,671	72,265
Customer Interruptions	17,788	12,044	7,305	3,667	23,563	10,356
Customer-Hours Interrupted	16,038	14,148	7,185	4,296	17,010	5,198
SAIDI (minutes)	13.78	12.07	6.09	3.63	14.24	4.32
CAIDI (minutes)	54.10	70.48	59.01	70.29	43.31	30.12
SAIFI (interruptions)	0.255	0.171	0.103	0.052	0.329	0.143
ASAI (percentage)	99.997%	99.998%	99.999%	99.999%	99.997%	99.999%

Table 4: Non-Utility Generation Outages – All Islands, Unnormalized PAGE 4 OF 26

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	69,825	70,303	70,745	71,049	71,671	72,265
Customer Interruptions	6,401	16,308	3	180	44,362	0
Customer-Hours Interrupted	4,671	3,704	13	92	24,264	0
SAIDI (minutes)	4.01	3.16	0.01	0.08	20.31	0.00
CAIDI (minutes)	43.78	13.63	255.00	30.71	32.82	0.00
SAIFI (interruptions)	0.092	0.232	0.000	0.003	0.619	0.000
ASAI (percentage)	99.999%	99.999%	100.000%	100.000%	99.996%	100.000%

Table 5: Generation, Transmission, and Distribution Outages – Maui, Unnormalized

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	64,909	65,390	65,799	66,107	66,701	67,267
Customer Interruptions	142,271	189,489	118,080	230,067	214,637	181,105
Customer-Hours Interrupted	167,123	504,962	177,695	860,210	462,804	321,230
SAIDI (minutes)	154.48	463.34	162.03	780.74	416.31	286.53
CAIDI (minutes)	70.48	159.89	90.29	224.34	129.37	106.42
SAIFI (interruptions)	2.192	2.898	1.795	3.480	3.218	2.692
ASAI (percentage)	99.971%	99.912%	99.969%	99.851%	99.921%	99.945%

Table 6: Transmission and Distribution Outages –Maui, Unnormalized

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	64,909	65,390	65,799	66,107	66,701	67,267
Customer Interruptions	128,824	168,666	118,077	230,067	152,495	176,181
Customer-Hours Interrupted	159,788	493,409	177,682	860,210	426,968	318,482
SAIDI (minutes)	147.70	452.74	162.02	780.74	384.08	284.08
CAIDI (minutes)	74.42	175.52	90.29	224.34	167.99	108.46
SAIFI (interruptions)	1.985	2.579	1.795	3.480	2.286	2.619
ASAI (percentage)	99.972%	99.914%	99.969%	99.851%	99.927%	99.946%

Table 7: Utility Generation Outages – Maui, Unnormalized

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	64,909	65,390	65,799	66,107	66,701	67,267
Customer Interruptions	7,046	4,515	0	0	17,960	4,924
Customer-Hours Interrupted	2,665	7,849	0	0	11,658	2,748
SAIDI (minutes)	2.46	7.20	0.00	0.00	10.49	2.45
CAIDI (minutes)	22.69	104.30	0.00	0.00	38.95	33.48
SAIFI (interruptions)	0.109	0.069	0.000	0.000	0.269	0.073
ASAI (percentage)	100.000%	99.999%	100.000%	100.000%	99.998%	100.000%

Table 8: Non-Utility Generation Outages – Maui, Unnormalized

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	64,909	65,390	65,799	66,107	66,701	67,267
Customer Interruptions	6,401	16,308	3	0	44,182	0
Customer-Hours Interrupted	4,671	3,704	13	0	24,178	0
SAIDI (minutes)	4.32	3.40	0.01	0.00	21.75	0.00
CAIDI (minutes)	43.78	13.63	255.00	0.00	32.83	0.00
SAIFI (interruptions)	0.099	0.249	0.000	0.000	0.662	0.000
ASAI (percentage)	99.999%	99.999%	100.000%	100.000%	99.996%	100.000%

Table 9: Generation, Transmission, and Distribution Outages – Moloka‘i, Unnormalized

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	3,191	3,193	3,212	3,209	3,232	3,250
Customer Interruptions	21,113	18,192	17,610	12,700	20,101	9,411
Customer-Hours Interrupted	35,756	23,110	38,058	32,315	99,544	23,818
SAIDI (minutes)	672.23	434.21	710.85	604.19	1847.88	439.76
CAIDI (minutes)	101.61	76.22	129.67	152.67	297.13	151.85
SAIFI (interruptions)	6.616	5.697	5.482	3.958	6.219	2.896
ASAI (percentage)	99.872%	99.917%	99.865%	99.885%	99.648%	99.916%

Table 10: Transmission and Distribution Outages – Moloka‘i, Unnormalized

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	3,191	3,193	3,212	3,209	3,232	3,250
Customer Interruptions	18,189	14,373	15,259	10,952	17,177	7,196
Customer-Hours Interrupted	32,790	19,415	34,985	29,132	96,584	22,916
SAIDI (minutes)	616.46	364.79	653.46	544.68	1792.93	423.12
CAIDI (minutes)	108.16	81.05	137.57	159.60	337.37	191.08
SAIFI (interruptions)	5.699	4.501	4.750	3.413	5.314	2.214
ASAI (percentage)	99.883%	99.931%	99.876%	99.896%	99.659%	99.919%

Table 11: Utility Generation Outages – Moloka‘i, Unnormalized

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	3,191	3,193	3,212	3,209	3,232	3,250
Customer Interruptions	2,924	3,819	2,351	1,748	2,924	2,215
Customer-Hours Interrupted	2,966	3,695	3,073	3,183	2,960	902
SAIDI (minutes)	55.77	69.42	57.40	59.51	54.94	16.65
CAIDI (minutes)	60.87	58.05	78.42	109.26	60.74	24.42
SAIFI (interruptions)	0.916	1.196	0.732	0.545	0.905	0.682
ASAI (percentage)	99.989%	99.987%	99.989%	99.989%	99.990%	99.997%

Table 12: Non-Utility Generation Outages – Moloka‘i, Unnormalized

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	3,191	3,193	3,212	3,209	3,232	3,250
Customer Interruptions	0	0	0	0	0	0
Customer-Hours Interrupted	0	0	0	0	0	0
SAIDI (minutes)	0.00	0.00	0.00	0.00	0.00	0.00
CAIDI (minutes)	0.00	0.00	0.00	0.00	0.00	0.00
SAIFI (interruptions)	0.000	0.000	0.000	0.000	0.000	0.000
ASAI (percentage)	100.000%	100.000%	100.000%	100.000%	100.000%	100.000%

Table 13: Generation, Transmission, and Distribution Outages – Lāna‘i, Unnormalized

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	1,724	1,720	1,733	1,733	1,738	1,749
Customer Interruptions	12,265	6,055	5,865	5,524	6,479	5,045
Customer-Hours Interrupted	16,192	5,452	4,584	91,714	6,874	3,121
SAIDI (minutes)	563.46	190.20	158.66	3176.26	237.27	107.10
CAIDI (minutes)	79.21	54.02	46.89	996.17	63.65	37.12
SAIFI (interruptions)	7.113	3.521	3.383	3.188	3.727	2.885
ASAI (percentage)	99.893%	99.964%	99.970%	99.396%	99.955%	99.980%

Table 14: Transmission and Distribution Outages – Lāna‘i, Unnormalized

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	1,724	1,720	1,733	1,733	1,738	1,749
Customer Interruptions	4,447	2,345	911	3,425	3,620	1,828
Customer-Hours Interrupted	5,786	2,848	472	90,510	4,395	1,572
SAIDI (minutes)	201.34	99.35	16.35	3134.53	151.71	53.95
CAIDI (minutes)	78.07	72.86	31.10	1585.57	72.85	51.61
SAIFI (interruptions)	2.579	1.364	0.526	1.977	2.083	1.045
ASAI (percentage)	99.962%	99.981%	99.997%	99.404%	99.971%	99.990%

Table 15: Utility Generation Outages – Lāna‘i, Unnormalized

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	1,724	1,720	1,733	1,733	1,738	1,749
Customer Interruptions	7,818	3,710	4,954	1,919	2,679	3,217
Customer-Hours Interrupted	10,406	2,604	4,112	1,113	2,392	1,549
SAIDI (minutes)	362.12	90.85	142.32	38.53	82.58	53.15
CAIDI (minutes)	79.86	42.11	49.80	34.79	53.58	28.89
SAIFI (interruptions)	4.534	2.157	2.858	1.108	1.541	1.840
ASAI (percentage)	99.931%	99.983%	99.973%	99.993%	99.984%	99.990%

Table 16: Non-Utility Generation Outages – Lāna‘i, Unnormalized

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	1,724	1,720	1,733	1,733	1,738	1,749
Customer Interruptions	0	0	0	180	180	0
Customer-Hours Interrupted	0	0	0	92	86	0
SAIDI (minutes)	0.00	0.00	0.00	3.19	2.98	0.00
CAIDI (minutes)	0.00	0.00	0.00	30.71	28.75	0.00
SAIFI (interruptions)	0.000	0.000	0.000	0.104	0.104	0.000
ASAI (percentage)	100.000%	100.000%	100.000%	99.999%	99.999%	100.000%

Table 17: Generation, Transmission, and Distribution Outages – All Islands, Normalized²

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	69,825	70,303	70,745	71,049	71,671	72,265
Customer Interruptions	147,964	114,267	113,783	117,429	181,037	148,205
Customer-Hours Interrupted	168,547	157,047	159,383	178,350	272,398	190,802
SAIDI (minutes)	144.83	134.03	135.18	150.62	228.04	158.42
CAIDI (minutes)	68.35	82.46	84.05	91.13	90.28	77.25
SAIFI (interruptions)	2.119	1.625	1.608	1.653	2.526	2.051
ASAI (percentage)	99.972%	99.974%	99.974%	99.971%	99.957%	99.970%

² Exclusions include:

- 7/11/14 due to unknown on company generation on Lanai
- 8/7/14 due to effects of Tropical Storm Iselle on Maui
- 8/8/14 due to effects of Tropical Storm Iselle on Maui
- 10/7/14 due to substation equipment failure on Maui
- 1/2/15 due to Kona Storm on Maui
- 1/3/15 due to Kona Storm on Maui
- 2/14/15 due to Valentine's Day storm on Maui
- 2/24/15 due to unknown and equipment deterioration on Maui
- 11/19/15 due to trees or branches in lines on Maui
- 11/20/15 due to motor vehicle accident and trees or branches in lines on Maui
- 12/18/15 due to substation equipment failure on Maui
- 4/3/16 due to motor vehicle accident on Maui
- 7/2/16 due to West Maui Mountains wildfire on Maui
- 12/18/16 due to trees or branches in lines during high winds on Maui
- 1/21/17 due to high winds on Lanai
- 3/2/17 due to under frequency load shed on Maui
- 10/24/17 due to an island wide outage on Maui
- 11/26/17 due to under frequency load shed and a fault caused by tree branch on Maui
- 8/23/18 due to effects of Hurricane Lane on Maui
- 8/24/18 due to effects of Hurricane Lane on Maui
- 9/12/18 due to effects of Tropical Storm Olivia on Maui
- 10/20/18 under-frequency load shedding (UFLS) due to rapid drop in as-available generation on Maui
- 2/10/19 due to effects of winter storm/high winds, vegetation, and flashover on Maui
- 2/12/19 due to effects of winter storm/high winds on Maui
- 11/22/19 due to high winds on Maui

Table 18: Transmission and Distribution Outages – All Islands, Normalized² PAGE 8 OF 26

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	69,825	70,303	70,745	71,049	71,671	72,265
Customer Interruptions	125,715	86,481	106,475	113,582	135,488	137,849
Customer-Hours Interrupted	151,862	144,209	152,185	173,962	248,682	185,604
SAIDI (minutes)	130.49	123.07	129.07	146.91	208.19	154.10
CAIDI (minutes)	72.48	100.05	85.76	91.90	110.13	80.79
SAIFI (interruptions)	1.800	1.230	1.505	1.599	1.890	1.908
ASAI (percentage)	99.975%	99.977%	99.976%	99.972%	99.960%	99.971%

Table 19: Utility Generation Outages – All Islands, Normalized²

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	69,825	70,303	70,745	71,049	71,671	72,265
Customer Interruptions	15,848	11,478	7,305	3,667	23,563	10,356
Customer-Hours Interrupted	12,015	9,134	7,185	4,296	17,010	5,198
SAIDI (minutes)	10.32	7.79	6.09	3.63	14.24	4.32
CAIDI (minutes)	45.49	47.74	59.01	70.29	43.31	30.12
SAIFI (interruptions)	0.227	0.163	0.103	0.052	0.329	0.143
ASAI (percentage)	99.998%	99.999%	99.999%	99.999%	99.997%	99.999%

Table 20: Non-Utility Generation Outages – All Islands, Normalized²

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	69,825	70,303	70,745	71,049	71,671	72,265
Customer Interruptions	6,401	16,308	3	180	21,986	0
Customer-Hours Interrupted	4,671	3,704	13	92	6,706	0
SAIDI (minutes)	4.01	3.16	0.01	0.08	5.61	0.00
CAIDI (minutes)	43.78	13.63	255.00	30.71	18.30	0.00
SAIFI (interruptions)	0.092	0.232	0.000	0.003	0.307	0.000
ASAI (percentage)	99.999%	99.999%	100.000%	100.000%	99.999%	100.000%

Table 21: Generation, Transmission, and Distribution Outages – Maui, Normalized²

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	64,909	65,390	65,799	66,107	66,701	67,267
Customer Interruptions	116,684	90,020	90,308	100,952	154,457	133,749
Customer-Hours Interrupted	120,630	128,486	116,740	143,751	165,980	163,862
SAIDI (minutes)	111.51	117.89	106.45	130.47	149.31	146.16
CAIDI (minutes)	62.03	85.64	77.56	85.44	64.48	73.51
SAIFI (interruptions)	1.798	1.377	1.372	1.527	2.316	1.988
ASAI (percentage)	99.979%	99.978%	99.980%	99.975%	99.972%	99.972%

Table 22: Transmission and Distribution Outages – Maui, Normalized²

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	64,909	65,390	65,799	66,107	66,701	67,267
Customer Interruptions	103,457	69,763	90,305	100,952	114,691	128,825
Customer-Hours Interrupted	113,324	121,947	116,728	143,751	147,702	161,115
SAIDI (minutes)	104.75	111.89	106.44	130.47	132.86	143.71
CAIDI (minutes)	65.72	104.88	77.56	85.44	77.27	75.04
SAIFI (interruptions)	1.594	1.067	1.372	1.527	1.719	1.915
ASAI (percentage)	99.980%	99.979%	99.980%	99.975%	99.975%	99.973%

Table 23: Utility Generation Outages – Maui, Normalized²

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	64,909	65,390	65,799	66,107	66,701	67,267
Customer Interruptions	6,826	3,949	0	0	17,960	4,924
Customer-Hours Interrupted	2,636	2,835	0	0	11,658	2,748
SAIDI (minutes)	2.44	2.60	0.00	0.00	10.49	2.45
CAIDI (minutes)	23.17	43.07	0.00	0.00	38.95	33.48
SAIFI (interruptions)	0.105	0.060	0.000	0.000	0.269	0.073
ASAI (percentage)	100.000%	100.000%	100.000%	100.000%	99.998%	100.000%

Table 24: Non-Utility Generation Outages – Maui, Normalized²

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	64,909	65,390	65,799	66,107	66,701	67,267
Customer Interruptions	6,401	16,308	3	0	21,806	0
Customer-Hours Interrupted	4,671	3,704	13	0	6,620	0
SAIDI (minutes)	4.32	3.40	0.01	0.00	5.96	0.00
CAIDI (minutes)	43.78	13.63	255.00	0.00	18.22	0.00
SAIFI (interruptions)	0.099	0.249	0.000	0.000	0.327	0.000
ASAI (percentage)	99.999%	99.999%	100.000%	100.000%	99.999%	100.000%

Table 25: Generation, Transmission, and Distribution Outages – Moloka'i, Normalized²

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	3,191	3,193	3,212	3,209	3,232	3,250
Customer Interruptions	21,113	18,192	17,610	12,700	20,101	9,411
Customer-Hours Interrupted	35,756	23,110	38,058	32,315	99,544	23,818
SAIDI (minutes)	672.23	434.21	710.85	604.19	1847.88	439.76
CAIDI (minutes)	101.61	76.22	129.67	152.67	297.13	151.85
SAIFI (interruptions)	6.616	5.697	5.482	3.958	6.219	2.896
ASAI (percentage)	99.872%	99.917%	99.865%	99.885%	99.648%	99.916%

Table 26: Transmission and Distribution Outages – Moloka‘i, Normalized² PAGE 10 OF 26

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	3,191	3,193	3,212	3,209	3,232	3,250
Customer Interruptions	18,189	14,373	15,259	10,952	17,177	7,196
Customer-Hours Interrupted	32,790	19,415	34,985	29,132	96,584	22,916
SAIDI (minutes)	616.46	364.79	653.46	544.68	1792.93	423.12
CAIDI (minutes)	108.16	81.05	137.57	159.60	337.37	191.08
SAIFI (interruptions)	5.699	4.501	4.750	3.413	5.314	2.214
ASAI (percentage)	99.883%	99.931%	99.876%	99.896%	99.659%	99.919%

Table 27: Utility Generation Outages – Moloka‘i, Normalized²

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	3,191	3,193	3,212	3,209	3,232	3,250
Customer Interruptions	2,924	3,819	2,351	1,748	2,924	2,215
Customer-Hours Interrupted	2,966	3,695	3,073	3,183	2,960	902
SAIDI (minutes)	55.77	69.42	57.40	59.51	54.94	16.65
CAIDI (minutes)	60.87	58.05	78.42	109.26	60.74	24.42
SAIFI (interruptions)	0.916	1.196	0.732	0.545	0.905	0.682
ASAI (percentage)	99.989%	99.987%	99.989%	99.989%	99.990%	99.997%

Table 28: Non-Utility Generation Outages – Moloka‘i, Normalized²

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	3,191	3,193	3,212	3,209	3,232	3,250
Customer Interruptions	0	0	0	0	0	0
Customer-Hours Interrupted	0	0	0	0	0	0
SAIDI (minutes)	0.00	0.00	0.00	0.00	0.00	0.00
CAIDI (minutes)	0.00	0.00	0.00	0.00	0.00	0.00
SAIFI (interruptions)	0.000	0.000	0.000	0.000	0.000	0.000
ASAI (percentage)	100.000%	100.000%	100.000%	100.000%	100.000%	100.000%

Table 29: Generation, Transmission, and Distribution Outages – Lāna‘i, Normalized²

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	1,724	1,720	1,733	1,733	1,738	1,749
Customer Interruptions	10,167	6,055	5,865	3,777	6,479	5,045
Customer-Hours Interrupted	12,161	5,452	4,584	2,284	6,874	3,121
SAIDI (minutes)	423.19	190.20	158.66	79.10	237.27	107.10
CAIDI (minutes)	71.77	54.02	46.89	36.28	63.65	37.12
SAIFI (interruptions)	5.896	3.521	3.383	2.180	3.727	2.885
ASAI (percentage)	99.919%	99.964%	99.970%	99.985%	99.955%	99.980%

Table 30: Transmission and Distribution Outages – Lāna‘i, Normalized²

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	1,724	1,720	1,733	1,733	1,738	1,749
Customer Interruptions	4,069	2,345	911	1,678	3,620	1,828
Customer-Hours Interrupted	5,748	2,848	472	1,079	4,395	1,572
SAIDI (minutes)	200.03	99.35	16.35	37.38	151.71	53.95
CAIDI (minutes)	84.76	72.86	31.10	38.59	72.85	51.61
SAIFI (interruptions)	2.360	1.364	0.526	0.969	2.083	1.045
ASAI (percentage)	99.962%	99.981%	99.997%	99.993%	99.971%	99.990%

Table 31: Utility Generation Outages – Lāna‘i, Normalized²

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	1,724	1,720	1,733	1,733	1,738	1,749
Customer Interruptions	6,098	3,710	4,954	1,919	2,679	3,217
Customer-Hours Interrupted	6,413	2,604	4,112	1,113	2,392	1,549
SAIDI (minutes)	223.16	90.85	142.32	38.53	82.58	53.15
CAIDI (minutes)	63.10	42.11	49.80	34.79	53.58	28.89
SAIFI (interruptions)	3.537	2.157	2.858	1.108	1.541	1.840
ASAI (percentage)	99.958%	99.983%	99.973%	99.993%	99.984%	99.990%

Table 32: Non-Utility Generation Outages – Lāna‘i, Normalized²

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Number of Customers	1,724	1,720	1,733	1,733	1,738	1,749
Customer Interruptions	0	0	0	180	180	0
Customer-Hours Interrupted	0	0	0	92	86	0
SAIDI (minutes)	0.00	0.00	0.00	3.19	2.98	0.00
CAIDI (minutes)	0.00	0.00	0.00	30.71	28.75	0.00
SAIFI (interruptions)	0.000	0.000	0.000	0.104	0.104	0.000
ASAI (percentage)	100.000%	100.000%	100.000%	99.999%	99.999%	100.000%

The following charts and discussion are based on the annual reliability index results for generation, transmission, and distribution outages on a normalized basis (data from Table 17, above).

Figure 1: Normalized System Average Interruption Duration Index (SAIDI)

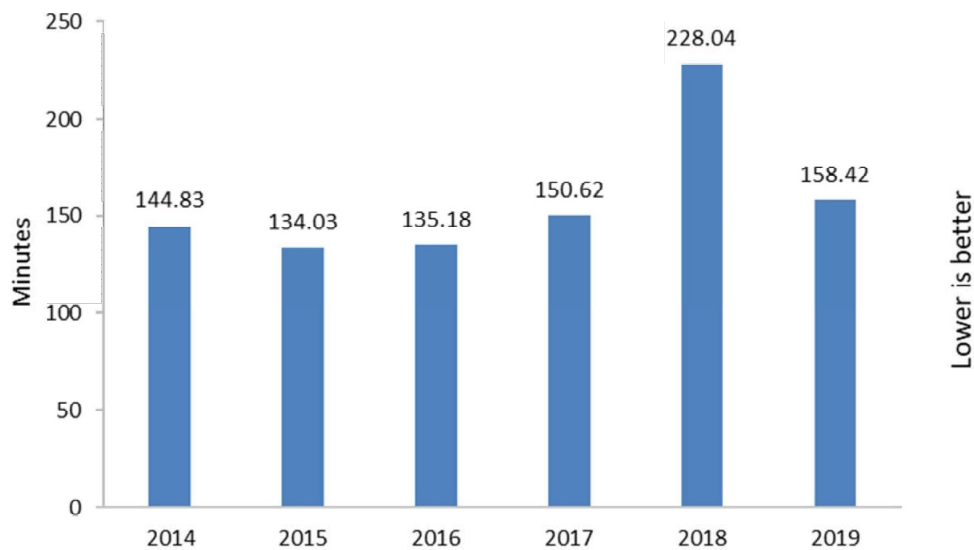


Figure 1 shows the SAIDI values for 2014 to 2019.

The 2019 SAIDI is 158.42 minutes, about a 31% decrease compared to the 2018 SAIDI result of 228.04 minutes. The customer hours interrupted was 190,802 hours in 2019 compared to 272,398 hours in 2018.

The following events significantly impacted the 2019 SAIDI result:

1. December 25, 2019 (Wednesday) – Various weather-related outages affected Maui and Moloka‘i. This resulted in a sustained outage to 6,346 customers for up to 19 hours and 54 minutes and contributed 12.16 minutes to the annual SAIDI.
2. February 27, 2019 (Wednesday) – A large Eucalyptus tree fell and contacted conductors, causing a swing short in Makawao, Maui. This resulted in a sustained outage to 6,080 customers for up to 18 hours and 56 minutes and contributed 8.15 minutes to the annual SAIDI.
3. August 31, 2019 (Saturday) – Under-frequency load shed due to cable fault at Kaonoulu Substation. This resulted in a sustained outage to 10,950 customers for up to 40 minutes and contributed 5.79 minutes to the annual SAIDI.

Figure 2: Normalized System Average Interruption Frequency Index (SAIFI)

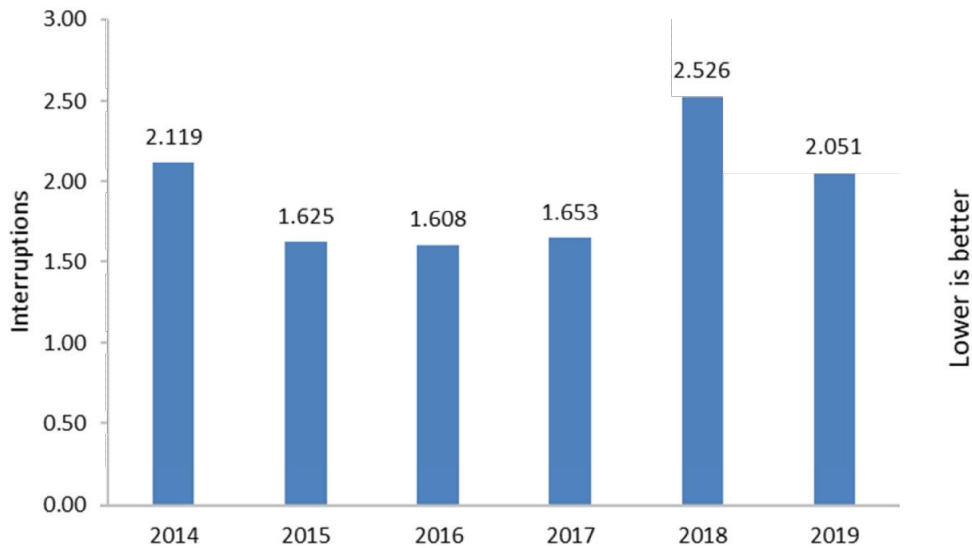


Figure 2 shows the SAIFI values for 2014 to 2019.

The 2019 SAIFI of 2.051 is about a 19% decrease compared to the 2018 SAIFI result of 2.526. The number of customer interruptions in 2019 was 148,205 as compared to 181,037 customer interruptions in 2018.

The following events significantly impacted the 2019 SAIFI result:

1. October 2, 2019 (Wednesday) – Under-frequency load shed due to smoke and debris from brushfire on Maui. This resulted in a sustained outage to 16,814 customers for up to 20 minutes and contributed 0.233 to the annual SAIFI.
2. August 31, 2019 (Saturday) – Under-frequency load shed due to cable fault at Kaonoulu Substation. This resulted in a sustained outage to 10,950 customers for up to 40 minutes and contributed 0.152 to the annual SAIFI.
3. March 9, 2019 (Saturday) – A tree branch fell onto conductors in Haiku, Maui. This resulted in a sustained outage to 6,549 customers for up to 2 hours and 9 minutes and contributed 0.091 to the annual SAIFI.

Figure 3: Normalized Customer Average Interruption Duration Index (CAIDI)

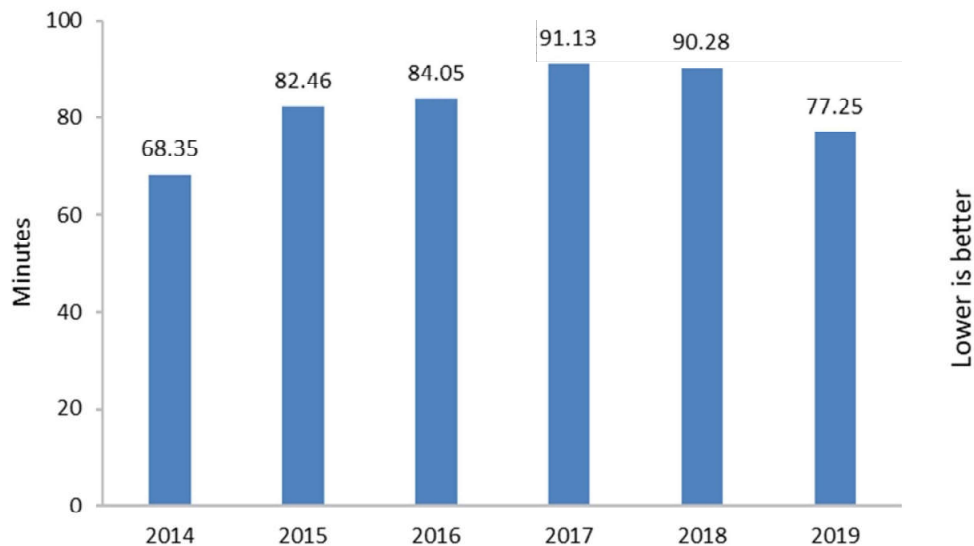


Figure 3 shows the CAIDI values for 2014 to 2019.

The 2019 CAIDI of 77.25 minutes is about a 14% decrease compared to the 2018 CAIDI of 90.28 minutes.

The following events significantly affected the 2019 CAIDI results:

1. December 25, 2019 (Wednesday) – Various weather-related outages affected Maui and Moloka‘i. This resulted in a sustained outage to 6,346 customers for up to 19 hours and 54 minutes and contributed 2.74 minutes to the annual CAIDI.
2. February 3, 2019 (Sunday) – Two poles fell due to broken anchor on Kamehameha Highway on Moloka‘i. This resulted in a sustained outage to 414 customers for up to 19 hours and 28 minutes and contributed 1.97 minutes to the annual CAIDI.
3. June 9, 2019 (Sunday) – Pole broke due to motor vehicle accident in Makawao, Maui. This resulted in a sustained outage to 400 customers for up to 9 hours and 58 minutes and contributed 1.30 minutes to the annual CAIDI.

Figure 4: Normalized Average System Availability Index (ASAI)

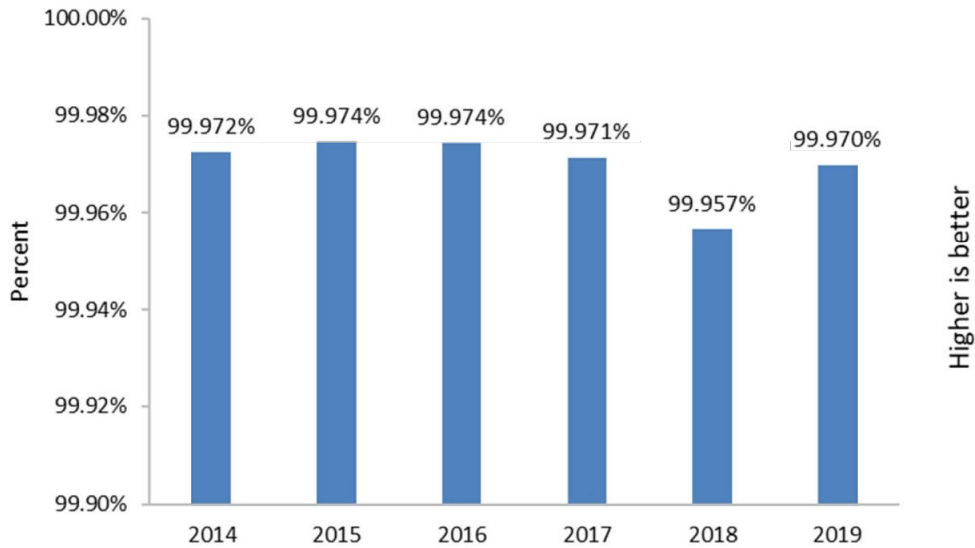
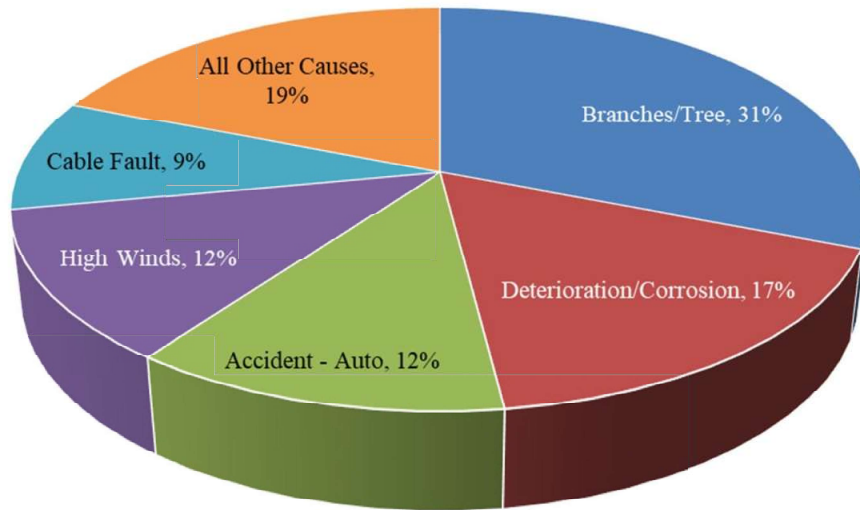


Figure 4 shows the ASAI values for 2014 to 2019.

The 2019 ASAI of 99.970% is a 0.013% increase compared to the 2018 ASAI of 99.957%. The customer hours interrupted was 190,802 hours in 2019 compared to 272,398 hours in 2018.

Figure 5: Outage Causes for 2019



The top five outage causes by customer hours interrupted, as illustrated in Figure 5, accounted for about 81% of the total customer hours interrupted in 2019. These include:

<u>Outage Cause</u>	<u>Description</u>
1. Branches/Tree	Vegetation contacting or falling onto overhead conductors
2. Deterioration/Corrosion	Failed, broken, or corroded equipment
3. Accident – Auto	Motor vehicle collision with company equipment
4. High Winds	Outages due to high/gusty winds
5. Cable Fault	Underground cable or cable component failure

From 2018 to 2019, Branches/Tree remained the top outage cause. The Deterioration/Corrosion, Accident – Auto, and Cable Fault outage causes are new to the top five as 2nd, 3rd, and 5th, respectively. High Winds went from 2nd to 4th.

Maui Electric Company, Limited
Normalized Sustained Interruption Summary – System Total

From: January 1, 2019 To: December 31, 2019

Outage Cause	Customer Hours Interrupted	Customer Interruptions	SAIFI (interruptions)	SAIDI (minutes)	CAIDI (minutes)
Branches/Tree	58,861.0	41,908	0.580	48.87	84.27
Deterioration/Corrosion	32,404.8	12,766	0.177	26.91	152.30
Accident - Auto	22,718.6	8,547	0.118	18.86	159.48
High Winds	22,204.1	11,179	0.155	18.44	119.17
Cable Fault	16,271.4	16,422	0.227	13.51	59.45
Fire	8,663.4	22,289	0.308	7.19	23.32
Scheduled	7,706.2	4,330	0.060	6.40	106.78
Failure/Defect	5,292.1	7,272	0.101	4.39	43.66
Object in Line - Foreign Object	3,788.2	5,080	0.070	3.15	44.74
Forced	2,580.8	4,561	0.063	2.14	33.95
Auto UFLS	2,448.4	5,429	0.075	2.03	27.06
Other Company Personnel	1,821.6	4,104	0.057	1.51	26.63
Object in Line - Balloon	1,463.0	1,330	0.018	1.21	66.00
Unknown	1,325.9	639	0.009	1.10	124.50
Flashover	976.7	300	0.004	0.81	195.34
Overgrown	967.7	344	0.005	0.80	168.78
Object in Line - Animal	474.7	413	0.006	0.39	68.97
Accident - Other	240.2	143	0.002	0.20	100.79
Transformer - Failure	148.4	36	0.000	0.12	247.25
Faulty Operation	146.0	794	0.011	0.12	11.03
Customer - Equipment	83.3	83	0.001	0.07	60.20
Overload	72.1	33	0.000	0.06	131.00
Switching	54.3	174	0.002	0.05	18.74
System Change	41.0	10	0.000	0.03	246.00
Heavy Rain	30.7	10	0.000	0.03	184.00
Transformer - Overload	9.4	5	0.000	0.01	112.60
Accident - Construction	8.0	4	0.000	0.01	120.00
Customer - Requested	0.0	0	0.000	0.00	0.00
Flooding	0.0	0	0.000	0.00	0.00
Landslide	0.0	0	0.000	0.00	0.00
Lightning	0.0	0	0.000	0.00	0.00
Manual Load Shed	0.0	0	0.000	0.00	0.00
Natural Disaster/Tsunami/Earthquake	0.0	0	0.000	0.00	0.00
Object in Line - Man	0.0	0	0.000	0.00	0.00
Other	0.0	0	0.000	0.00	0.00
Vandalism	0.0	0	0.000	0.00	0.00
Total	190,801.9	148,205	2.051	158.42	77.25

Average System Availability = 99.970%
Number of customers for the period = 72,265
24-month annual SAIDI (minutes) average for the period 1/1/2018 - 12/31/2019 = 193.23
24-month average number of customers for the period 1/1/2018 - 12/31/2019 = 71,968

Notes: Outage causes are listed in descending order of SAIDI. Outages due to customer requests are not included in the service reliability indices.

Maui Electric Company, Limited
Normalized Sustained Interruption Summary – Maui

From: January 1, 2019 To: December 31, 2019

Outage Cause	Customer Hours Interrupted	Customer Interruptions	SAIFI (interruptions)	SAIDI (minutes)	CAIDI (minutes)
Branches/Tree	54,852.3	39,682	0.590	48.93	82.94
Accident - Auto	19,855.4	7,448	0.111	17.71	159.95
High Winds	19,707.9	9,603	0.143	17.58	123.14
Deterioration/Corrosion	19,534.5	10,678	0.159	17.42	109.76
Cable Fault	15,691.7	16,113	0.240	14.00	58.43
Fire	8,663.4	22,289	0.331	7.73	23.32
Scheduled	7,081.8	3,745	0.056	6.32	113.46
Failure/Defect	5,289.8	7,269	0.108	4.72	43.66
Object in Line - Foreign Object	3,788.2	5,080	0.076	3.38	44.74
Forced	2,346.2	4,051	0.060	2.09	34.75
Other Company Personnel	1,821.6	4,104	0.061	1.62	26.63
Object in Line - Balloon	1,463.0	1,330	0.020	1.30	66.00
Unknown	1,070.4	493	0.007	0.95	130.28
Overgrown	967.7	344	0.005	0.86	168.78
Flashover	653.9	153	0.002	0.58	256.42
Object in Line - Animal	284.2	217	0.003	0.25	78.57
Accident - Other	240.2	143	0.002	0.21	100.79
Transformer - Failure	148.4	36	0.001	0.13	247.25
Faulty Operation	146.0	794	0.012	0.13	11.03
Customer - Equipment	83.3	83	0.001	0.07	60.20
Overload	72.1	33	0.000	0.06	131.00
System Change	41.0	10	0.000	0.04	246.00
Heavy Rain	30.7	10	0.000	0.03	184.00
Switching	11.7	32	0.000	0.01	22.00
Transformer - Overload	9.4	5	0.000	0.01	112.60
Accident - Construction	8.0	4	0.000	0.01	120.00
Auto UFLS	0.0	0	0.000	0.00	0.00
Customer - Requested	0.0	0	0.000	0.00	0.00
Flooding	0.0	0	0.000	0.00	0.00
Landslide	0.0	0	0.000	0.00	0.00
Lightning	0.0	0	0.000	0.00	0.00
Manual Load Shed	0.0	0	0.000	0.00	0.00
Natural Disaster/Tsunami/Earthquake	0.0	0	0.000	0.00	0.00
Object in Line - Man	0.0	0	0.000	0.00	0.00
Other	0.0	0	0.000	0.00	0.00
Vandalism	0.0	0	0.000	0.00	0.00
Total	163,862.4	133,749	1.988	146.16	73.51

Average System Availability = 99.972%
Number of customers for the period = 67,267
24-month annual SAIDI (minutes) average for the period 1/1/2018 - 12/31/2019 = 147.73
24-month average number of customers for the period 1/1/2018 - 12/31/2019 = 66,984

Notes: Outage causes are listed in descending order of SAIDI. Outages due to customer requests are not included in the service reliability indices.

Maui Electric Company, Limited
Normalized Sustained Interruption Summary – Moloka‘i

From: January 1, 2019 To: December 31, 2019

Outage Cause	Customer Hours Interrupted	Customer Interruptions	SAIFI (interruptions)	SAIDI (minutes)	CAIDI (minutes)
Deterioration/Corrosion	12,480.8	2,001	0.616	230.44	374.24
Branches/Tree	3,266.9	1,462	0.450	60.32	134.07
Accident - Auto	2,863.2	1,099	0.338	52.87	156.32
High Winds	2,280.9	816	0.251	42.11	167.71
Auto UFLS	901.6	2,215	0.682	16.65	24.42
Scheduled	583.3	570	0.175	10.77	61.40
Cable Fault	579.8	309	0.095	10.70	112.57
Flashover	319.2	144	0.044	5.89	133.00
Unknown	253.2	142	0.044	4.68	107.00
Forced	223.3	501	0.154	4.12	26.74
Switching	42.6	142	0.044	0.79	18.00
Object in Line - Animal	23.3	10	0.003	0.43	140.00
Accident - Construction	0.0	0	0.000	0.00	0.00
Accident - Other	0.0	0	0.000	0.00	0.00
Customer - Equipment	0.0	0	0.000	0.00	0.00
Customer - Requested	0.0	0	0.000	0.00	0.00
Failure/Defect	0.0	0	0.000	0.00	0.00
Faulty Operation	0.0	0	0.000	0.00	0.00
Fire	0.0	0	0.000	0.00	0.00
Flooding	0.0	0	0.000	0.00	0.00
Heavy Rain	0.0	0	0.000	0.00	0.00
Landslide	0.0	0	0.000	0.00	0.00
Lightning	0.0	0	0.000	0.00	0.00
Manual Load Shed	0.0	0	0.000	0.00	0.00
Natural Disaster/Tsunami/Earthquake	0.0	0	0.000	0.00	0.00
Object in Line - Balloon	0.0	0	0.000	0.00	0.00
Object in Line - Foreign Object	0.0	0	0.000	0.00	0.00
Object in Line - Man	0.0	0	0.000	0.00	0.00
Other	0.0	0	0.000	0.00	0.00
Other Company Personnel	0.0	0	0.000	0.00	0.00
Overgrown	0.0	0	0.000	0.00	0.00
Overload	0.0	0	0.000	0.00	0.00
System Change	0.0	0	0.000	0.00	0.00
Transformer - Failure	0.0	0	0.000	0.00	0.00
Transformer - Overload	0.0	0	0.000	0.00	0.00
Vandalism	0.0	0	0.000	0.00	0.00
Total	23,818.1	9,411	2.896	439.76	151.85

Average System Availability =	99.916%
Number of customers for the period =	3,250
24-month annual SAIDI (minutes) average for the period 1/1/2018 - 12/31/2019 =	1,143.82
24-month average number of customers for the period 1/1/2018 - 12/31/2019 =	3,241

Notes: Outage causes are listed in descending order of SAIDI. Outages due to customer requests are not included in the service reliability indices.

Maui Electric Company, Limited
Normalized Sustained Interruption Summary – Lāna‘i

From: January 1, 2019 To: December 31, 2019

Outage Cause	Customer Hours Interrupted	Customer Interruptions	SAIFI (interruptions)	SAIDI (minutes)	CAIDI (minutes)
Auto UFLS	1,546.8	3,214	1.838	53.07	28.88
Branches/Tree	741.8	764	0.437	25.45	58.25
Deterioration/Corrosion	389.5	87	0.050	13.37	268.64
High Winds	215.3	760	0.435	7.39	17.00
Object in Line - Animal	167.2	186	0.106	5.74	53.95
Scheduled	41.2	15	0.009	1.41	164.67
Forced	11.4	9	0.005	0.39	76.00
Flashover	3.6	3	0.002	0.12	72.00
Failure/Defect	2.3	3	0.002	0.08	46.33
Unknown	2.3	4	0.002	0.08	34.00
Accident - Auto	0.0	0	0.000	0.00	0.00
Accident - Construction	0.0	0	0.000	0.00	0.00
Accident - Other	0.0	0	0.000	0.00	0.00
Cable Fault	0.0	0	0.000	0.00	0.00
Customer - Equipment	0.0	0	0.000	0.00	0.00
Customer - Requested	0.0	0	0.000	0.00	0.00
Faulty Operation	0.0	0	0.000	0.00	0.00
Fire	0.0	0	0.000	0.00	0.00
Flooding	0.0	0	0.000	0.00	0.00
Heavy Rain	0.0	0	0.000	0.00	0.00
Landslide	0.0	0	0.000	0.00	0.00
Lightning	0.0	0	0.000	0.00	0.00
Manual Load Shed	0.0	0	0.000	0.00	0.00
Natural Disaster/Tsunami/Earthquake	0.0	0	0.000	0.00	0.00
Object in Line - Balloon	0.0	0	0.000	0.00	0.00
Object in Line - Foreign Object	0.0	0	0.000	0.00	0.00
Object in Line - Man	0.0	0	0.000	0.00	0.00
Other	0.0	0	0.000	0.00	0.00
Other Company Personnel	0.0	0	0.000	0.00	0.00
Overgrown	0.0	0	0.000	0.00	0.00
Overload	0.0	0	0.000	0.00	0.00
Switching	0.0	0	0.000	0.00	0.00
System Change	0.0	0	0.000	0.00	0.00
Transformer - Failure	0.0	0	0.000	0.00	0.00
Transformer - Overload	0.0	0	0.000	0.00	0.00
Vandalism	0.0	0	0.000	0.00	0.00
Total	3,121.4	5,045	2.885	107.10	37.12

Average System Availability = 99.980%
Number of customers for the period = 1,749
24-month annual SAIDI (minutes) average for the period 1/1/2018 - 12/31/2019 = 172.19
24-month average number of customers for the period 1/1/2018 - 12/31/2019 = 1,743

Notes: Outage causes are listed in descending order of SAIDI. Outages due to customer requests are not included in the service reliability indices.

Maui Electric Company, Limited
Normalized Sustained Interruption Summary – System Total

From: January 1, 2019 To: December 31, 2019

	Interruption Count	% of Total	Customer Hours Interrupted	% of Total
<u>Equipment</u>	169	23.2%	55,320.7	29.0%
Deterioration/Corrosion	94	12.9%	32,404.8	17.0%
Cable Fault	35	4.8%	16,271.4	8.5%
Failure/Defect	19	2.6%	5,292.1	2.8%
Flashover	5	0.7%	976.7	0.5%
Transformer - Failure	6	0.8%	148.4	0.1%
Faulty Operation	4	0.5%	146.0	0.1%
Overload	4	0.5%	72.1	0.0%
Transformer - Overload	2	0.3%	9.4	0.0%
<u>Error</u>	12	1.6%	1,875.9	1.0%
Other Company Personnel	9	1.2%	1,821.6	1.0%
Switching	3	0.4%	54.3	0.0%
<u>Generation</u>	7	1.0%	2,448.4	1.3%
Auto UFLS	7	1.0%	2,448.4	1.3%
Manual Load Shed	0	0.0%	0.0	0.0%
Other	0	0.0%	0.0	0.0%
<u>Maintenance</u>	274	37.6%	10,328.0	5.4%
Scheduled	223	30.6%	7,706.2	4.0%
Forced	50	6.9%	2,580.8	1.4%
System Change	1	0.1%	41.0	0.0%
<u>Other</u>	0	0.0%	0.0	0.0%
Other	0	0.0%	0.0	0.0%
<u>Public (Non-Utility)</u>	64	8.8%	37,439.5	19.6%
Accident - Auto	18	2.5%	22,718.6	11.9%
Fire	7	1.0%	8,663.4	4.5%
Object in Line - Foreign Object	9	1.2%	3,788.2	2.0%
Object in Line - Balloon	1	0.1%	1,463.0	0.8%
Object in Line - Animal	17	2.3%	474.7	0.2%
Accident - Other	7	1.0%	240.2	0.1%
Customer - Equipment	4	0.5%	83.3	0.0%
Accident - Construction	1	0.1%	8.0	0.0%
Customer - Requested	0	0.0%	0.0	0.0%
Object in Line - Man	0	0.0%	0.0	0.0%
Vandalism	0	0.0%	0.0	0.0%
<u>Unknown</u>	20	2.7%	1,325.9	0.7%
Unknown	20	2.7%	1,325.9	0.7%
<u>Vegetation</u>	149	20.4%	59,828.7	31.4%
Branches/Tree	129	17.7%	58,861.0	30.8%
Overgrown	20	2.7%	967.7	0.5%
<u>Weather</u>	34	4.7%	22,234.8	11.7%
High Winds	33	4.5%	22,204.1	11.6%
Heavy Rain	1	0.1%	30.7	0.0%
Flooding	0	0.0%	0.0	0.0%
Landslide	0	0.0%	0.0	0.0%
Lightning	0	0.0%	0.0	0.0%
Natural Disaster/Tsunami/Earthquake	0	0.0%	0.0	0.0%
Total	729		190,801.9	

Note: Outages due to customer requests are not included in the service reliability indices.

Maui Electric Company, Limited
Normalized Sustained Interruption Summary – Maui

From: January 1, 2019 To: December 31, 2019

	Interruption Count	% of Total	Customer Hours Interrupted	% of Total
<u>Equipment</u>	156	22.9%	41,545.5	25.4%
Deterioration/Corrosion	85	12.5%	19,534.5	11.9%
Cable Fault	34	5.0%	15,691.7	9.6%
Failure/Defect	18	2.6%	5,289.8	3.2%
Flashover	3	0.4%	653.9	0.4%
Transformer - Failure	6	0.9%	148.4	0.1%
Faulty Operation	4	0.6%	146.0	0.1%
Overload	4	0.6%	72.1	0.0%
Transformer - Overload	2	0.3%	9.4	0.0%
<u>Error</u>	11	1.6%	1,833.3	1.1%
Other Company Personnel	9	1.3%	1,821.6	1.1%
Switching	2	0.3%	11.7	0.0%
<u>Generation</u>	0	0.0%	0.0	0.0%
Auto UFLS	0	0.0%	0.0	0.0%
Manual Load Shed	0	0.0%	0.0	0.0%
Other	0	0.0%	0.0	0.0%
<u>Maintenance</u>	264	38.8%	9,468.9	5.8%
Scheduled	218	32.0%	7,081.8	4.3%
Forced	45	6.6%	2,346.2	1.4%
System Change	1	0.1%	41.0	0.0%
<u>Other</u>	0	0.0%	0.0	0.0%
Other	0	0.0%	0.0	0.0%
<u>Public (Non-Utility)</u>	57	8.4%	34,385.7	21.0%
Accident - Auto	15	2.2%	19,855.4	12.1%
Fire	7	1.0%	8,663.4	5.3%
Object in Line - Foreign Object	9	1.3%	3,788.2	2.3%
Object in Line - Balloon	1	0.1%	1,463.0	0.9%
Object in Line - Animal	13	1.9%	284.2	0.2%
Accident - Other	7	1.0%	240.2	0.1%
Customer - Equipment	4	0.6%	83.3	0.1%
Accident - Construction	1	0.1%	8.0	0.0%
Customer - Requested	0	0.0%	0.0	0.0%
Object in Line - Man	0	0.0%	0.0	0.0%
Vandalism	0	0.0%	0.0	0.0%
<u>Unknown</u>	18	2.6%	1,070.4	0.7%
Unknown	18	2.6%	1,070.4	0.7%
<u>Vegetation</u>	145	21.3%	55,820.0	34.1%
Branches/Tree	125	18.4%	54,852.3	33.5%
Overgrown	20	2.9%	967.7	0.6%
<u>Weather</u>	30	4.4%	19,738.6	12.0%
High Winds	29	4.3%	19,707.9	12.0%
Heavy Rain	1	0.1%	30.7	0.0%
Flooding	0	0.0%	0.0	0.0%
Landslide	0	0.0%	0.0	0.0%
Lightning	0	0.0%	0.0	0.0%
Natural Disaster/Tsunami/Earthquake	0	0.0%	0.0	0.0%
Total	681		163,862.4	

Note: Outages due to customer requests are not included in the service reliability indices.

Maui Electric Company, Limited
Normalized Sustained Interruption Summary – Moloka‘i

From: January 1, 2019 To: December 31, 2019

	Interruption Count	% of Total	Customer Hours Interrupted	% of Total
<u>Equipment</u>	9	36.0%	13,379.8	56.2%
Deterioration/Corrosion	7	28.0%	12,480.8	52.4%
Cable Fault	1	4.0%	579.8	2.4%
Flashover	1	4.0%	319.2	1.3%
Failure/Defect	0	0.0%	0.0	0.0%
Faulty Operation	0	0.0%	0.0	0.0%
Overload	0	0.0%	0.0	0.0%
Transformer - Failure	0	0.0%	0.0	0.0%
Transformer - Overload	0	0.0%	0.0	0.0%
<u>Error</u>	1	4.0%	42.6	0.2%
Switching	1	4.0%	42.6	0.2%
Other Company Personnel	0	0.0%	0.0	0.0%
<u>Generation</u>	1	4.0%	901.6	3.8%
Auto UFLS	1	4.0%	901.6	3.8%
Manual Load Shed	0	0.0%	0.0	0.0%
Other	0	0.0%	0.0	0.0%
<u>Maintenance</u>	5	20.0%	806.6	3.4%
Scheduled	2	8.0%	583.3	2.4%
Forced	3	12.0%	223.3	0.9%
System Change	0	0.0%	0.0	0.0%
<u>Other</u>	0	0.0%	0.0	0.0%
Other	0	0.0%	0.0	0.0%
<u>Public (Non-Utility)</u>	4	16.0%	2,886.6	12.1%
Accident - Auto	3	12.0%	2,863.2	12.0%
Object in Line - Animal	1	4.0%	23.3	0.1%
Accident - Construction	0	0.0%	0.0	0.0%
Accident - Other	0	0.0%	0.0	0.0%
Customer - Equipment	0	0.0%	0.0	0.0%
Customer - Requested	0	0.0%	0.0	0.0%
Fire	0	0.0%	0.0	0.0%
Object in Line - Balloon	0	0.0%	0.0	0.0%
Object in Line - Foreign Object	0	0.0%	0.0	0.0%
Object in Line - Man	0	0.0%	0.0	0.0%
Vandalism	0	0.0%	0.0	0.0%
<u>Unknown</u>	1	4.0%	253.2	1.1%
Unknown	1	4.0%	253.2	1.1%
<u>Vegetation</u>	1	4.0%	3,266.9	13.7%
Branches/Tree	1	4.0%	3,266.9	13.7%
Overgrown	0	0.0%	0.0	0.0%
<u>Weather</u>	3	12.0%	2,280.9	9.6%
High Winds	3	12.0%	2,280.9	9.6%
Flooding	0	0.0%	0.0	0.0%
Heavy Rain	0	0.0%	0.0	0.0%
Landslide	0	0.0%	0.0	0.0%
Lightning	0	0.0%	0.0	0.0%
Natural Disaster/Tsunami/Earthquake	0	0.0%	0.0	0.0%
Total	25		23,818.1	

Note: Outages due to customer requests are not included in the service reliability indices.

Maui Electric Company, Limited
Normalized Sustained Interruption Summary – Lāna‘i

From: January 1, 2019 To: December 31, 2019

	Interruption Count	% of Total	Customer Hours Interrupted	% of Total
<u>Equipment</u>	4	17.4%	395.5	12.7%
Deterioration/Corrosion	2	8.7%	389.5	12.5%
Flashover	1	4.3%	3.6	0.1%
Failure/Defect	1	4.3%	2.3	0.1%
Cable Fault	0	0.0%	0.0	0.0%
Faulty Operation	0	0.0%	0.0	0.0%
Overload	0	0.0%	0.0	0.0%
Transformer - Failure	0	0.0%	0.0	0.0%
Transformer - Overload	0	0.0%	0.0	0.0%
<u>Error</u>	0	0.0%	0.0	0.0%
Other Company Personnel	0	0.0%	0.0	0.0%
Switching	0	0.0%	0.0	0.0%
<u>Generation</u>	6	26.1%	1,546.8	49.6%
Auto UFLS	6	26.1%	1,546.8	49.6%
Manual Load Shed	0	0.0%	0.0	0.0%
Other	0	0.0%	0.0	0.0%
<u>Maintenance</u>	5	21.7%	52.6	1.7%
Scheduled	3	13.0%	41.2	1.3%
Forced	2	8.7%	11.4	0.4%
System Change	0	0.0%	0.0	0.0%
<u>Other</u>	0	0.0%	0.0	0.0%
Other	0	0.0%	0.0	0.0%
<u>Public (Non-Utility)</u>	3	13.0%	167.2	5.4%
Object in Line - Animal	3	13.0%	167.2	5.4%
Accident - Auto	0	0.0%	0.0	0.0%
Accident - Construction	0	0.0%	0.0	0.0%
Accident - Other	0	0.0%	0.0	0.0%
Customer - Equipment	0	0.0%	0.0	0.0%
Customer - Requested	0	0.0%	0.0	0.0%
Fire	0	0.0%	0.0	0.0%
Object in Line - Balloon	0	0.0%	0.0	0.0%
Object in Line - Foreign Object	0	0.0%	0.0	0.0%
Object in Line - Man	0	0.0%	0.0	0.0%
Vandalism	0	0.0%	0.0	0.0%
<u>Unknown</u>	1	4.3%	2.3	0.1%
Unknown	1	4.3%	2.3	0.1%
<u>Vegetation</u>	3	13.0%	741.8	23.8%
Branches/Tree	3	13.0%	741.8	23.8%
Overgrown	0	0.0%	0.0	0.0%
<u>Weather</u>	1	4.3%	215.3	6.9%
High Winds	1	4.3%	215.3	6.9%
Flooding	0	0.0%	0.0	0.0%
Heavy Rain	0	0.0%	0.0	0.0%
Landslide	0	0.0%	0.0	0.0%
Lightning	0	0.0%	0.0	0.0%
Natural Disaster/Tsunami/Earthquake	0	0.0%	0.0	0.0%
Total	23		3,121.4	

Note: Outages due to customer requests are not included in the service reliability indices.

DEFINITION OF TERMS

CUSTOMER INTERRUPTION

One interruption of one customer.

INTERRUPTION

The loss of service to one or more customers as a result of one or more component outages.

INTERRUPTION DURATION

The time period from the initiation of an interruption until service has been restored to the affected customers.

MOMENTARY INTERRUPTION

An interruption having a duration of five minutes or less, typically limited to the period required to restore service by an interrupting device.

OUTAGE

The loss of ability of a component to deliver power. An outage may or may not cause an interruption of service to customers, depending on the system configuration.

SUSTAINED INTERRUPTION

Any interruption not classified as a momentary interruption. That is, any interruption that lasts more than five minutes.

Note: Interruptions to customers at their request are not included.

Reliability indices are based on the standards defined by the Institute of Electrical and Electronics Engineers (IEEE). Four indices that convey a meaningful representation of the level of reliability are as follows:

RELIABILITY INDICES

AVERAGE SERVICE AVAILABILITY INDEX (ASAI)

ASAI indicates the fraction of time that the average customer received service during a predefined period of time. Customer hours service demand is determined by multiplying the total number of customers served by the number of hours in the period.

$$\text{ASAI} = \frac{\sum \text{Customer Hours Service Availability}}{\sum \text{Customer Hours Service Demand}} \times 100\%$$

CUSTOMER AVERAGE INTERRUPTION DURATION INDEX (CAIDI)

CAIDI indicates the average time required to restore service during a predefined period of time.

$$\text{CAIDI} = \frac{\sum (\text{Duration of Interruption} \times \text{No. of Sustained Customer Interruptions})}{\sum \text{No. of Sustained Customer Interruptions}} = \frac{\text{SAIDI}}{\text{SAIFI}}$$

SYSTEM AVERAGE INTERRUPTION DURATION INDEX (SAIDI)

SAIDI indicates the total sustained interruption duration for the average customer during a predefined period of time. It is commonly measured in minutes or hours of interruption.

$$\text{SAIDI} = \frac{\sum (\text{Duration of Interruption} \times \text{No. of Sustained Customer Interruptions})}{\text{Total No. of Customers Served}}$$

SYSTEM AVERAGE INTERRUPTION FREQUENCY INDEX (SAIFI)

SAIFI indicates how often the average customer experiences a sustained interruption during a predefined period of time.

$$\text{SAIFI} = \frac{\sum \text{No. of Sustained Customer Interruptions}}{\text{Total No. of Customers Served}}$$

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