



May 17, 2021

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 2020

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 2020. (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

2020

May 17, 2021

INTRODUCTION

This is Hawaiian Electric Company, Inc.'s 2020 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, 2021. 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 2020 were determined to be MEDs and are therefore excluded from the normalized indices.

- 1/3/20 due to faulty equipment operation and unknown causes
- 2/9/20 due to vegetation and equipment deterioration during high winds
- 2/10/20 due to high winds, vegetation, and equipment deterioration
- 2/18/20 due to cable fault and faulty equipment operation
- 12/26/20 due to substation equipment-related fire

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

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>	<u>2020</u>
Number of Customers	302,499	303,732	304,359	304,965	305,627	306,243
Customer Interruptions	578,092	394,758	426,050	404,503	449,341	360,868
Customer-Hours Interrupted	766,068	553,427	703,324	627,251	890,903	612,894
SAIDI (minutes)	151.95	109.33	138.65	123.41	174.90	120.08
CAIDI (minutes)	79.51	84.12	99.05	93.04	118.96	101.90
SAIFI (interruptions)	1.911	1.300	1.400	1.326	1.470	1.178
ASAI (percentage)	99.971%	99.979%	99.974%	99.977%	99.967%	99.977%

Table 2: Transmission and Distribution Outages – Unnormalized

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>	<u>2020</u>
Number of Customers	302,499	303,732	304,359	304,965	305,627	306,243
Customer Interruptions	437,534	328,474	397,604	404,502	445,204	340,731
Customer-Hours Interrupted	721,807	506,993	699,880	627,238	890,348	609,039
SAIDI (minutes)	143.17	100.15	137.97	123.41	174.79	119.32
CAIDI (minutes)	98.98	92.61	105.61	93.04	119.99	107.25
SAIFI (interruptions)	1.446	1.081	1.306	1.326	1.457	1.113
ASAI (percentage)	99.973%	99.981%	99.974%	99.977%	99.967%	99.977%

Table 3: Utility Generation Outages – Unnormalized

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>	<u>2020</u>
Number of Customers	302,499	303,732	304,359	304,965	305,627	306,243
Customer Interruptions	26,914	66,284	17,341	0	3,646	2,892
Customer-Hours Interrupted	18,772	46,434	1,776	0	425	924
SAIDI (minutes)	3.72	9.17	0.35	0.00	0.08	0.18
CAIDI (minutes)	41.85	42.03	6.14	0.00	7.00	19.16
SAIFI (interruptions)	0.089	0.218	0.057	0.000	0.012	0.009
ASAI (percentage)	99.999%	99.998%	100.000%	100.000%	100.000%	100.000%

Table 4: Non-Utility Generation Outages – Unnormalized

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>	<u>2020</u>
Number of Customers	302,499	303,732	304,359	304,965	305,627	306,243
Customer Interruptions	113,644	0	11,105	1	491	17,245
Customer-Hours Interrupted	25,489	0	1,668	13	130	2,931
SAIDI (minutes)	5.06	0.00	0.33	0.00	0.03	0.57
CAIDI (minutes)	13.46	0.00	9.01	753.00	15.92	10.20
SAIFI (interruptions)	0.376	0.000	0.036	0.000	0.002	0.056
ASAI (percentage)	99.999%	100.000%	100.000%	100.000%	100.000%	100.000%

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

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>	<u>2020</u>
Number of Customers	302,499	303,732	304,359	304,965	305,627	306,243
Customer Interruptions	439,687	304,466	350,078	382,106	337,799	279,813
Customer-Hours Interrupted	500,853	421,384	489,908	568,968	530,394	416,577
SAIDI (minutes)	99.34	83.24	96.58	111.94	104.13	81.62
CAIDI (minutes)	68.35	83.04	83.97	89.34	94.21	89.33
SAIFI (interruptions)	1.454	1.002	1.150	1.253	1.105	0.914
ASAI (percentage)	99.981%	99.984%	99.982%	99.979%	99.980%	99.985%

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
- 1/3/20 due to faulty equipment operation and unknown causes
- 2/9/20 due to vegetation and equipment deterioration during high winds
- 2/10/20 due to high winds, vegetation, and equipment deterioration
- 2/18/20 due to cable fault and faulty equipment operation
- 12/26/20 due to substation equipment-related fire

Table 6: Transmission and Distribution Outages – Normalized²

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>	<u>2020</u>
Number of Customers	302,499	303,732	304,359	304,965	305,627	306,243
Customer Interruptions	321,880	304,466	321,632	382,105	333,662	259,676
Customer-Hours Interrupted	460,172	421,384	486,464	568,955	529,838	412,722
SAIDI (minutes)	91.27	83.24	95.90	111.94	104.02	80.86
CAIDI (minutes)	85.78	83.04	90.75	89.34	95.28	95.36
SAIFI (interruptions)	1.064	1.002	1.057	1.253	1.092	0.848
ASAI (percentage)	99.983%	99.984%	99.982%	99.979%	99.980%	99.985%

Table 7: Utility Generation Outages – Normalized²

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>	<u>2020</u>
Number of Customers	302,499	303,732	304,359	304,965	305,627	306,243
Customer Interruptions	26,914	0	17,341	0	3,646	2,892
Customer-Hours Interrupted	18,772	0	1,776	0	425	924
SAIDI (minutes)	3.72	0.00	0.35	0.00	0.08	0.18
CAIDI (minutes)	41.85	0.00	6.14	0.00	7.00	19.16
SAIFI (interruptions)	0.089	0.000	0.057	0.000	0.012	0.009
ASAI (percentage)	99.999%	100.000%	100.000%	100.000%	100.000%	100.000%

Table 8: Non-Utility Generation Outages – Normalized²

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>	<u>2020</u>
Number of Customers	302,499	303,732	304,359	304,965	305,627	306,243
Customer Interruptions	90,893	0	11,105	1	491	17,245
Customer-Hours Interrupted	21,909	0	1,668	13	130	2,931
SAIDI (minutes)	4.35	0.00	0.33	0.00	0.03	0.57
CAIDI (minutes)	14.46	0.00	9.01	753.00	15.92	10.20
SAIFI (interruptions)	0.300	0.000	0.036	0.000	0.002	0.056
ASAI (percentage)	99.999%	100.000%	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)

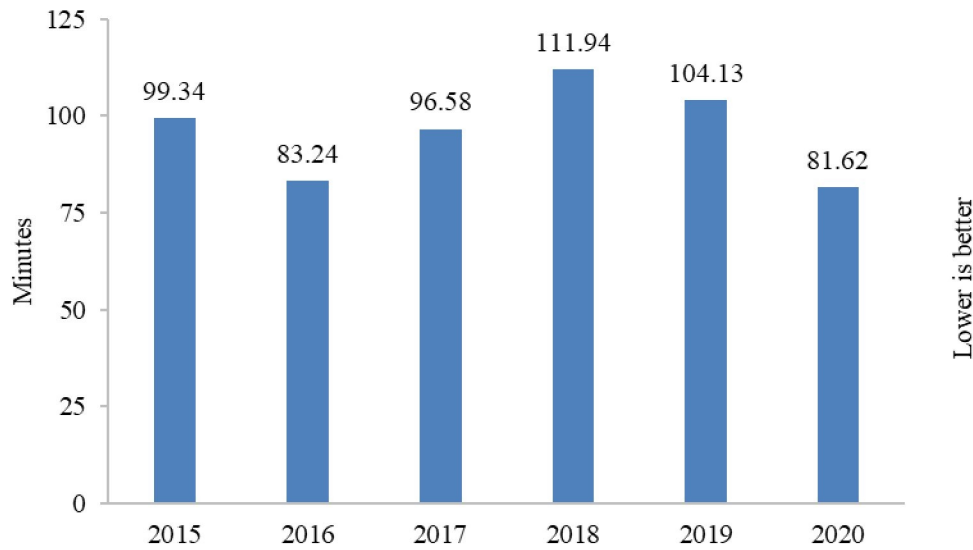


Figure 1 shows the SAIDI values for 2015 to 2020.

The 2020 SAIDI of 81.62 minutes is about a 22% decrease compared to the 2019 SAIDI of 104.13 minutes. The customer hours interrupted was 416,577 hours in 2020 compared to 530,394 hours in 2019.

The following events significantly impacted the 2020 SAIDI results:

1. March 16, 2020 (Monday) – A switch vault flashed over. This resulted in a sustained outage to 3,103 customers for up to 4 hours and 39 minutes and contributed 2.60 minutes to the annual SAIDI.
2. April 14, 2020 (Tuesday) – A lightning storm affected various parts of O‘ahu. This resulted in a sustained outage to 13,045 customers for up to 13 hours and 5 minutes and contributed 2.43 minutes to the annual SAIDI.
3. November 23, 2020 (Monday) – A switch vault flashed over. This resulted in a sustained outage to 1,389 customers for up to 6 hours and 45 minutes and contributed 1.84 minutes to the annual SAIDI.

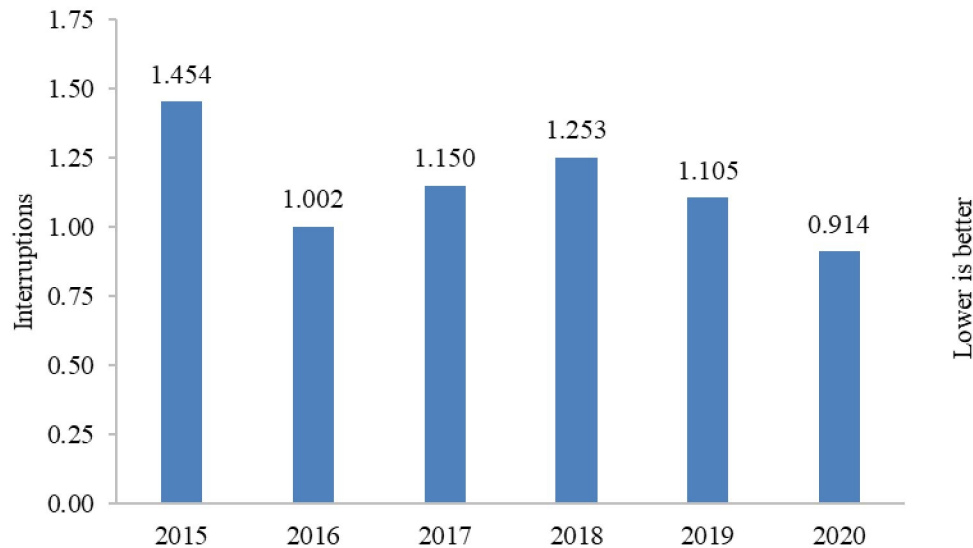
Figure 2: Normalized System Average Interruption Frequency Index (SAIFI)

Figure 2 shows the SAIFI values for 2015 to 2020.

The 2020 SAIFI of 0.914 is about a 17% decrease from the 2019 SAIFI of 1.105. The number of customer interruptions was 279,813 in 2020 compared to 337,799 customer interruptions in 2019.

The following events significantly impacted the 2020 SAIFI results:

1. June 7, 2020 (Sunday) – Underfrequency load shed due to IPP generating units tripped offline. This resulted in a sustained outage to 15,540 customers for up to 29 minutes and contributed 0.051 interruptions to the annual SAIFI.
2. April 14, 2020 (Tuesday) – A lightning storm affected various parts of O‘ahu. This resulted in a sustained outage to 13,045 customers for up to 13 hours and 5 minutes and contributed 0.043 interruptions to the annual SAIFI.
3. March 16, 2020 (Monday) – A cable fault and defective switch flashed over. This resulted in a sustained outage to 4,798 customers for up to 2 hours and 28 minutes and contributed 0.016 interruptions to the annual SAIFI.

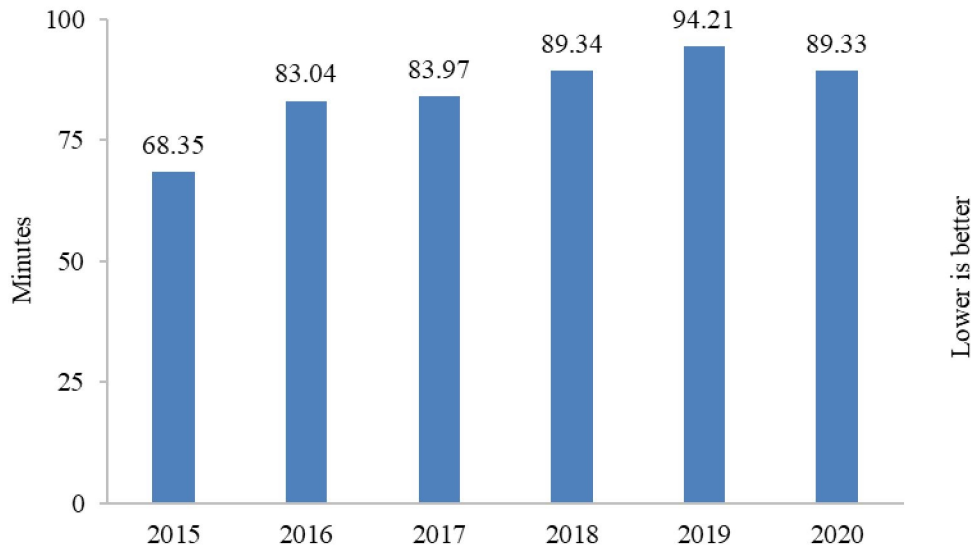
Figure 3: Normalized Customer Average Interruption Duration Index (CAIDI)

Figure 3 shows the CAIDI values for 2015 to 2020.

The 2020 CAIDI of 89.33 minutes is about a 5% decrease compared to the 2019 CAIDI of 94.21 minutes.

The following events significantly affected the 2020 CAIDI results:

1. March 16, 2020 (Monday) – A switch vault flashed over. This resulted in a sustained outage to 3,103 customers for up to 4 hours and 39 minutes and contributed 1.88 minutes to the annual CAIDI.
2. November 23, 2020 (Monday) – A switch vault flashed over. This resulted in a sustained outage to 1,389 customers for up to 6 hours and 45 minutes and contributed 1.57 minutes to the annual CAIDI.
3. June 5, 2020 (Friday) – A defective wood crossarm broke and pulled down an insulator. This resulted in a sustained outage to 1,866 customers for up to 5 hours and 37 minutes and contributed 1.34 minutes to the annual CAIDI.

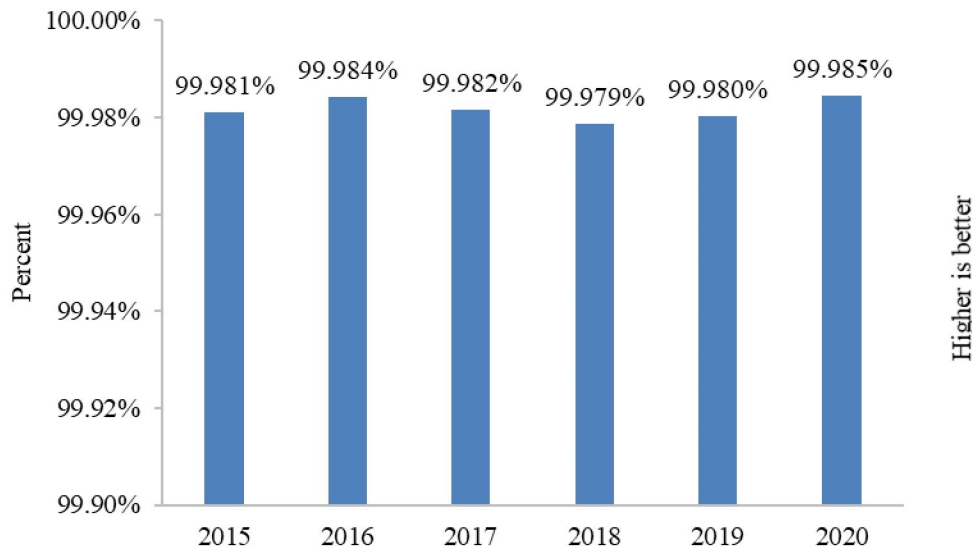
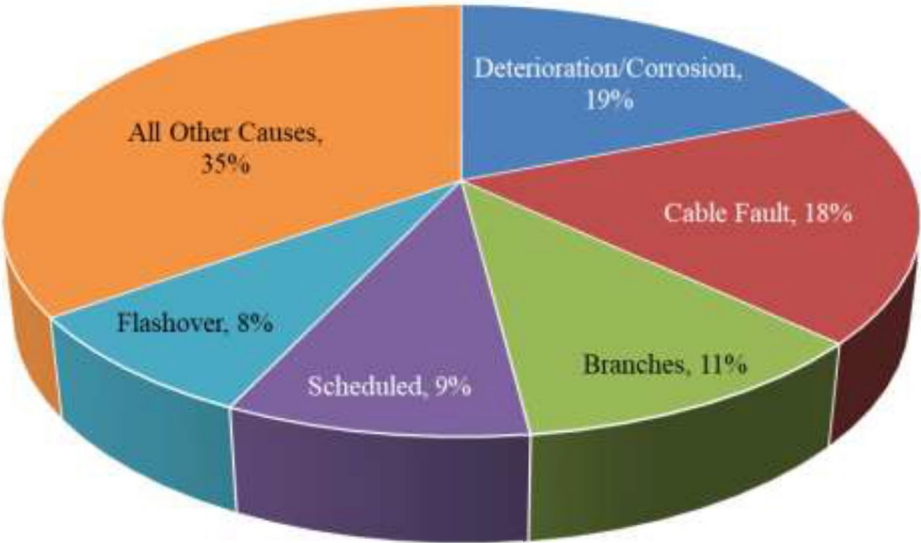
Figure 4: Normalized Average System Availability Index (ASAI)

Figure 4 shows the ASAI values for 2015 to 2020.

The 2020 ASAI of 99.985% is a 0.005% increase from the 2019 ASAI of 99.980%. The customer hours interrupted was 416,577 hours in 2020 compared to 530,394 hours in 2019.

Figure 5: Outage Causes for 2020



The top five outage causes by customer hours interrupted, as illustrated in Figure 5, accounted for about 65% of the total customer hours interrupted in 2020. These include:

<u>Outage Cause</u>	<u>Description</u>
1. Deterioration/Corrosion	Equipment breakdown from natural causes
2. Cable Fault	Failure of underground cable or cable component
3. Branches	Disconnected portion of vegetation contacts/damages equipment
4. Scheduled	Planned maintenance requiring an interruption only after customers were given sufficient notice
5. Flashover	Abnormal electrical discharge that directly results in an interruption

From 2019 to 2020, Deterioration/Corrosion replaced Cable Fault as the top outage cause. Cable Fault is now the 2nd top outage cause. Branches³ and Scheduled remained as the 3rd and 4th top outage causes, respectively. Flashover replaced Accident – Auto as the 5th top outage cause.

³ From 2019 to 2020, Branches and Tree were separated into individual outage causes from Branches/Tree, which was used in previous reports.

Hawaiian Electric Company, Inc.
Normalized Sustained Interruption Summary

From: January 1, 2020 To: December 31, 2020

Outage Cause	Customer Hours Interrupted	Customer Interruptions	SAIFI (interruptions)	SAIDI (minutes)	CAIDI (minutes)
Deterioration/Corrosion	78,583.7	35,381	0.116	15.40	133.26
Cable Fault	74,192.6	56,964	0.186	14.54	78.15
Branches	45,074.7	27,483	0.090	8.83	98.41
Scheduled	38,307.5	10,214	0.033	7.51	225.03
Flashover	35,356.3	19,075	0.062	6.93	111.21
Accident - Auto	23,980.9	10,920	0.036	4.70	131.76
Unknown	22,303.5	19,067	0.062	4.37	70.18
Forced	18,042.5	18,427	0.060	3.53	58.75
Overgrown	13,667.0	8,999	0.029	2.68	91.12
Lightning	12,416.6	13,051	0.043	2.43	57.08
High Winds	10,531.0	6,543	0.021	2.06	96.57
Faulty Operation	6,084.9	5,547	0.018	1.19	65.82
Object in Line - Foreign Object	4,970.1	1,969	0.006	0.97	151.45
Object in Line - Animal	4,736.3	4,460	0.015	0.93	63.72
Overload	4,369.7	2,621	0.009	0.86	100.03
Accident - Construction	4,055.5	2,723	0.009	0.79	89.36
Switching	3,792.5	8,384	0.027	0.74	27.14
Auto UFLS	3,722.3	20,057	0.065	0.73	11.14
Fire	3,413.7	679	0.002	0.67	301.65
Object in Line - Balloon	2,508.4	3,120	0.010	0.49	48.24
Transformer - Failure	2,374.0	588	0.002	0.47	242.25
Other	1,965.4	1,252	0.004	0.39	94.19
Other Company Personnel	989.8	1,832	0.006	0.19	32.42
Customer - Equipment	593.4	162	0.001	0.12	219.79
Transformer - Overload	366.3	258	0.001	0.07	85.17
Vandalism	122.6	26	0.000	0.02	283.00
Failure/Defect	56.5	11	0.000	0.01	308.00
Accident - Other	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
System Change	0.0	0	0.000	0.00	0.00
Tree	0.0	0	0.000	0.00	0.00
Total	416,577.5	279,813	0.914	81.62	89.33

Average System Availability = 99.985%
 Number of customers for the period = 306,243
 24-month annual SAIDI (minutes) average for the period 1/1/2019 - 12/31/2020 = 92.87
 24-month average number of customers for the period 1/1/2019 - 12/31/2020 = 305,935

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, 2020

To: December 31, 2020

Outage Cause Category/Cause	Interruption Count	% of Total	Customer Hours Interrupted	% of Total
<u>Equipment</u>	849	39.5%	201,383.9	48.3%
Deterioration/Corrosion	223	10.4%	78,583.7	18.9%
Cable Fault	518	24.1%	74,192.6	17.8%
Flashover	24	1.1%	35,356.3	8.5%
Faulty Operation	17	0.8%	6,084.9	1.5%
Overload	17	0.8%	4,369.7	1.0%
Transformer - Failure	28	1.3%	2,374.0	0.6%
Transformer - Overload	21	1.0%	366.3	0.1%
Failure/Defect	1	0.0%	56.5	0.0%
<u>Error</u>	33	1.5%	4,782.3	1.1%
Switching	20	0.9%	3,792.5	0.9%
Other Company Personnel	13	0.6%	989.8	0.2%
<u>Generation</u>	21	1.0%	3,722.3	0.9%
Auto UFLS	21	1.0%	3,722.3	0.9%
Manual Load Shed	0	0.0%	0.0	0.0%
Other	0	0.0%	0.0	0.0%
<u>Maintenance</u>	801	37.2%	56,350.0	13.5%
Scheduled	647	30.1%	38,307.5	9.2%
Forced	154	7.2%	18,042.5	4.3%
System Change	0	0.0%	0.0	0.0%
<u>Other</u>	10	0.5%	1,965.4	0.5%
Other	10	0.5%	1,965.4	0.5%
<u>Public (Non-Utility)</u>	125	5.8%	44,380.9	10.7%
Accident - Auto	31	1.4%	23,980.9	5.8%
Object in Line - Foreign Object	5	0.2%	4,970.1	1.2%
Object in Line - Animal	35	1.6%	4,736.3	1.1%
Accident - Construction	13	0.6%	4,055.5	1.0%
Fire	5	0.2%	3,413.7	0.8%
Object in Line - Balloon	8	0.4%	2,508.4	0.6%
Customer - Equipment	27	1.3%	593.4	0.1%
Vandalism	1	0.0%	122.6	0.0%
Accident - Other	0	0.0%	0.0	0.0%
Object in Line - Man	0	0.0%	0.0	0.0%
<u>Unknown</u>	152	7.1%	22,303.5	5.4%
Unknown	152	7.1%	22,303.5	5.4%
<u>Vegetation</u>	136	6.3%	58,741.7	14.1%
Branches	100	4.6%	45,074.7	10.8%
Overgrown	36	1.7%	13,667.0	3.3%
Tree	0	0.0%	0.0	0.0%
<u>Weather</u>	25	1.2%	22,947.6	5.5%
Lightning	4	0.2%	12,416.6	3.0%
High Winds	21	1.0%	10,531.0	2.5%
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	2,152		416,577.5	

Note: Outage causes are listed in descending order of Customer Hours Interrupted within each Cause Category. Outages due to customer requests are not included in the service reliability indices.

APPENDIX

ANNUAL SERVICE RELIABILITY REPORT

2020

May 17, 2021

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 2020

May 17, 2021

INTRODUCTION

This is Hawai'i Electric Light Company, Inc.'s 2020 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, 2021. 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

There were no days in 2020 that were identified to be MEDs.

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

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>	<u>2020</u>
Number of Customers	83,622	84,367	85,041	85,408	86,068	86,826
Customer Interruptions	345,143	196,249	151,681	216,840	263,410	157,964
Customer-Hours Interrupted	661,703	247,641	263,828	328,406	362,225	186,333
SAIDI (minutes)	474.78	176.12	186.14	230.71	252.52	128.76
CAIDI (minutes)	115.03	75.71	104.36	90.87	82.51	70.78
SAIFI (interruptions)	4.127	2.326	1.784	2.539	3.060	1.819
ASAI (percentage)	99.910%	99.967%	99.965%	99.956%	99.952%	99.976%

Table 2: Transmission and Distribution Outages – Unnormalized

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>	<u>2020</u>
Number of Customers	83,622	84,367	85,041	85,408	86,068	86,826
Customer Interruptions	261,025	118,879	120,857	137,897	230,102	95,278
Customer-Hours Interrupted	644,887	227,989	259,368	297,702	357,482	176,156
SAIDI (minutes)	462.72	162.14	182.99	209.14	249.21	121.73
CAIDI (minutes)	148.24	115.07	128.76	129.53	93.21	110.93
SAIFI (interruptions)	3.121	1.409	1.421	1.615	2.673	1.097
ASAI (percentage)	99.912%	99.969%	99.965%	99.960%	99.953%	99.977%

Table 3: Utility Generation Outages – Unnormalized

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>	<u>2020</u>
Number of Customers	83,622	84,367	85,041	85,408	86,068	86,826
Customer Interruptions	76,909	58,077	22,253	28,948	14,302	42,257
Customer-Hours Interrupted	16,017	16,766	2,728	16,346	1,782	6,047
SAIDI (minutes)	11.49	11.92	1.92	11.48	1.24	4.18
CAIDI (minutes)	12.50	17.32	7.36	33.88	7.48	8.59
SAIFI (interruptions)	0.920	0.688	0.262	0.339	0.166	0.487
ASAI (percentage)	99.998%	99.998%	100.000%	99.998%	100.000%	99.999%

Table 4: Non-Utility Generation Outages – Unnormalized

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>	<u>2020</u>
Number of Customers	83,622	84,367	85,041	85,408	86,068	86,826
Customer Interruptions	7,209	19,293	8,571	49,995	19,006	20,429
Customer-Hours Interrupted	799	2,886	1,731	14,357	2,961	4,130
SAIDI (minutes)	0.57	2.05	1.22	10.09	2.06	2.85
CAIDI (minutes)	6.65	8.97	12.12	17.23	9.35	12.13
SAIFI (interruptions)	0.086	0.229	0.101	0.585	0.221	0.235
ASAI (percentage)	100.000%	100.000%	100.000%	99.998%	100.000%	99.999%

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

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>	<u>2020</u>
Number of Customers	83,622	84,367	85,041	85,408	86,068	86,826
Customer Interruptions	192,196	185,013	128,861	216,840	160,467	157,964
Customer-Hours Interrupted	214,740	204,049	191,415	328,406	236,484	186,333
SAIDI (minutes)	154.08	145.12	135.05	230.71	164.86	128.76
CAIDI (minutes)	67.04	66.17	89.13	90.87	88.42	70.78
SAIFI (interruptions)	2.298	2.193	1.515	2.539	1.864	1.819
ASAI (percentage)	99.971%	99.972%	99.974%	99.956%	99.969%	99.976%

Table 6: Transmission and Distribution Outages – Normalized²

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>	<u>2020</u>
Number of Customers	83,622	84,367	85,041	85,408	86,068	86,826
Customer Interruptions	108,078	107,643	98,037	137,897	127,159	95,278
Customer-Hours Interrupted	197,925	184,397	186,955	297,702	231,741	176,156
SAIDI (minutes)	142.01	131.14	131.90	209.14	161.55	121.73
CAIDI (minutes)	109.88	102.78	114.42	129.53	109.35	110.93
SAIFI (interruptions)	1.292	1.276	1.153	1.615	1.477	1.097
ASAI (percentage)	99.973%	99.975%	99.975%	99.960%	99.969%	99.977%

² Exclusions include:
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 7: Utility Generation Outages – Normalized²

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>	<u>2020</u>
Number of Customers	83,622	84,367	85,041	85,408	86,068	86,826
Customer Interruptions	76,909	58,077	22,253	28,948	14,302	42,257
Customer-Hours Interrupted	16,017	16,766	2,728	16,346	1,782	6,047
SAIDI (minutes)	11.49	11.92	1.92	11.48	1.24	4.18
CAIDI (minutes)	12.50	17.32	7.36	33.88	7.48	8.59
SAIFI (interruptions)	0.920	0.688	0.262	0.339	0.166	0.487
ASAI (percentage)	99.998%	99.998%	100.000%	99.998%	100.000%	99.999%

Table 8: Non-Utility Generation Outages – Normalized²

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>	<u>2020</u>
Number of Customers	83,622	84,367	85,041	85,408	86,068	86,826
Customer Interruptions	7,209	19,293	8,571	49,995	19,006	20,429
Customer-Hours Interrupted	799	2,886	1,731	14,357	2,961	4,130
SAIDI (minutes)	0.57	2.05	1.22	10.09	2.06	2.85
CAIDI (minutes)	6.65	8.97	12.12	17.23	9.35	12.13
SAIFI (interruptions)	0.086	0.229	0.101	0.585	0.221	0.235
ASAI (percentage)	100.000%	100.000%	100.000%	99.998%	100.000%	99.999%

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)

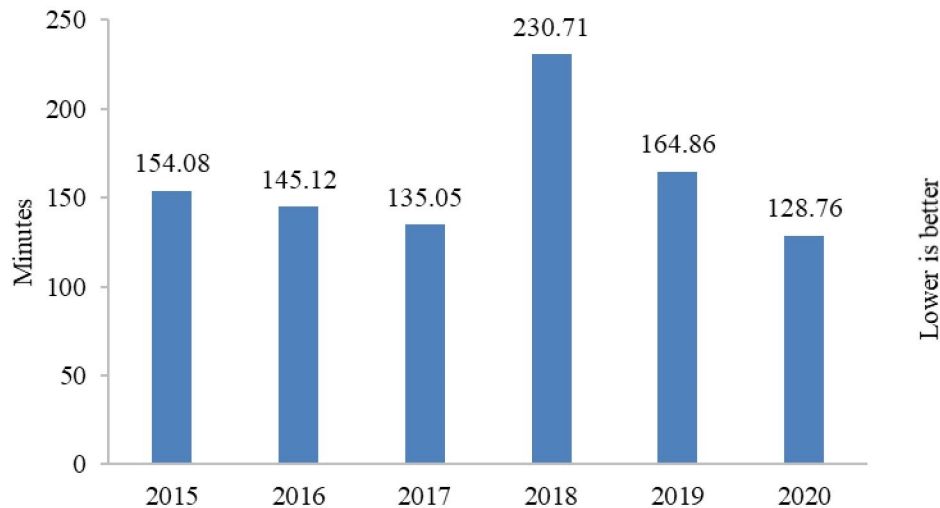


Figure 1 shows the SAIDI values for 2015 to 2020.

The 2020 SAIDI of 128.76 minutes is about a 22% decrease compared to the 2019 SAIDI of 164.86 minutes. The customer hours interrupted was 186,333 hours in 2020 compared to 236,484 hours in 2019.

The following events significantly impacted the 2020 SAIDI results:

1. December 26, 2020 (Saturday) – Weather-related outages affected various parts of Hawai'i Island during a High Wind Advisory. This resulted in a sustained outage to 6,080 customers for up to 27 hours and 33 minutes and contributed 13.81 minutes to the annual SAIDI.
2. August 7, 2020 (Friday) – A Eucalyptus tree fell and rested on transmission conductors and static wire fell. This resulted in a sustained outage to 3,312 customers for up to 6 hours and 47 minutes and contributed 6.52 minutes to the annual SAIDI.
3. January 9, 2020 (Thursday) – A broken insulator and conductors down during a Wind Advisory and Flash Flood Watch. This resulted in a sustained outage to 2,116 customers for up to 5 hours and 48 minutes and contributed 6.15 minutes to the annual SAIDI.

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

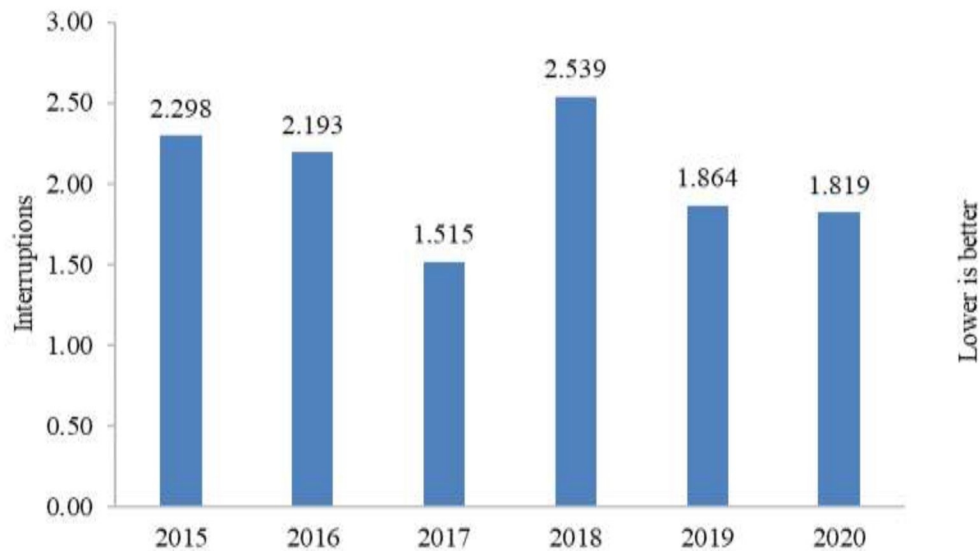


Figure 2 shows the SAIFI values for 2015 to 2020.

The 2020 SAIFI of 1.819 is about a 2% decrease from the 2019 SAIFI of 1.864. The number of customer interruptions was 157,964 in 2020 compared to 160,467 interruptions in 2019.

The following events significantly impacted the 2020 SAIFI results:

1. July 16, 2020 (Thursday) – Underfrequency load shed when a generator tripped offline. This resulted in a sustained outage to 19,524 customers for up to 27 minutes and contributed 0.225 interruptions to the annual SAIFI.
2. June 16, 2020 (Tuesday) – Underfrequency load shed when an IPP wind farm tripped offline. This resulted in a sustained outage to 10,684 customers for up to 10 minutes and contributed 0.123 interruptions to the annual SAIFI.
3. August 28, 2020 (Friday) – Underfrequency load shed when a generator tripped offline. This resulted in a sustained outage to 10,516 customers for up to 7 minutes and contributed 0.121 interruptions to the annual SAIFI.

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

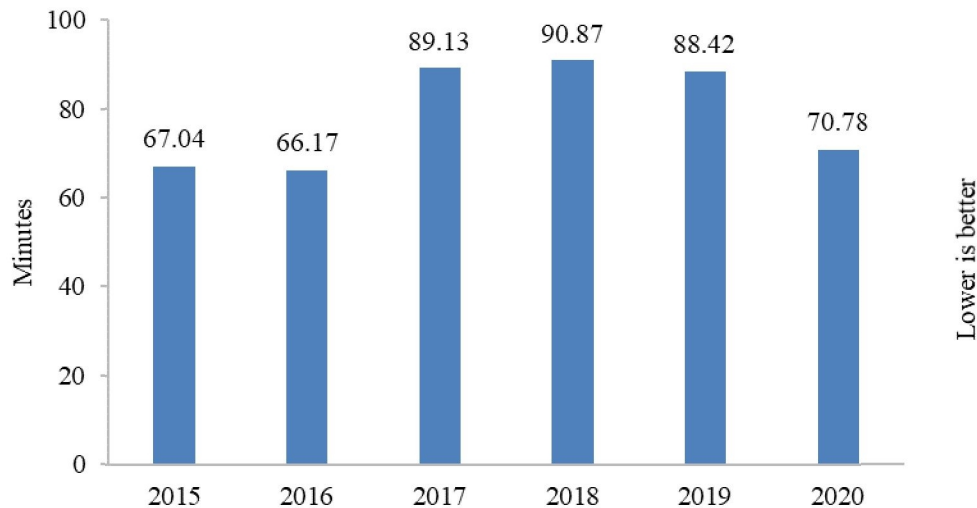


Figure 3 shows the CAIDI values for 2015 to 2020.

The 2020 CAIDI of 70.78 minutes is about a 20% decrease compared to the 2019 CAIDI of 88.42 minutes.

The following events significantly impacted the 2020 CAIDI results:

1. December 26, 2020 (Saturday) – Weather-related outages affected various parts of Hawai'i Island during a High Wind Advisory. This resulted in a sustained outage to 6,080 customers for up to 27 hours and 33 minutes and contributed 5.06 minutes to the annual CAIDI.
2. January 9, 2020 (Thursday) – A broken insulator and conductors down during a Wind Advisory and Flash Flood Watch. This resulted in a sustained outage to 2,116 customers for up to 5 hours and 48 minutes and contributed 2.47 minutes to the annual CAIDI.
3. August 7, 2020 (Friday) – A Eucalyptus tree fell and rested on transmission conductors and static wire fell. This resulted in a sustained outage to 3,312 customers for up to 6 hours and 47 minutes and contributed 2.15 minutes to the annual CAIDI.

Figure 4: Normalized Average System Availability Index (ASAI)

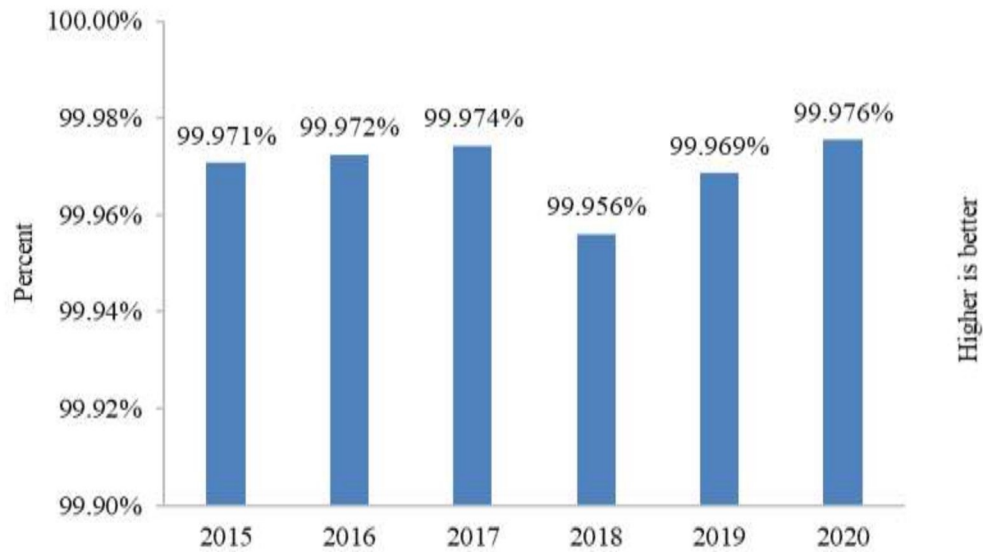
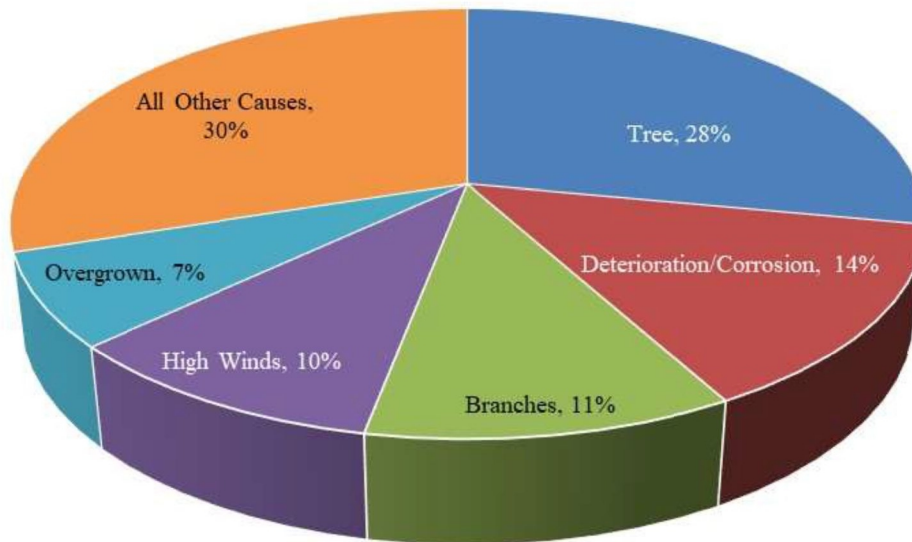


Figure 4 shows the ASAI values for 2015 to 2020.

The 2020 ASAI of 99.976% was a 0.007% increase from the 2019 ASAI of 99.969%. The customer hours interrupted was 186,333 hours in 2020 compared to 236,484 hours in 2019.

Figure 5: Outage Causes for 2020



The top five outage causes by customer hours interrupted, as illustrated in Figure 5, accounted for about 70% of the total customer hours interrupted in 2020. These include:

<u>Outage Cause</u>	<u>Description</u>
1. Tree	Entire downed tree contacts/damages equipment
2. Deterioration/Corrosion	Equipment breakdown from natural causes
3. Branches	Disconnected portion of vegetation contacts/damages equipment
4. High Winds	Direct wind force on any equipment
5. Overgrown	Living section of vegetation growing into equipment

From 2019 to 2020, Tree³ was the top outage cause and Branches³ replaced Accident – Auto as the 3rd top outage cause. Deterioration/Corrosion and High Winds remain as the 2nd and 4th top outage causes, respectively. Overgrown replaced Scheduled as the 5th top outage cause.

³ From 2019 to 2020, Branches and Tree were separated into individual outage causes from Branches/Tree, which was used in previous reports.

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

From: January 1, 2020 To: December 31, 2020

Outage Cause	Customer Hours Interrupted	Customer Interruptions	SAIFI (interruptions)	SAIDI (minutes)	CAIDI (minutes)
Tree	53,033.2	23,064	0.266	36.65	137.96
Deterioration/Corrosion	25,769.0	16,719	0.193	17.81	92.48
Branches	20,140.6	13,158	0.152	13.92	91.84
High Winds	18,889.9	4,714	0.054	13.05	240.43
Overgrown	12,790.1	5,210	0.060	8.84	147.30
Accident - Auto	9,162.4	3,903	0.045	6.33	140.85
Auto UFLS	8,813.4	52,002	0.599	6.09	10.17
Accident - Construction	8,014.5	7,142	0.082	5.54	67.33
Scheduled	6,891.3	1,677	0.019	4.76	246.56
Unknown	6,207.7	3,388	0.039	4.29	109.94
Cable Fault	3,184.5	1,558	0.018	2.20	122.64
Object in line - Foreign Object	3,095.7	2,101	0.024	2.14	88.41
Forced	2,815.5	6,588	0.076	1.95	25.64
Lightning	1,672.1	1,588	0.018	1.16	63.18
Other	1,645.2	10,716	0.123	1.14	9.21
Transformer - Failure	1,549.6	373	0.004	1.07	249.27
Failure/Defect	1,134.1	404	0.005	0.78	168.42
Natural Disaster/Tsunami/Earthquake	630.6	586	0.007	0.44	64.57
Object in Line - Animal	272.3	182	0.002	0.19	89.77
Faulty Operation	242.3	2,634	0.030	0.17	5.52
Other Company Personnel	214.2	156	0.002	0.15	82.39
Object in Line - Balloon	88.8	82	0.001	0.06	65.00
Customer - Equipment	30.4	7	0.000	0.02	260.71
Fire	27.8	3	0.000	0.02	555.00
Accident - Other	12.6	6	0.000	0.01	125.50
Transformer - Overload	5.2	3	0.000	0.00	104.00
Flooding	0.0	0	0.000	0.00	0.00
Flashover	0.0	0	0.000	0.00	0.00
Heavy Rain	0.0	0	0.000	0.00	0.00
Vandalism	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
System Change	0.0	0	0.000	0.00	0.00
Landslide	0.0	0	0.000	0.00	0.00
Switching	0.0	0	0.000	0.00	0.00
Manual Load Shed	0.0	0	0.000	0.00	0.00
Total	186,333.0	157,964	1.819	128.76	70.78

Average System Availability = 99.976%
Number of customers for the period = 86,826
24-month annual SAIDI (minutes) average for the period 1/1/2019 - 12/31/2020 = 146.81
24-month average number of customers for the period 1/1/2019 - 12/31/2020 = 86,447

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, 2020 To: December 31, 2020

Outage Cause Category/Cause	Interruption Count	% of Total	Customer Hours Interrupted	% of Total
<u>Equipment</u>	131	13.4%	31,884.7	17.1%
Deterioration/Corrosion	47	4.8%	25,769.0	13.8%
Cable Fault	32	3.3%	3,184.5	1.7%
Transformer - Failure	35	3.6%	1,549.6	0.8%
Failure/Defect	14	1.4%	1,134.1	0.6%
Faulty Operation	2	0.2%	242.3	0.1%
Transformer - Overload	1	0.1%	5.2	0.0%
Flashover	0	0.0%	0.0	0.0%
Overload	0	0.0%	0.0	0.0%
<u>Error</u>	5	0.5%	214.2	0.1%
Other Company Personnel	5	0.5%	214.2	0.1%
Switching	0	0.0%	0.0	0.0%
<u>Generation</u>	8	0.8%	8,813.4	4.7%
Auto UFLS	8	0.8%	8,813.4	4.7%
Manual Load Shed	0	0.0%	0.0	0.0%
Other	0	0.0%	0.0	0.0%
<u>Maintenance</u>	289	29.5%	9,706.9	5.2%
Scheduled	192	19.6%	6,891.3	3.7%
Forced	97	9.9%	2,815.5	1.5%
System Change	0	0.0%	0.0	0.0%
<u>Other</u>	3	0.3%	1,645.2	0.9%
Other	3	0.3%	1,645.2	0.9%
<u>Public (Non-Utility)</u>	73	7.5%	20,704.4	11.1%
Accident - Auto	16	1.6%	9,162.4	4.9%
Accident - Construction	26	2.7%	8,014.5	4.3%
Object in Line - Foreign Object	1	0.1%	3,095.7	1.7%
Object in Line - Animal	25	2.6%	272.3	0.1%
Object in Line - Balloon	1	0.1%	88.8	0.0%
Customer - Equipment	2	0.2%	30.4	0.0%
Fire	1	0.1%	27.8	0.0%
Accident - Other	1	0.1%	12.6	0.0%
Object in Line - Man	0	0.0%	0.0	0.0%
Vandalism	0	0.0%	0.0	0.0%
<u>Unknown</u>	98	10.0%	6,207.7	3.3%
Unknown	98	10.0%	6,207.7	3.3%
<u>Vegetation</u>	349	35.6%	85,963.9	46.1%
Tree	166	17.0%	53,033.2	28.5%
Branches	119	12.2%	20,140.6	10.8%
Overgrown	64	6.5%	12,790.1	6.9%
<u>Weather</u>	23	2.3%	21,192.6	11.4%
High Winds	10	1.0%	18,889.9	10.1%
Lightning	12	1.2%	1,672.1	0.9%
Natural Disaster/Tsunami/Earthquake	1	0.1%	630.6	0.3%
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%
Total	979		186,333.0	

Note: Outage causes are listed in descending order of Customer Hours Interrupted within each Cause Category. Outages due to customer requests are not included in the service reliability indices.

APPENDIX

ANNUAL SERVICE RELIABILITY REPORT

2020

May 17, 2021

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

2020

May 17, 2021

INTRODUCTION

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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.

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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, 2021. 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 2020 were determined to be MEDs and are therefore excluded from the normalized indices.

- 12/26/2020 due to weather and vegetation-related outages during high winds and rain (Maui only)

* Previously reported information has been revised based on updated data.

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

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>	<u>2020</u>
Number of Customers	70,303	70,745	71,049	71,671	72,265	73,007
Customer Interruptions	213,736	141,555	248,291	241,217	195,561	138,758
Customer-Hours Interrupted	533,523	220,337	984,239	569,222	348,169	286,661
SAIDI (minutes)	455.33	186.87	831.18	476.53	289.08	235.59
CAIDI (minutes)	149.77	93.39	237.84	141.59	106.82	123.95
SAIFI (interruptions)	3.040	2.001	3.495	3.366	2.706	1.901
ASAI (percentage)	99.913%	99.965%	99.842%	99.909%	99.945%	99.955%

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

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>	<u>2020</u>
Number of Customers	70,303	70,745	71,049	71,671	72,265	73,007
Customer Interruptions	185,384	134,247	244,444	173,292	185,205	113,209
Customer-Hours Interrupted	515,672	213,140	979,851	527,947	342,971	255,678
SAIDI (minutes)	440.10	180.77	827.48	441.98	284.76	210.13
CAIDI (minutes)	166.90	95.26	240.51	182.79	111.11	135.51
SAIFI (interruptions)	2.637	1.898	3.441	2.418	2.563	1.551
ASAI (percentage)	99.916%	99.966%	99.843%	99.916%	99.946%	99.960%

Table 3: Utility Generation Outages – All Islands, Unnormalized

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>	<u>2020</u>
Number of Customers	70,303	70,745	71,049	71,671	72,265	73,007
Customer Interruptions	12,044	7,305	3,667	23,563	10,356	25,549
Customer-Hours Interrupted	14,148	7,185	4,296	17,010	5,198	30,982
SAIDI (minutes)	12.07	6.09	3.63	14.24	4.32	25.46
CAIDI (minutes)	70.48	59.01	70.29	43.31	30.12	72.76
SAIFI (interruptions)	0.171	0.103	0.052	0.329	0.143	0.350
ASAI (percentage)	99.998%	99.999%	99.999%	99.997%	99.999%	99.995%

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

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>	<u>2020</u>
Number of Customers	70,303	70,745	71,049	71,671	72,265	73,007
Customer Interruptions	16,308	3	180	44,362	0	0
Customer-Hours Interrupted	3,704	13	92	24,264	0	0
SAIDI (minutes)	3.16	0.01	0.08	20.31	0.00	0.00
CAIDI (minutes)	13.63	255.00	30.71	32.82	0.00	0.00
SAIFI (interruptions)	0.232	0.000	0.003	0.619	0.000	0.000
ASAI (percentage)	99.999%	100.000%	100.000%	99.996%	100.000%	100.000%

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

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019*</u>	<u>2020</u>
Number of Customers	65,390	65,799	66,107	66,701	67,267	68,001
Customer Interruptions	189,489	118,080	230,067	214,637	181,075	122,409
Customer-Hours Interrupted	504,962	177,695	860,210	462,804	321,110	238,851
SAIDI (minutes)	463.34	162.03	780.74	416.31	286.42	210.75
CAIDI (minutes)	159.89	90.29	224.34	129.37	106.40	117.08
SAIFI (interruptions)	2.898	1.795	3.480	3.218	2.692	1.800
ASAI (percentage)	99.912%	99.969%	99.851%	99.921%	99.946%	99.960%

Table 6: Transmission and Distribution Outages –Maui, Unnormalized

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019*</u>	<u>2020</u>
Number of Customers	65,390	65,799	66,107	66,701	67,267	68,001
Customer Interruptions	168,666	118,077	230,067	152,495	176,151	103,812
Customer-Hours Interrupted	493,409	177,682	860,210	426,968	318,362	222,440
SAIDI (minutes)	452.74	162.02	780.74	384.08	283.97	196.27
CAIDI (minutes)	175.52	90.29	224.34	167.99	108.44	128.56
SAIFI (interruptions)	2.579	1.795	3.480	2.286	2.619	1.527
ASAI (percentage)	99.914%	99.969%	99.851%	99.927%	99.946%	99.963%

Table 7: Utility Generation Outages – Maui, Unnormalized

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>	<u>2020</u>
Number of Customers	65,390	65,799	66,107	66,701	67,267	68,001
Customer Interruptions	4,515	0	0	17,960	4,924	18,597
Customer-Hours Interrupted	7,849	0	0	11,658	2,748	16,411
SAIDI (minutes)	7.20	0.00	0.00	10.49	2.45	14.48
CAIDI (minutes)	104.30	0.00	0.00	38.95	33.48	52.95
SAIFI (interruptions)	0.069	0.000	0.000	0.269	0.073	0.273
ASAI (percentage)	99.999%	100.000%	100.000%	99.998%	100.000%	99.997%

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

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>	<u>2020</u>
Number of Customers	65,390	65,799	66,107	66,701	67,267	68,001
Customer Interruptions	16,308	3	0	44,182	0	0
Customer-Hours Interrupted	3,704	13	0	24,178	0	0
SAIDI (minutes)	3.40	0.01	0.00	21.75	0.00	0.00
CAIDI (minutes)	13.63	255.00	0.00	32.83	0.00	0.00
SAIFI (interruptions)	0.249	0.000	0.000	0.662	0.000	0.000
ASAI (percentage)	99.999%	100.000%	100.000%	99.996%	100.000%	100.000%

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

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019*</u>	<u>2020</u>
Number of Customers	3,193	3,212	3,209	3,232	3,250	3,259
Customer Interruptions	18,192	17,610	12,700	20,101	9,441	13,893
Customer-Hours Interrupted	23,110	38,058	32,315	99,544	23,938	42,964
SAIDI (minutes)	434.21	710.85	604.19	1847.88	441.98	791.07
CAIDI (minutes)	76.22	129.67	152.67	297.13	152.13	185.55
SAIFI (interruptions)	5.697	5.482	3.958	6.219	2.905	4.263
ASAI (percentage)	99.917%	99.865%	99.885%	99.648%	99.916%	99.850%

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

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019*</u>	<u>2020</u>
Number of Customers	3,193	3,212	3,209	3,232	3,250	3,259
Customer Interruptions	14,373	15,259	10,952	17,177	7,226	7,719
Customer-Hours Interrupted	19,415	34,985	29,132	96,584	23,036	28,848
SAIDI (minutes)	364.79	653.46	544.68	1792.93	425.33	531.16
CAIDI (minutes)	81.05	137.57	159.60	337.37	191.28	224.23
SAIFI (interruptions)	4.501	4.750	3.413	5.314	2.224	2.369
ASAI (percentage)	99.931%	99.876%	99.896%	99.659%	99.919%	99.899%

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

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>	<u>2020</u>
Number of Customers	3,193	3,212	3,209	3,232	3,250	3,259
Customer Interruptions	3,819	2,351	1,748	2,924	2,215	6,174
Customer-Hours Interrupted	3,695	3,073	3,183	2,960	902	14,116
SAIDI (minutes)	69.42	57.40	59.51	54.94	16.65	259.92
CAIDI (minutes)	58.05	78.42	109.26	60.74	24.42	137.19
SAIFI (interruptions)	1.196	0.732	0.545	0.905	0.682	1.895
ASAI (percentage)	99.987%	99.989%	99.989%	99.990%	99.997%	99.951%

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

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>	<u>2020</u>
Number of Customers	3,193	3,212	3,209	3,232	3,250	3,259
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>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>	<u>2020</u>
Number of Customers	1,720	1,733	1,733	1,738	1,749	1,747
Customer Interruptions	6,055	5,865	5,524	6,479	5,045	2,456
Customer-Hours Interrupted	5,452	4,584	91,714	6,874	3,121	4,846
SAIDI (minutes)	190.20	158.66	3176.26	237.27	107.10	166.39
CAIDI (minutes)	54.02	46.89	996.17	63.65	37.12	118.38
SAIFI (interruptions)	3.521	3.383	3.188	3.727	2.885	1.406
ASAI (percentage)	99.964%	99.970%	99.396%	99.955%	99.980%	99.968%

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

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>	<u>2020</u>
Number of Customers	1,720	1,733	1,733	1,738	1,749	1,747
Customer Interruptions	2,345	911	3,425	3,620	1,828	1,678
Customer-Hours Interrupted	2,848	472	90,510	4,395	1,572	4,390
SAIDI (minutes)	99.35	16.35	3134.53	151.71	53.95	150.76
CAIDI (minutes)	72.86	31.10	1585.57	72.85	51.61	156.99
SAIFI (interruptions)	1.364	0.526	1.977	2.083	1.045	0.960
ASAI (percentage)	99.981%	99.997%	99.404%	99.971%	99.990%	99.971%

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

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>	<u>2020</u>
Number of Customers	1,720	1,733	1,733	1,738	1,749	1,747
Customer Interruptions	3,710	4,954	1,919	2,679	3,217	778
Customer-Hours Interrupted	2,604	4,112	1,113	2,392	1,549	455
SAIDI (minutes)	90.85	142.32	38.53	82.58	53.15	15.63
CAIDI (minutes)	42.11	49.80	34.79	53.58	28.89	35.10
SAIFI (interruptions)	2.157	2.858	1.108	1.541	1.840	0.445
ASAI (percentage)	99.983%	99.973%	99.993%	99.984%	99.990%	99.997%

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

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>	<u>2020</u>
Number of Customers	1,720	1,733	1,733	1,738	1,749	1,747
Customer Interruptions	0	0	180	180	0	0
Customer-Hours Interrupted	0	0	92	86	0	0
SAIDI (minutes)	0.00	0.00	3.19	2.98	0.00	0.00
CAIDI (minutes)	0.00	0.00	30.71	28.75	0.00	0.00
SAIFI (interruptions)	0.000	0.000	0.104	0.104	0.000	0.000
ASAI (percentage)	100.000%	100.000%	99.999%	99.999%	100.000%	100.000%

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

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>	<u>2020</u>
Number of Customers	70,303	70,745	71,049	71,671	72,265	73,007
Customer Interruptions	114,267	113,783	117,429	181,037	148,205	125,931
Customer-Hours Interrupted	157,047	159,383	178,350	272,398	190,802	202,513
SAIDI (minutes)	134.03	135.18	150.62	228.04	158.42	166.43
CAIDI (minutes)	82.46	84.05	91.13	90.28	77.25	96.49
SAIFI (interruptions)	1.625	1.608	1.653	2.526	2.051	1.725
ASAI (percentage)	99.974%	99.974%	99.971%	99.957%	99.970%	99.968%

² Exclusions include:

- 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
- 12/26/20 due to weather and vegetation-related outages during high winds and rain on Maui

Table 18: Transmission and Distribution Outages – All Islands, Normalized² **PAGE 8 OF 27**

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>	<u>2020</u>
Number of Customers	70,303	70,745	71,049	71,671	72,265	73,007
Customer Interruptions	86,481	106,475	113,582	135,488	137,849	100,382
Customer-Hours Interrupted	144,209	152,185	173,962	248,682	185,604	171,531
SAIDI (minutes)	123.07	129.07	146.91	208.19	154.10	140.97
CAIDI (minutes)	100.05	85.76	91.90	110.13	80.79	102.53
SAIFI (interruptions)	1.230	1.505	1.599	1.890	1.908	1.375
ASAI (percentage)	99.977%	99.976%	99.972%	99.960%	99.971%	99.973%

Table 19: Utility Generation Outages – All Islands, Normalized²

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>	<u>2020</u>
Number of Customers	70,303	70,745	71,049	71,671	72,265	73,007
Customer Interruptions	11,478	7,305	3,667	23,563	10,356	25,549
Customer-Hours Interrupted	9,134	7,185	4,296	17,010	5,198	30,982
SAIDI (minutes)	7.79	6.09	3.63	14.24	4.32	25.46
CAIDI (minutes)	47.74	59.01	70.29	43.31	30.12	72.76
SAIFI (interruptions)	0.163	0.103	0.052	0.329	0.143	0.350
ASAI (percentage)	99.999%	99.999%	99.999%	99.997%	99.999%	99.995%

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

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>	<u>2020</u>
Number of Customers	70,303	70,745	71,049	71,671	72,265	73,007
Customer Interruptions	16,308	3	180	21,986	0	0
Customer-Hours Interrupted	3,704	13	92	6,706	0	0
SAIDI (minutes)	3.16	0.01	0.08	5.61	0.00	0.00
CAIDI (minutes)	13.63	255.00	30.71	18.30	0.00	0.00
SAIFI (interruptions)	0.232	0.000	0.003	0.307	0.000	0.000
ASAI (percentage)	99.999%	100.000%	100.000%	99.999%	100.000%	100.000%

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

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019*</u>	<u>2020</u>
Number of Customers	65,390	65,799	66,107	66,701	67,267	68,001
Customer Interruptions	90,020	90,308	100,952	154,457	133,719	109,582
Customer-Hours Interrupted	128,486	116,740	143,751	165,980	163,742	154,703
SAIDI (minutes)	117.89	106.45	130.47	149.31	146.05	136.50
CAIDI (minutes)	85.64	77.56	85.44	64.48	73.47	84.71
SAIFI (interruptions)	1.377	1.372	1.527	2.316	1.988	1.611
ASAI (percentage)	99.978%	99.980%	99.975%	99.972%	99.972%	99.974%

Table 22: Transmission and Distribution Outages – Maui, Normalized² **PAGE 9 OF 27**

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019*</u>	<u>2020</u>
Number of Customers	65,390	65,799	66,107	66,701	67,267	68,001
Customer Interruptions	69,763	90,305	100,952	114,691	128,795	90,985
Customer-Hours Interrupted	121,947	116,728	143,751	147,702	160,995	138,293
SAIDI (minutes)	111.89	106.44	130.47	132.86	143.60	122.02
CAIDI (minutes)	104.88	77.56	85.44	77.27	75.00	91.20
SAIFI (interruptions)	1.067	1.372	1.527	1.719	1.915	1.338
ASAI (percentage)	99.979%	99.980%	99.975%	99.975%	99.973%	99.977%

Table 23: Utility Generation Outages – Maui, Normalized²

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>	<u>2020</u>
Number of Customers	65,390	65,799	66,107	66,701	67,267	68,001
Customer Interruptions	3,949	0	0	17,960	4,924	18,597
Customer-Hours Interrupted	2,835	0	0	11,658	2,748	16,411
SAIDI (minutes)	2.60	0.00	0.00	10.49	2.45	14.48
CAIDI (minutes)	43.07	0.00	0.00	38.95	33.48	52.95
SAIFI (interruptions)	0.060	0.000	0.000	0.269	0.073	0.273
ASAI (percentage)	100.000%	100.000%	100.000%	99.998%	100.000%	99.997%

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

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>	<u>2020</u>
Number of Customers	65,390	65,799	66,107	66,701	67,267	68,001
Customer Interruptions	16,308	3	0	21,806	0	0
Customer-Hours Interrupted	3,704	13	0	6,620	0	0
SAIDI (minutes)	3.40	0.01	0.00	5.96	0.00	0.00
CAIDI (minutes)	13.63	255.00	0.00	18.22	0.00	0.00
SAIFI (interruptions)	0.249	0.000	0.000	0.327	0.000	0.000
ASAI (percentage)	99.999%	100.000%	100.000%	99.999%	100.000%	100.000%

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

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019*</u>	<u>2020</u>
Number of Customers	3,193	3,212	3,209	3,232	3,250	3,259
Customer Interruptions	18,192	17,610	12,700	20,101	9,441	13,893
Customer-Hours Interrupted	23,110	38,058	32,315	99,544	23,938	42,964
SAIDI (minutes)	434.21	710.85	604.19	1847.88	441.98	791.07
CAIDI (minutes)	76.22	129.67	152.67	297.13	152.13	185.55
SAIFI (interruptions)	5.697	5.482	3.958	6.219	2.905	4.263
ASAI (percentage)	99.917%	99.865%	99.885%	99.648%	99.916%	99.850%

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

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019*</u>	<u>2020</u>
Number of Customers	3,193	3,212	3,209	3,232	3,250	3,259
Customer Interruptions	14,373	15,259	10,952	17,177	7,226	7,719
Customer-Hours Interrupted	19,415	34,985	29,132	96,584	23,036	28,848
SAIDI (minutes)	364.79	653.46	544.68	1792.93	425.33	531.16
CAIDI (minutes)	81.05	137.57	159.60	337.37	191.28	224.23
SAIFI (interruptions)	4.501	4.750	3.413	5.314	2.224	2.369
ASAI (percentage)	99.931%	99.876%	99.896%	99.659%	99.919%	99.899%

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

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>	<u>2020</u>
Number of Customers	3,193	3,212	3,209	3,232	3,250	3,259
Customer Interruptions	3,819	2,351	1,748	2,924	2,215	6,174
Customer-Hours Interrupted	3,695	3,073	3,183	2,960	902	14,116
SAIDI (minutes)	69.42	57.40	59.51	54.94	16.65	259.92
CAIDI (minutes)	58.05	78.42	109.26	60.74	24.42	137.19
SAIFI (interruptions)	1.196	0.732	0.545	0.905	0.682	1.895
ASAI (percentage)	99.987%	99.989%	99.989%	99.990%	99.997%	99.951%

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

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>	<u>2020</u>
Number of Customers	3,193	3,212	3,209	3,232	3,250	3,259
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>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>	<u>2020</u>
Number of Customers	1,720	1,733	1,733	1,738	1,749	1,747
Customer Interruptions	6,055	5,865	3,777	6,479	5,045	2,456
Customer-Hours Interrupted	5,452	4,584	2,284	6,874	3,121	4,846
SAIDI (minutes)	190.20	158.66	79.10	237.27	107.10	166.39
CAIDI (minutes)	54.02	46.89	36.28	63.65	37.12	118.38
SAIFI (interruptions)	3.521	3.383	2.180	3.727	2.885	1.406
ASAI (percentage)	99.964%	99.970%	99.985%	99.955%	99.980%	99.968%

Table 30: Transmission and Distribution Outages – Lāna‘i, Normalized² **PAGE 11 OF 27**

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>	<u>2020</u>
Number of Customers	1,720	1,733	1,733	1,738	1,749	1,747
Customer Interruptions	2,345	911	1,678	3,620	1,828	1,678
Customer-Hours Interrupted	2,848	472	1,079	4,395	1,572	4,390
SAIDI (minutes)	99.35	16.35	37.38	151.71	53.95	150.76
CAIDI (minutes)	72.86	31.10	38.59	72.85	51.61	156.99
SAIFI (interruptions)	1.364	0.526	0.969	2.083	1.045	0.960
ASAI (percentage)	99.981%	99.997%	99.993%	99.971%	99.990%	99.971%

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

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>	<u>2020</u>
Number of Customers	1,720	1,733	1,733	1,738	1,749	1,747
Customer Interruptions	3,710	4,954	1,919	2,679	3,217	778
Customer-Hours Interrupted	2,604	4,112	1,113	2,392	1,549	455
SAIDI (minutes)	90.85	142.32	38.53	82.58	53.15	15.63
CAIDI (minutes)	42.11	49.80	34.79	53.58	28.89	35.10
SAIFI (interruptions)	2.157	2.858	1.108	1.541	1.840	0.445
ASAI (percentage)	99.983%	99.973%	99.993%	99.984%	99.990%	99.997%

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

	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>	<u>2020</u>
Number of Customers	1,720	1,733	1,733	1,738	1,749	1,747
Customer Interruptions	0	0	180	180	0	0
Customer-Hours Interrupted	0	0	92	86	0	0
SAIDI (minutes)	0.00	0.00	3.19	2.98	0.00	0.00
CAIDI (minutes)	0.00	0.00	30.71	28.75	0.00	0.00
SAIFI (interruptions)	0.000	0.000	0.104	0.104	0.000	0.000
ASAI (percentage)	100.000%	100.000%	99.999%	99.999%	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 17, above).

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

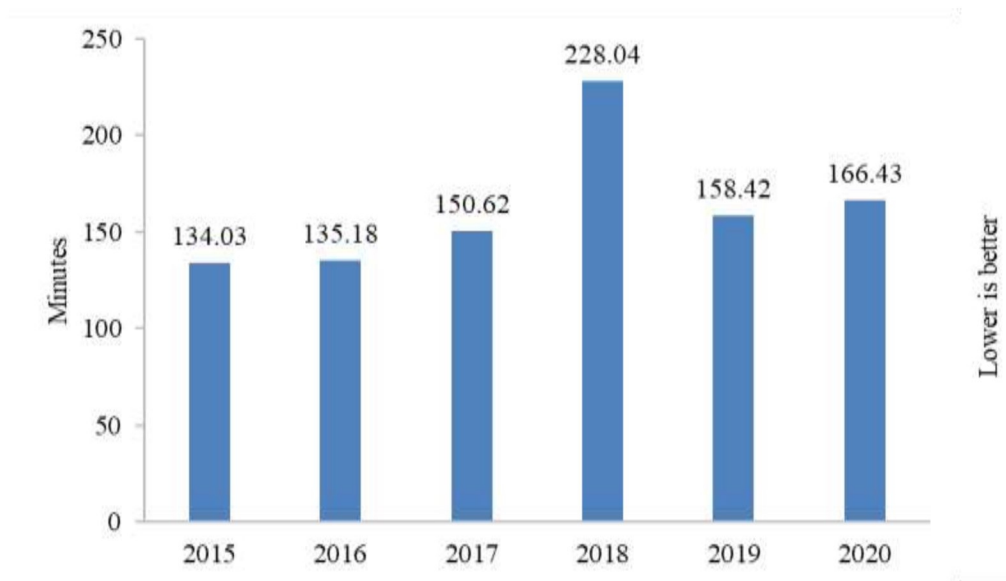


Figure 1 shows the SAIDI values for 2015 to 2020.

The 2020 SAIDI is 166.43 minutes, about a 5% increase compared to the 2019 SAIDI result of 158.42 minutes. The customer hours interrupted was 202,513 hours in 2020 compared to 190,802 hours in 2019.

The following events significantly impacted the 2020 SAIDI result:

1. February 10 and 12, 2020 (Monday, Wednesday) – Snow, wind, and vegetation-related outages affected various parts of Maui. This resulted in a sustained outage to 623 customers for up to 292 hours and 4 minutes and contributed 12.01 minutes to the annual SAIDI.
2. June 2, 2020 (Tuesday) – Underfrequency load shed when a generator tripped offline on Maui. This resulted in a sustained outage to 18,377 customers for up to 53 minutes and contributed 10.78 minutes to the annual SAIDI.
3. October 3, 2020 (Saturday) – An equipment failure and slow circuit breaker operation resulted in generators tripping offline and underfrequency load shed on Moloka‘i. Island-wide outage. This resulted in a sustained outage to 3,266 customers for up to 10 hours and 1 minute and contributed 10.69 minutes to the annual SAIDI.

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

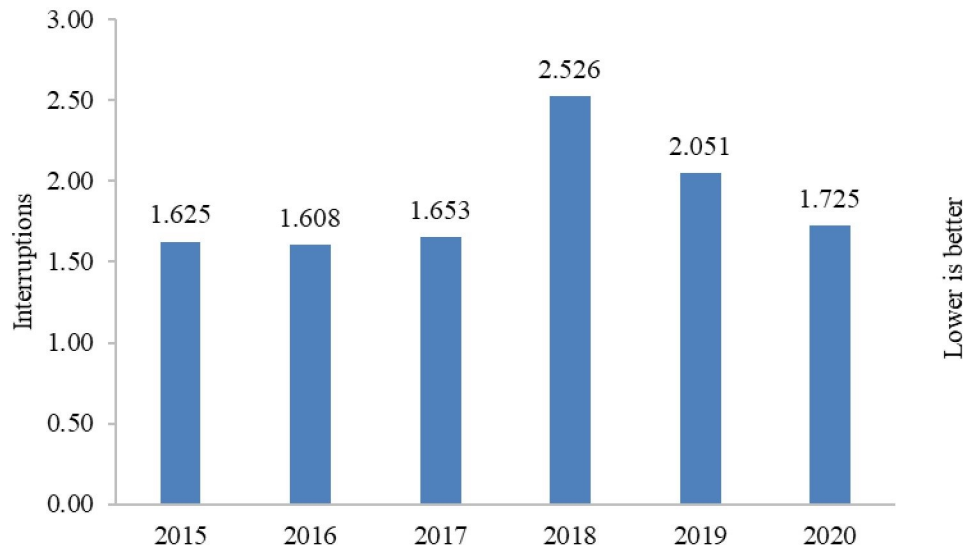


Figure 2 shows the SAIFI values for 2015 to 2020.

The 2020 SAIFI of 1.725 is about a 16% decrease compared to the 2019 SAIFI result of 2.051. The number of customer interruptions in 2020 was 125,931 as compared to 148,205 customer interruptions in 2019.

The following events significantly impacted the 2020 SAIFI result:

1. June 2, 2020 (Tuesday) – Underfrequency load shed when a generator tripped offline on Maui. This resulted in a sustained outage to 18,377 customers for up to 53 minutes and contributed 0.252 interruptions to the annual SAIFI.
2. March 1, 2020 (Sunday) – During high winds, tree branches contacted transmission conductors on Maui. This resulted in a sustained outage to 8,065 customers for up to 11 hours and 40 minutes and contributed 0.110 interruptions to the annual SAIFI.
3. March 6, 2020 (Friday) – During high winds, tree branches contacted transmission conductors on Maui. This resulted in a sustained outage to 7,490 customers for up to 7 hours and 10 minutes and contributed 0.103 to the annual SAIFI.

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

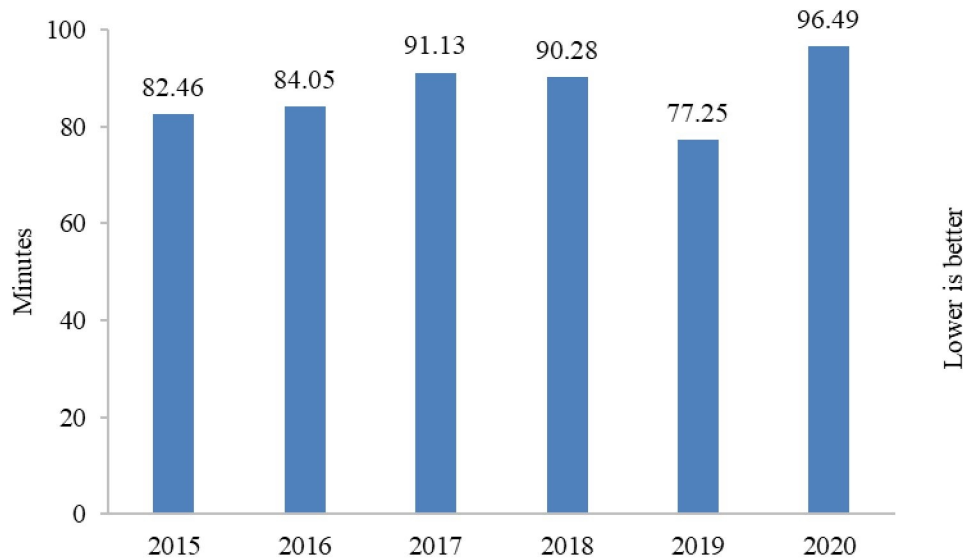


Figure 3 shows the CAIDI values for 2015 to 2020.

The 2020 CAIDI of 96.49 minutes is about a 25% increase compared to the 2019 CAIDI of 77.25 minutes.

The following events significantly affected the 2020 CAIDI results:

1. February 10 and 12, 202 (Monday, Wednesday) – Snow, wind, and vegetation-related outages affected various parts of Maui. This resulted in a sustained outage to 623 customers for up to 292 hours and 4 minutes and contributed 6.52 minutes to the annual CAIDI.
2. October 3, 2020 (Saturday) – An equipment failure and slow circuit breaker operation resulted in generators tripping offline and underfrequency load shed on Moloka‘i. Island-wide outage. This resulted in a sustained outage to 3,266 customers for up to 10 hours and 1 minute and contributed 3.79 minutes to the annual CAIDI.
3. January 7, 2020 (Tuesday) – Manual load shed when two generators tripped offline on Moloka‘i. Island-wide outage. This resulted in a sustained outage to 3,250 customers for up to 9 hours and 44 minutes and contributed 2.97 minutes to the annual CAIDI.

Figure 4: Normalized Average System Availability Index (ASAI)

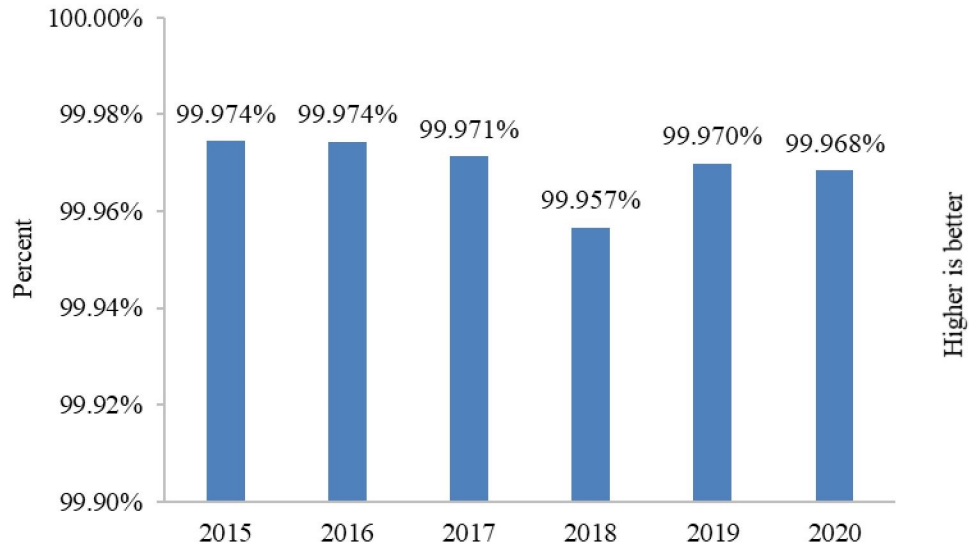
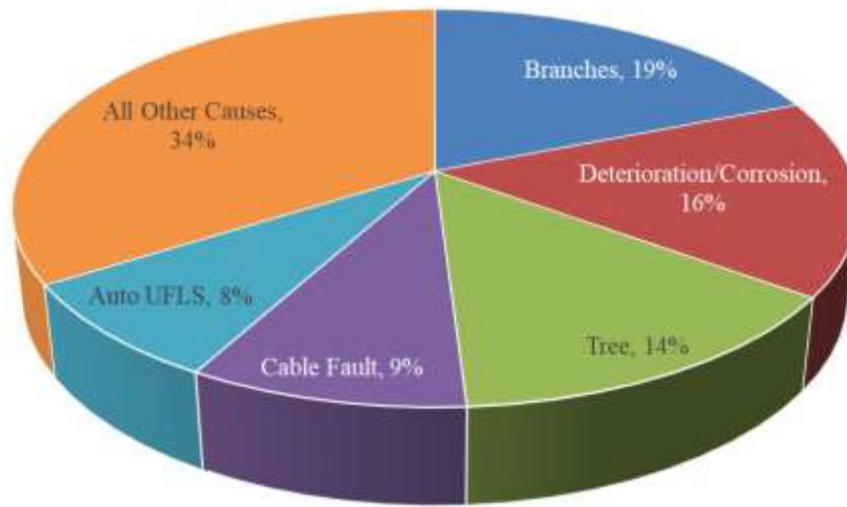


Figure 4 shows the ASAI values for 2015 to 2020.

The 2020 ASAI of 99.968% is a 0.002% decrease compared to the 2019 ASAI of 99.970%. The customer hours interrupted was 202,513 hours in 2020 compared to 190,802 hours in 2019.

Figure 5: Outage Causes for 2020



The top five outage causes by customer hours interrupted, as illustrated in Figure 5, accounted for about 66% of the total customer hours interrupted in 2020. These include:

<u>Outage Cause</u>	<u>Description</u>
1. Branches	Disconnected portion of vegetation contacts/damages equipment
2. Deterioration/Corrosion	Equipment breakdown from natural causes
3. Tree	Entire downed tree contacts/damages equipment
4. Cable Fault	Failure of underground cable or cable component
5. Auto UFLS	Controlled automatic load shed to recover from underfrequency conditions

From 2019 to 2020, Branches³ and Deterioration/Corrosion remained as the top two outage causes. Tree³ replaced Accident – Auto as the 3rd top outage cause. Cable Fault went from 5th to 4th and Auto UFLS replaced Cable Fault as the 5th top outage cause.

³ From 2019 to 2020, Branches and Tree were separated into individual outage causes from Branches/Tree, which was used in previous reports.

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

From: January 1, 2020 To: December 31, 2020

Outage Cause	Customer Hours Interrupted	Customer Interruptions	SAIFI (interruptions)	SAIDI (minutes)	CAIDI (minutes)
Branches	37,907.5	27,301	0.374	31.15	83.31
Deterioration/Corrosion	32,605.4	16,424	0.225	26.80	119.11
Tree	27,847.1	15,857	0.217	22.89	105.37
Cable Fault	17,734.5	11,901	0.163	14.57	89.41
Auto UFLS	16,397.9	22,079	0.302	13.48	44.56
Accident - Auto	11,907.6	5,616	0.077	9.79	127.22
High Winds	11,759.4	1,979	0.027	9.66	356.53
Manual Load Shed	11,290.7	3,250	0.045	9.28	208.44
Failure/Defect	8,243.2	1,443	0.020	6.77	342.75
Flashover	7,466.7	5,455	0.075	6.14	82.13
Forced	5,910.4	5,061	0.069	4.86	70.07
Unknown	3,966.6	3,855	0.053	3.26	61.74
Scheduled	3,298.8	1,553	0.021	2.71	127.45
Object in Line - Balloon	1,829.6	2,294	0.031	1.50	47.85
Overgrown	1,429.1	289	0.004	1.17	296.71
Object in Line - Foreign Object	947.5	290	0.004	0.78	196.03
Accident - Other	566.0	307	0.004	0.47	110.63
Other Company Personnel	258.1	134	0.002	0.21	115.56
Overload	257.8	464	0.006	0.21	33.34
Transformer - Failure	251.8	44	0.001	0.21	343.36
Fire	216.1	20	0.000	0.18	648.15
Faulty Operation	101.3	40	0.001	0.08	152.00
Accident - Construction	98.7	63	0.001	0.08	94.00
Heavy Rain	90.5	66	0.001	0.07	82.24
Other	51.7	100	0.001	0.04	31.00
Object in Line - Animal	39.9	23	0.000	0.03	104.17
Customer - Equipment	34.5	14	0.000	0.03	148.00
Lightning	2.4	2	0.000	0.00	71.00
System Change	2.1	7	0.000	0.00	18.00
Flooding	0.0	0	0.000	0.00	0.00
Landslide	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
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	202,512.8	125,931	1.725	166.43	96.49

Average System Availability = 99.968%
Number of customers for the period = 73,007
24-month annual SAIDI (minutes) average for the period 1/1/2019 - 12/31/2020 = 162.43
24-month average number of customers for the period 1/1/2019 - 12/31/2020 = 72,636

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, 2020 To: December 31, 2020

Outage Cause	Customer Hours Interrupted	Customer Interruptions	SAIFI (interruptions)	SAIDI (minutes)	CAIDI (minutes)
Branches	33,240.9	26,350	0.387	29.33	75.69
Tree	26,953.8	15,550	0.229	23.78	104.00
Deterioration/Corrosion	19,520.4	13,113	0.193	17.22	89.32
Cable Fault	13,998.9	10,743	0.158	12.35	78.18
Auto UFLS	13,117.1	18,377	0.270	11.57	42.83
High Winds	9,791.0	777	0.011	8.64	756.06
Failure/Defect	8,183.2	1,438	0.021	7.22	341.44
Accident - Auto	7,488.6	4,886	0.072	6.61	91.96
Flashover	7,399.7	5,451	0.080	6.53	81.45
Forced	3,870.6	4,637	0.068	3.42	50.08
Unknown	3,091.5	3,232	0.048	2.73	57.39
Scheduled	1,892.9	881	0.013	1.67	128.91
Object in Line - Balloon	1,829.6	2,294	0.034	1.61	47.85
Overgrown	1,429.1	289	0.004	1.26	296.71
Object in Line - Foreign Object	947.5	290	0.004	0.84	196.03
Accident - Other	566.0	307	0.005	0.50	110.63
Other Company Personnel	258.1	134	0.002	0.23	115.56
Overload	257.8	464	0.007	0.23	33.34
Transformer - Failure	248.2	43	0.001	0.22	346.37
Fire	216.1	20	0.000	0.19	648.15
Faulty Operation	101.3	40	0.001	0.09	152.00
Accident - Construction	98.7	63	0.001	0.09	94.00
Heavy Rain	90.5	66	0.001	0.08	82.24
Other	51.7	100	0.001	0.05	31.00
Customer - Equipment	34.5	14	0.000	0.03	148.00
Object in Line - Animal	21.3	14	0.000	0.02	91.21
Lightning	2.4	2	0.000	0.00	71.00
System Change	2.1	7	0.000	0.00	18.00
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
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
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	154,703.3	109,582	1.611	136.50	84.71

Average System Availability = 99.974%
Number of customers for the period = 68,001
24-month annual SAIDI (minutes) average for the period 1/1/2019 - 12/31/2020 = 141.28
24-month average number of customers for the period 1/1/2019 - 12/31/2020 = 67,634

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, 2020 To: December 31, 2020

Outage Cause	Customer Hours Interrupted	Customer Interruptions	SAIFI (interruptions)	SAIDI (minutes)	CAIDI (minutes)
Deterioration/Corrosion	13,007.4	3,266	1.002	239.50	238.96
Manual Load Shed	11,290.7	3,250	0.997	207.89	208.44
Accident - Auto	4,419.0	730	0.224	81.36	363.21
Branches	4,241.6	751	0.230	78.10	338.87
Auto UFLS	2,825.7	2,924	0.897	52.03	57.98
Forced	2,039.8	424	0.130	37.56	288.65
Cable Fault	1,496.8	628	0.193	27.56	143.00
Scheduled	1,170.4	578	0.177	21.55	121.49
Tree	893.3	307	0.094	16.45	174.59
Unknown	850.6	609	0.187	15.66	83.80
High Winds	728.9	426	0.131	13.42	102.67
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
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
Flashover	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
Natural Disaster/Tsunami/Earthquake	0.0	0	0.000	0.00	0.00
Object in Line - Animal	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	42,964.0	13,893	4.263	791.07	185.55

Average System Availability = 99.850%
Number of customers for the period = 3,259
24-month annual SAIDI (minutes) average for the period 1/1/2019 - 12/31/2020 = 616.53
24-month average number of customers for the period 1/1/2019 - 12/31/2020 = 3,254

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, 2020 To: December 31, 2020

Outage Cause	Customer Hours Interrupted	Customer Interruptions	SAIFI (interruptions)	SAIDI (minutes)	CAIDI (minutes)
Cable Fault	2,238.9	530	0.303	76.88	253.45
High Winds	1,239.5	776	0.444	42.57	95.84
Auto UFLS	455.1	778	0.445	15.63	35.10
Branches	425.1	200	0.114	14.60	127.53
Scheduled	235.5	94	0.054	8.09	150.34
Deterioration/Corrosion	77.7	45	0.026	2.67	103.58
Flashover	66.9	4	0.002	2.30	1,004.00
Failure/Defect	60.0	5	0.003	2.06	719.60
Unknown	24.6	14	0.008	0.84	105.36
Object in Line - Animal	18.7	9	0.005	0.64	124.33
Transformer - Failure	3.6	1	0.001	0.12	214.00
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
Customer - Equipment	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
Forced	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 - Overload	0.0	0	0.000	0.00	0.00
Tree	0.0	0	0.000	0.00	0.00
Vandalism	0.0	0	0.000	0.00	0.00
Total	4,845.5	2,456	1.406	166.39	118.38

Average System Availability = 99.968%
Number of customers for the period = 1,747
24-month annual SAIDI (minutes) average for the period 1/1/2019 - 12/31/2020 = 136.75
24-month average number of customers for the period 1/1/2019 - 12/31/2020 = 1,748

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, 2020 To: December 31, 2020

Outage Cause Category/Cause	Interruption Count	% of Total	Customer Hours Interrupted	% of Total
<u>Equipment</u>	192	27.8%	66,660.7	32.9%
Deterioration/Corrosion	82	11.9%	32,605.4	16.1%
Cable Fault	66	9.6%	17,734.5	8.8%
Failure/Defect	25	3.6%	8,243.2	4.1%
Flashover	6	0.9%	7,466.7	3.7%
Overload	4	0.6%	257.8	0.1%
Transformer - Failure	8	1.2%	251.8	0.1%
Faulty Operation	1	0.1%	101.3	0.1%
Transformer - Overload	0	0.0%	0.0	0.0%
<u>Error</u>	8	1.2%	258.1	0.1%
Other Company Personnel	8	1.2%	258.1	0.1%
Switching	0	0.0%	0.0	0.0%
<u>Generation</u>	7	1.0%	27,688.6	13.7%
Auto UFLS	6	0.9%	16,397.9	8.1%
Manual Load Shed	1	0.1%	11,290.7	5.6%
Other	0	0.0%	0.0	0.0%
<u>Maintenance</u>	214	31.0%	9,211.3	4.5%
Forced	61	8.8%	5,910.4	2.9%
Scheduled	152	22.0%	3,298.8	1.6%
System Change	1	0.1%	2.1	0.0%
<u>Other</u>	1	0.1%	51.7	0.0%
Other	1	0.1%	51.7	0.0%
<u>Public (Non-Utility)</u>	54	7.8%	15,639.9	7.7%
Accident - Auto	9	1.3%	11,907.6	5.9%
Object in Line - Balloon	3	0.4%	1,829.6	0.9%
Object in Line - Foreign Object	8	1.2%	947.5	0.5%
Accident - Other	5	0.7%	566.0	0.3%
Fire	4	0.6%	216.1	0.1%
Accident - Construction	7	1.0%	98.7	0.0%
Object in Line - Animal	9	1.3%	39.9	0.0%
Customer - Equipment	9	1.3%	34.5	0.0%
Object in Line - Man	0	0.0%	0.0	0.0%
Vandalism	0	0.0%	0.0	0.0%
<u>Unknown</u>	44	6.4%	3,966.6	2.0%
Unknown	44	6.4%	3,966.6	2.0%
<u>Vegetation</u>	147	21.3%	67,183.7	33.2%
Branches	86	12.4%	37,907.5	18.7%
Tree	54	7.8%	27,847.1	13.8%
Overgrown	7	1.0%	1,429.1	0.7%
<u>Weather</u>	24	3.5%	11,852.3	5.9%
High Winds	20	2.9%	11,759.4	5.8%
Heavy Rain	3	0.4%	90.5	0.0%
Lightning	1	0.1%	2.4	0.0%
Flooding	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	691		202,512.8	

Note: Outage causes are listed in descending order of Customer Hours Interrupted within each Cause Category. 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, 2020 To: December 31, 2020

Outage Cause Category/Cause	Interruption Count	% of Total	Customer Hours Interrupted	% of Total
<u>Equipment</u>	175	28.0%	49,709.6	32.1%
Deterioration/Corrosion	76	12.1%	19,520.4	12.6%
Cable Fault	59	9.4%	13,998.9	9.0%
Failure/Defect	23	3.7%	8,183.2	5.3%
Flashover	5	0.8%	7,399.7	4.8%
Overload	4	0.6%	257.8	0.2%
Transformer - Failure	7	1.1%	248.2	0.2%
Faulty Operation	1	0.2%	101.3	0.1%
Transformer - Overload	0	0.0%	0.0	0.0%
<u>Error</u>	8	1.3%	258.1	0.2%
Other Company Personnel	8	1.3%	258.1	0.2%
Switching	0	0.0%	0.0	0.0%
<u>Generation</u>	1	0.2%	13,117.1	8.5%
Auto UFLS	1	0.2%	13,117.1	8.5%
Manual Load Shed	0	0.0%	0.0	0.0%
Other	0	0.0%	0.0	0.0%
<u>Maintenance</u>	192	30.7%	5,765.6	3.7%
Forced	58	9.3%	3,870.6	2.5%
Scheduled	133	21.2%	1,892.9	1.2%
System Change	1	0.2%	2.1	0.0%
<u>Other</u>	1	0.2%	51.7	0.0%
Other	1	0.2%	51.7	0.0%
<u>Public (Non-Utility)</u>	50	8.0%	11,202.3	7.2%
Accident - Auto	7	1.1%	7,488.6	4.8%
Object in Line - Balloon	3	0.5%	1,829.6	1.2%
Object in Line - Foreign Object	8	1.3%	947.5	0.6%
Accident - Other	5	0.8%	566.0	0.4%
Fire	4	0.6%	216.1	0.1%
Accident - Construction	7	1.1%	98.7	0.1%
Customer - Equipment	9	1.4%	34.5	0.0%
Object in Line - Animal	7	1.1%	21.3	0.0%
Object in Line - Man	0	0.0%	0.0	0.0%
Vandalism	0	0.0%	0.0	0.0%
<u>Unknown</u>	40	6.4%	3,091.5	2.0%
Unknown	40	6.4%	3,091.5	2.0%
<u>Vegetation</u>	140	22.4%	61,623.8	39.8%
Branches	82	13.1%	33,240.9	21.5%
Tree	51	8.1%	26,953.8	17.4%
Overgrown	7	1.1%	1,429.1	0.9%
<u>Weather</u>	19	3.0%	9,883.8	6.4%
High Winds	15	2.4%	9,791.0	6.3%
Heavy Rain	3	0.5%	90.5	0.1%
Lightning	1	0.2%	2.4	0.0%
Flooding	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	626		154,703.3	

Note: Outage causes are listed in descending order of Customer Hours Interrupted within each Cause Category. 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, 2020 To: December 31, 2020

Outage Cause Category/Cause	Interruption Count	% of Total	Customer Hours Interrupted	% of Total
<u>Equipment</u>	5	19.2%	14,504.2	33.8%
Deterioration/Corrosion	1	3.8%	13,007.4	30.3%
Cable Fault	4	15.4%	1,496.8	3.5%
Failure/Defect	0	0.0%	0.0	0.0%
Faulty Operation	0	0.0%	0.0	0.0%
Flashover	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>	3	11.5%	14,116.4	32.9%
Manual Load Shed	1	3.8%	11,290.7	26.3%
Auto UFLS	2	7.7%	2,825.7	6.6%
Other	0	0.0%	0.0	0.0%
<u>Maintenance</u>	7	26.9%	3,210.1	7.5%
Forced	3	11.5%	2,039.8	4.7%
Scheduled	4	15.4%	1,170.4	2.7%
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>	2	7.7%	4,419.0	10.3%
Accident - Auto	2	7.7%	4,419.0	10.3%
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%
Fire	0	0.0%	0.0	0.0%
Object in Line - Animal	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	3.8%	850.6	2.0%
Unknown	1	3.8%	850.6	2.0%
<u>Vegetation</u>	5	19.2%	5,134.9	12.0%
Branches	2	7.7%	4,241.6	9.9%
Tree	3	11.5%	893.3	2.1%
Overgrown	0	0.0%	0.0	0.0%
<u>Weather</u>	3	11.5%	728.9	1.7%
High Winds	3	11.5%	728.9	1.7%
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	26		42,964.0	

Note: Outage causes are listed in descending order of Customer Hours Interrupted within each Cause Category. 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, 2020 To: December 31, 2020

Outage Cause Category/Cause	Interruption Count	% of Total	Customer Hours Interrupted	% of Total
<u>Equipment</u>	12	30.8%	2,447.0	50.5%
Cable Fault	3	7.7%	2,238.9	46.2%
Deterioration/Corrosion	5	12.8%	77.7	1.6%
Flashover	1	2.6%	66.9	1.4%
Failure/Defect	2	5.1%	60.0	1.2%
Transformer - Failure	1	2.6%	3.6	0.1%
Faulty Operation	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>	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>	3	7.7%	455.1	9.4%
Auto UFLS	3	7.7%	455.1	9.4%
Manual Load Shed	0	0.0%	0.0	0.0%
Other	0	0.0%	0.0	0.0%
<u>Maintenance</u>	15	38.5%	235.5	4.9%
Scheduled	15	38.5%	235.5	4.9%
Forced	0	0.0%	0.0	0.0%
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>	2	5.1%	18.7	0.4%
Object in Line - Animal	2	5.1%	18.7	0.4%
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%
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>	3	7.7%	24.6	0.5%
Unknown	3	7.7%	24.6	0.5%
<u>Vegetation</u>	2	5.1%	425.1	8.8%
Branches	2	5.1%	425.1	8.8%
Overgrown	0	0.0%	0.0	0.0%
Tree	0	0.0%	0.0	0.0%
<u>Weather</u>	2	5.1%	1,239.5	25.6%
High Winds	2	5.1%	1,239.5	25.6%
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	39		4,845.5	

Note: Outage causes are listed in descending order of Customer Hours Interrupted within each Cause Category. Outages due to customer requests are not included in the service reliability indices.

APPENDIX

ANNUAL SERVICE RELIABILITY REPORT

2020

May 17, 2021

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.

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

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