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PUBLIC UTILITIES COMMISSION

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The Honorable Chair and Members of the
Hawai'i Public Utilities Commission
465 South King Street
Kekuanaoa Building, Room 103
Honolulu, Hawai'i 96813

Dear Commissioners:

Subject: Adequacy of Supply ("AOS")
Hawaiian Electric Company, Inc. ("Hawaiian Electric" or "Company")

The following information is respectfully submitted in accordance with paragraph 5.3a. of General Order No. 7 which states:

> *The generation capacity of the utility's plant, supplemented by electric power regularly available from other sources, must be sufficiently large to meet all reasonably expectable demands for service and provide a reasonable reserve for emergencies. A Statement shall be filed annually with the Commission within 30 days after the close of the year indicating the adequacy of such capacity and the method used to determine the required reserve capacity which forms the basis for future requirements in generation, transmission, and distribution plant expansion programs required under Rule 2.3h.1.*

2017 Adequacy of Supply Report Summary

- Hawaiian Electric's AOS is based on the Company's October 2016 Sales and Peak Forecast Update and other key assumptions.

- Hawaiian Electric's reserve capacity may not be sufficient to meet the Company's generating system reliability guideline of 4.5 years per day in 2017 and 2018. The anticipated reserve capacity shortfalls are relatively small and Hawaiian Electric can implement mitigation measures. This assumes the Schofield Generating Station is in service from 2018.

- The adjusted peak load experienced on Oahu in 2016 was 1,214 MW-net, and was served by Hawaiian Electric's total capability of 1,671 MW-net, including firm power purchases. This represents a reserve margin of approximately 40% over the 2016 adjusted system net peak. This reserve margin did not include the capacity of Honolulu Units 8 and 9, which were deactivated in January 2014.

- Honolulu Units 8 and 9 (with a combined rating of 107.3 MW-net) were deactivated on January 31, 2014. The 2017 AOS reference scenario reflects the Honolulu generating units remaining deactivated, and their capacities are not included in the reserve margin calculations.

- Hawaiian Electric is anticipating the addition of approximately 50 MW of utility-owned and operated, firm, dispatchable, generation on federal lands, for the purpose of improving energy security and resiliency for the Hawaiian Electric grid and for the Army facilities in central Oahu, as well as enabling the integration of more variable generation renewable resources. It is estimated that the security project, i.e., the Schofield Generating Station Project, may be in service in the 2018 timeframe and is included in the 2017 AOS reference scenario.

1. Peak Demand and System Capability in 2016

The adjusted peak load experienced on Oahu in 2016 was 1,214 MW-net, and was served by Hawaiian Electric's total capability of 1,671 MW-net, including firm power purchases. This represents a reserve margin of approximately 40%[1] over the 2016 adjusted system net peak. This reserve margin did not include the capacity of Honolulu Units 8 and 9, which were deactivated in January 2014.

The system peak occurred on Wednesday, August 24, 2016 at approximately 7:29 pm, and was 1,192 MW-net based on net Hawaiian Electric generation, net purchased power generation, the peak reduction benefits of energy efficiency demand-side management programs, and with several co-generators[2] operating at the time. Had these cogenerating units not been operating, the 2016 system peak would have been approximately 1,214 MW-net.

Hawaiian Electric's 2016 total generating capability of 1,671 MW-net includes 456.5 MW net of firm power purchased from (1) Kalaeloa Partners, L.P. ("Kalaeloa"), (2) AES Hawaii, Inc. ("AES"), and (3) H-POWER.

At times during 2016, Hawaiian Electric received energy from ten variable generation energy producers (i.e., IES Downstream, Par Hawaii, Kahuku Wind Power, Kapolei Sustainable Energy Park, Kawailoa Wind, Kalaeloa Solar Two, Kalaeloa Renewable Energy Park, Waianae

[1] The total capability value used in the calculation of this reserve margin does not account for units not available due to maintenance outages, forced outages or derates in unit capacities. The reserve margin calculation takes into account the approximately 21 MW of interruptible load that may be available at system peak. In actual real-time operations, reserves may be reduced due to maintenance, forced outages or deratings.

[2] At the time of the peak, certain units at Par Hawaii, IES Downstream, and Pearl Harbor were generating about 5 MW of power for use at their sites.

Solar, Waihonu North, Waihonu South). Since these contracts are not for firm capacity, they are not reflected in Hawaiian Electric's total firm generating capability.

2. Estimated Reserve Margins

Appendix 1 shows the forecasted reserve margin over the next five years, 2017-2021, based on Hawaiian Electric's October 2016 Sales and Peak Forecast Update, and includes estimated energy efficiency impacts and load management impacts. This is based on a Reference Scenario that is described in Section 5.

3. Criteria to Evaluate Hawaiian Electric's Adequacy of Supply

Hawaiian Electric's capacity planning criteria are applied to determine the adequacy of supply and whether or not there is enough generating capacity on the system. Hawaiian Electric's capacity planning criteria take into account that Hawaiian Electric must provide for its own backup generation since, as an island utility, it cannot import emergency power from a neighboring utility. Hawaiian Electric's capacity planning criteria are described in Section 3.1.

The results of the annual analysis of the adequacy of supply on the Hawaiian Electric system are a function of a number of forecasts, such as:

- peak demand, including the forecasted peak reduction benefits of (a) energy efficiency from the Public Benefit Fee Administrator's ("PBFA") programs and changes to codes and standards, and (b) customer-sited-photovoltaic ("PV") with battery installations; [§4.2]
- peak reduction benefits of existing load control programs; [§4.3]
- Equivalent Forced Outage Rate Demand ("EFORd") on the generating units; [§4.4]
- planned maintenance schedules for the generating units on the system; [§4.5]
- additions of firm generating capacity; [§4.7] and
- reductions of firm generating capacity. [§4.8]

Each of the current assumptions for these and other factors is discussed in Section 4.

3.1. Hawaiian Electric's Capacity Planning Criteria

Hawaiian Electric's capacity planning criteria consist of one rule and one reliability guideline. The reserve capacity shortfalls calculated herein are determined by the application of the reliability guideline based on various key inputs such as the EFORd's of each generating unit, the load to be served, the amount of capacity on the system, and the availability of the generating units.

3.1.1. Hawaiian Electric's Capacity Planning Rule

Rule 1:

The total capability of the system must at all times be equal to or greater than the summation of the following:

a. *the capacity needed to serve the estimated system peak load, less the total amount of interruptible loads;*
b. *the capacity of the unit scheduled for maintenance; and*
c. *the capacity that would be lost by the forced outage of the largest unit in service.*

Reserve Margin:

Consideration will be given to maintaining a reserve margin of approximately 20 percent based on Net Top Load Ratings.

Rule 1 includes load reduction benefits from interruptible load customers. Because Hawaiian Electric will not build reserve capacity to serve interruptible loads, interruptible load programs such as Hawaiian Electric's current Rider I and load management programs can have the effect of deferring the need for additional firm capacity generation.

PSIP Update Report Reserve Margin:

In the Hawaiian Electric Companies' Revised and Supplemented Power Supply Improvement Plans ("PSIPs") also referred to as the PSIP Update Report filed on December 23, 2016 in Docket No. 2014-0183, the planning reserve margin for O'ahu was assumed to be a minimum of 45% for capacity planning analysis as a proxy for its 4.5 years per day LOLP reliability guideline.[3] The analysis herein uses loss of load probability calculations rather than the 45% reserve margin proxy value.

3.1.2. Hawaiian Electric's Reliability Guideline: Loss of Load Probability

The application of Hawaiian Electric's generating system reliability guideline does take into account the Loss of Load Probability ("LOLP") that generating units could be unexpectedly lost from service.

Reliability Guideline:

[3] Refer to Appendix J of Hawaiian Electric Companies' PSIP Update Report for reference.

> *"Capacity planning analysis will include a calculation of risk (Loss of Load Probability) in years per day for each year of each plan of the long-range expansion study. In cases where risk is calculated to be less than 4.5 years per day, the plan will be reviewed by the Vice President of Power Supply, Senior Vice President of Operations, and the President for approval of use of the plan in the study."*

In order to determine whether there is enough capacity on the system to account for the probability that multiple units may be unexpectedly lost from service, the result of an LOLP calculation must be compared against Hawaiian Electric's generating system reliability guideline.

Hawaiian Electric has a reliability guideline threshold of 4.5 years per day. Hawaiian Electric plans to have sufficient generating capacity to maintain generating system reliability above 4.5 years per day. There should be enough generating capacity on the system such that the expectation of not being able to satisfy demand due to insufficient generation occurs no more than once every 4.5 years. Values less than 4.5 years per day indicate lower levels of reliability and an increased likelihood of generation-related customer outages.

One potential means to address the planning uncertainty and complexity would be to revise the capacity planning guideline. If the existing Loss of Load Probability of 4.5 years per day does not provide an adequate cushion to respond to quickly-changing parameters, such as changes in peak demand and individual unit availability factors, many of which may change rapidly from year to year, then the utility could plan for a higher reliability standard similar to that of many mainland utilities. Such an approach would not eliminate quickly-changing parameters, but it would add a measure of conservatism in recognition that the uncertainties undoubtedly exist.

In its direct testimony for the Campbell Industrial Park Generating Station and Transmission Additions Project (Docket No. 05-0145), filed on August 17, 2006, the Consumer Advocate stated:

> [HECO's reliability guideline] is less stringent than the guidelines used by mainland utilities. As will be addressed later in my testimony, this guideline should be re-evaluated to determine if it should be more stringent in the future (e.g., one day in 6 years) to ensure reliable service. However, this determination should be based on analyses that assess the tradeoff between electric service costs to the consumer and the increase in reliability to be gained. CA-T-1 at 32.

The typical reliability standard on the mainland is 10 years per day, which is more stringent than the 6 years per day suggested by the Consumer Advocate and the 4.5 years per day in Hawaiian Electric's reliability guideline. A scenario analysis of the reserve capacity shortfall based on a higher reliability guideline threshold of 10 years per day is included in Section 5. The results of the analysis show the additional amount of firm capacity that would be needed on the Oahu grid to meet a higher, 10 years per day, reliability standard based on the assumptions provided herein.

Please refer to Appendix 3 of the 2005 AOS for additional information related to Hawaiian Electric's reliability guideline.

3.2. Other Considerations in Determining the Timing of Unit Additions

The need for new generation is not based solely on the application of the criteria previously mentioned. As capacity needs become imminent, it is essential that Hawaiian Electric broaden its consideration to ensure timely installation of generation capacity necessary to meet its customers' energy needs.

Other near-term considerations may include:

1. the current condition and rated capacity of existing units;
2. required power purchase obligations and contract terminations;
3. the uncertainties surrounding non-utility generation resources;
4. transmission system considerations;
5. meeting environmental compliance standards; and
6. system stability considerations for Hawaiian Electric's isolated electrical system.

In the application of Hawaiian Electric's capacity planning criteria that are used to determine its adequacy of supply, the inputs drive the results. Two of the key inputs in the application of the capacity planning criteria are (1) projected peak demand (including the anticipated peak reduction benefits of energy efficiency from the PBFA's programs and changes to codes and standards and demand response programs) and (2) the total firm capacity on the system. These key inputs are described in the following sections.

4. Key Inputs to the 2017 AOS Analysis

4.1. Period Under Review

This adequacy of supply review covers the period 2017 to 2021, which coincides with the PSIP Near-Term Action Plan period and is consistent with the five-year look-ahead period from the 2016 AOS.

4.2. October 2016 Sales and Peak Forecast Update

Hawaiian Electric developed a sales and peak ("S&P") forecast in October 2016 ("October 2016 S&P forecast update"), which was subsequently approved by the Company for future planning purposes.[4] Hawaiian Electric's AOS is based on the Companies October 2016 S&P forecast update and other key assumptions.

Figure 1 illustrates Hawaiian Electric's historical system peaks, and compares them to the forecasts used in the 2016 and 2017 AOS analyses. The analyses contained in the 2016 AOS were based on the May 2015 peak forecast. Hawaiian Electric's planning analyses performed in the Hawaiian Electric Companies'[5] PSIP Update Report also used the May 2015 peak forecast incorporating adjustments from updated distributed energy resources and demand response programs.

In 2015 Hawaiian Electric experienced a system peak that was more than 41 MW higher than the previous year and at levels not seen since 2009. The peak was due to extreme weather conditions coupled with relatively moderate electricity prices which lead to higher air conditioning usage from existing and new units.

The October 2016 peak forecast update is higher than the May 2015 forecast because it took into consideration lower forecasted electricity prices, improved economic conditions, continued use of air conditioning and lower energy efficiency projections from the PBFA.

[4] The October 2016S&P forecast was developed after PSIP inputs were set and analyses in the PSIP Update Report were near completion. Hence, the analyses contained in the PSIP Update report were not able to use this forecast, and the short term reserve margin analysis performed herein is more current than that provided in the PSIP.
[5] "Hawaiian Electric Companies" or "Companies" refers collectively to Hawaiian Electric Company, Inc., Maui Electric Company, Limited and Hawai'i Electric Light, Inc.

Figure 1: Recorded Peaks and Future Year Projections

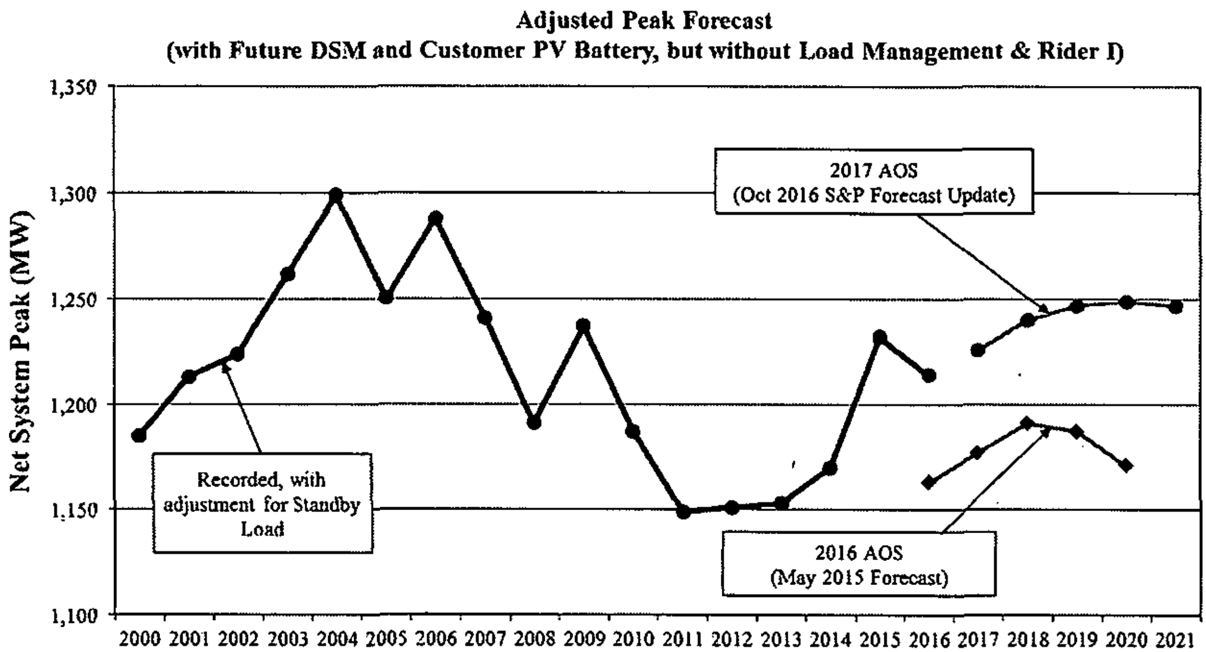

Table 1 below provides the recorded peaks from 2000 and the forecast used in the 2017 AOS.

For both the recorded and forecast data (from the October 2016 S&P Forecast Update), figures reflect an upward (standby) adjustment to account for the potential need to serve certain large customer loads (i.e., IES Downstream, Par Hawaii and Pearl Harbor) that are frequently served by their own internal generation. Figure 1 also includes estimated peak reduction benefits of energy efficiency programs and naturally occurring conservation. With the advent of storage technology (i.e., battery energy storage system ("BESS")) for the consumer market, impacts of customer-sited PV paired with batteries were included in the peak forecast. As solar capacity continues to grow year over year, daytime loads are projected to be reduced and, all else being equal, the average daily load profile is expected to have a more pronounced difference between daytime and evening peak. With an operating assumption of BESS charging during the day time hours, coincident with PV generation, and discharging the stored energy during the system priority peak period, the system peak has been reduced for this type of energy storage operation.

Table 1: Recorded Peaks and Future Year Projections

Net System Peak (MW) (with Future DSM and Customer PV Battery, but without Load Management & Rider I)			
Year	Actual	Actual Adj for Standby Load	2017 AOS Oct 2016 S&P Forecast Update
2000	1,164	1,185	
2001	1,191	1,213	
2002	1,204	1,224	
2003	1,242	1,262	
2004	1,281	1,299	
2005	1,230	1,250	
2006	1,265	1,288	
2007	1,216	1,241	
2008	1,186	1,191	
2009	1,213	1,237	
2010	1,162	1,187	
2011	1,141	1,149	
2012	1,141	1,151	
2013	1,144	1,153	
2014	1,165	1,170	
2015	1,206	1,232	
2016	1,192	1,214	
2017			1,226
2018			1,240
2019			1,247
2020			1,249
2021			1,247

4.3. Projected Peak Reduction Benefits of Load Control Programs

Hawaiian Electric is committed to pursuing Demand Response ("DR") programs designed to provide cost-effective resource options to meet the capacity needs and support the reliable operation of the system, as identified in the Integrated Demand Response Portfolio Plan ("IDRPP") filed with the commission on July 28, 2014, Update filed March 31, 2015, and Supplement filed November 20, 2015, in Docket No. 2007-0341.

On December 30, 2015, the Hawaiian Electric Companies submitted to the Commission for approval a DR Portfolio Application requesting:

- Approval of proposed tariff structure for DR programs;
- Approval of cost recovery mechanism;
- Approval of a 2-year program and budget approval cycle; and,
- Approval of the Companies' proposed reporting structure.

A Revised DR Portfolio filing, to be filed on February 10, 2017, will publish finalized DR program design and targets (MW) following the PSIP Update Report filing December 23, 2016. Pending Commission approval of the Revised DR Portfolio filing, the next AOS filing will be updated with the revised DR program load amounts. Hawaiian Electric will continue to implement DR in accordance with these targets in future years.

Table 2 shows the forecast of the peak reduction benefits towards Rule 1 and reserve margin calculations from the Companies PSIP Update Report high DG-PV DR forecast.

Table 2: Demand Response Impacts for Capacity Planning Purposes (MW)

Year	DR Total	Rider I	Total
2016	16.7	4.3	21.0
2017	6.4	4.3	10.7
2018	26.4	4.3	30.7
2019	42.5	4.3	46.8
2020	72.9	4.3	77.2
2021	82.3	4.3	86.6

4.4. Hawaiian Electric Generating Unit Forced Outages

Forced outages and de-ratings reduce generating unit availability and are accounted for in the EFORd statistic. EFORd, a measure of forced outages and operations in derated conditions, is a subcomponent of generating unit availability – and a key driver in the capacity planning criteria and reserve capacity shortfall calculations. Lower generating unit availability and higher EFORd both contribute to an increase in reserve capacity shortfalls. The definition of EFORd and an example of the application of the EFORd formula is provided in Appendix 2.

Outages for planned work and maintenance will continue to be more numerous and longer in duration than in previous years. Maintenance will continue to be a challenge for the existing units. As the generating units age,[6] they will need to be maintained more often and for longer periods of time. As the demand on existing generating units change to mitigate different resources on the system such as variable generation resources, the generating units operate harder to counteract the increasingly dynamic changes, which increase the likelihood of unscheduled (forced) outages and operations at derated power levels. Generating units that are shut down unexpectedly generally require immediate maintenance. As resources shift to make the emergency repairs, maintenance outage schedules slip, making maintenance scheduling flexibility difficult. In addition, generating units operating in a derated capacity typically cannot be afforded the luxury of a maintenance shutdown to restore the unit to full power operations. These units are generally operated for long periods in a derated state.

Table 3 provides the forward looking Hawaiian Electric EFORd data by unit. The forward looking EFORd values utilized in the 2017 AOS analysis are forecasted EFORd expectations for planning purposes based on a combination of historical data, experience, and operational judgment. The EFORd assumption generally reflects the 5-year average of the specific unit, or group of similar units. EFORd projections are not certain, however, and actual experience may differ from the projections. It is difficult to forecast EFORd due to unforeseen conditions of aging units, longer planned maintenance schedules, and the operating stress placed on the units. Refer to Appendix 3 for specific generating unit information on EFORd.

[6] Hawaiian Electric's generating units (not including the Campbell Industrial Park combustion turbine installed in 2009) are between 36 and 70 years old. Firm capacity IPP units are between 25 and 27 years old.

Table 3: Forward-looking EFORd

AOS EFORd Rates	
	2017 Forward Looking
Honolulu 8	8.5%
Honolulu 9	8.5%
Waiau 3	6.0%
Waiau 4	6.0%
Waiau 5	3.6%
Waiau 6	3.6%
Waiau 7	3.5%
Waiau 8	3.5%
Waiau 9	6.0%
Waiau 10	6.0%
Kahe 1	4.3%
Kahe 2	4.3%
Kahe 3	3.5%
Kahe 4	3.5%
Kahe 5	4.0%
Kahe 6	4.7%
CIP CT-1	2.5%
HECO	**4.1%**

Note: Honolulu units 8 & 9 were deactivated in 2014. Forward looking EFORd values for these units are based on historical data and shown for comparison purposes.

4.5. Planned Maintenance Schedules for the Generating Units on the System

Planned outages and maintenance outages reduce generating unit availabilities. The schedules for planned overhaul and maintenance outages change frequently due to unforeseeable findings during outage inspections or to changes in priorities due to unforeseeable problems. When major revisions to planned and/or maintenance outages occur, the Planned Maintenance Schedule is revised. The uncertainty of future maintenance schedules contributes to future planning uncertainty and may influence the magnitude of reserve capacity surplus or shortfalls.

4.6. Other Inputs

For the purposes of the analysis, DG-PV additions and demand response impacts were included. No future firm or variable resource additions were included, except for the Schofield Generating Station ("SGS") because the project has been approved by the Commission, so that capacity needs could be examined without the addition of future resources. Any future resources to be acquired could contribute to meeting the needs.

4.7. Additions of Capacity

4.7.1. Firm Capacity Additions

The State of Hawai'i Department of Transportation, Airports Division ("DOT"), 8 MW of distributed standby generation ("Airport DSG") is anticipated to be on-line and available for Hawaiian Electric's dispatch in mid-2017. Under an agreement between Hawaiian Electric and DOT ("Airport DSG Agreement"), Hawaiian Electric will be able to use the Airport DSG to serve system needs under certain conditions. Nearly all of the generation provided by the Airport DSG will be dispatchable by Hawaiian Electric under the conditions given in the agreement. The Commission approved the Airport DSG Agreement by Decision and Order issued March 2, 2010 in Docket No. 2009-0317. This capacity was included in the adequacy of supply analysis.

On September 30, 2015, in D&O No. 33178, the Commission approved the Schofield Generating Station ("SGS") Project with certain conditions and modifications. It is anticipated that this project could be in service in the 2018 timeframe. This capacity was included in the adequacy of supply analysis.

On October 29, 2015, Hawaiian Electric submitted a letter to the Commission providing its detailed outline of tasks necessary to shift its biodiesel use from the Campbell Industrial Park Combustion Turbine 1 ("CIP CT-1") to the SGS Project in accordance with ordering paragraph 6 of the Commissions D&O No. 33178. Following the shift of biodiesel use, Hawaiian Electric intends to use diesel at CIP CT-1. The operating capacity of CIP CT-1 using diesel may increase; subject to performance testing.

4.7.2. Non-Firm Additions

In addition to firm generation power projects, Hawaiian Electric purchases energy on an as-available basis from ten producers and anticipates adding additional variable generation renewable energy projects to the Hawaiian Electric system in the near future as these facilities achieve commercial operation.

Several variable generation independent power producers have power purchase agreements with Hawaiian Electric and others are in various stages of Commission approval. For example:

On December 12, 2013, in Docket No. 2013-0423, Hawaiian Electric submitted an application for Commission approval of a waiver from the Framework for Competitive Bidding and approval of a PPA with Na Pua Makani Power Partners, LLC, for up to 24 MW of wind power. On December 31, 2014 in D&O No. 32600, the Commission approved a waiver from the Framework for Competitive Bidding, subject to the conditions set forth in D&O No. 32600.

On October 3, 2016, in Docket No. 2016-0342, Hawaiian Electric submitted an application for the development and operation of the 20 MW West Loch PV farm. The facility is planned to be located on property leased from the United States Navy in West Loch Annex area of O'ahu.

4.8. Reductions of Firm Generating Capacity

4.8.1. Honolulu Units 8 and 9 Deactivation

Honolulu Units 8 and 9 (with a combined rating of 107.3 MW-net) were deactivated on January 31, 2014. The 2016 AOS reference scenario reflects the Honolulu generating units remaining deactivated, and their capacities are not included in the analysis.

4.8.1.1 Reactivation Option

Deactivated units may be reactivated in the event of an emergency and/or to mitigate reserve capacity shortfalls. Reserve capacity shortfalls may occur for a variety of reasons including unexpected long term outages of generating units or existing PPAs with IPPs for firm capacity being terminated or not being renegotiated and extended. In the case of Honolulu Units 8 and 9, reactivation would take approximately three months. In the event a situation warranted the reactivation of any deactivated units, the Company would inform the Commission accordingly and provide details supporting the basis for the need for such reactivation and its planned course of action.

4.8.2. Capacity from AES Hawaii, Inc.

The existing PPA with AES expires on September 1, 2022. On August 13, 2012, Hawaiian Electric submitted to the Commission a Petition for Declaratory Order regarding the Exemption of AES Hawaii's project from the Framework for Competitive Bidding, or in the alternative, Approval of Application for Waiver from the Framework for Competitive Bidding. On April 25, 2013, in D&O No. 31200, the Commission declared that the proposed renegotiation of the amended and restated PPA is exempt from the competitive bidding process. On November 13, 2015 Hawaiian Electric entered into Amendment No. 3 to the PPA. On January 22, 2016, the Company submitted to the Commission an application for approval of Amendment No. 3. On January 4, 2017, the Commission issued Order No. 34283 denying without prejudice Hawaiian Electric's request for approval of Amendment No. 3.

For the purposes of the 2017 AOS analysis, it is assumed that the capacity from AES is 180 MW through the end of the contract term.

4.9. Capacity from Kalaeloa Partners, L.P., Combined Cycle Unit

The existing PPA with Kalaeloa expires on May 23, 2016. The PPA states:

> *"...should the original Term end with the parties hereto actively negotiating for the purchase of the Facility or the Net Electric Energy Output of the Facility, then such Term shall be automatically extended on a month-to-month basis under the same terms and conditions as contained in this Agreement for so long as said negotiations continue in good faith. The month-to-month term extensions shall end sixty (60) days after either party notifies the other in writing that said negotiations have terminated."*

On November 10, 2011, Hawaiian Electric submitted to the Commission a Petition for Declaratory Order regarding the Exemption of Kalaeloa Partners, LP's ("KPLP") project from the Framework for Competitive Bidding, or in the alternative, Approval of Application for Waiver from the Framework for Competitive Bidding. On May 14, 2012, in D&O No. 30380, the Commission declared that the proposed renegotiation of the amended PPA is exempt from the competitive bidding process. In July 2016, Hawaiian Electric and KPLP reached agreement that neither Hawaiian Electric nor KPLP will give written notice of termination of the PPA prior to the end of the day on October 31, 2017.

For the purposes of the 2017 AOS analysis, it is assumed that the 208 MW of capacity provided by Kalaeloa remains in service beyond 2017.

5. Scenario Analysis

5.1. Description of Scenarios

In energy planning uncertainty is an important aspect. Therefore, a range of forecasts was considered in the analysis. Descriptions of the various planning scenarios are provided below:

- Reference Scenario
- Higher load forecast (60 MW increase in peak load)
- Revised system reliability guideline – Increased stringency of Hawaiian Electric's generating system reliability guideline from 4.5 years per day to 10 years per day

A scenario using a lower load forecast was not performed in the analysis. However, should lower loads occur in the future, it may provide more certainty regarding decisions to deactivate or decommission existing generation units.

A reference scenario consisting of assumptions such as Honolulu 8 & 9 remaining deactivated and are not counted towards capacity, no other unit deactivations, Kalaeloa remaining in service, and SGS included from April 2018, serves as the resource plan that the following scenarios can be compared to.

5.1.1. Higher Load Forecast

The Higher Load Scenario uses the assumption that the system peaks are higher by 60 MW. Such a scenario is possible if energy usage is higher than projected due to hotter or more humid than average weather conditions, lower than anticipated adoption of energy efficient measures and practices and/or an upswing in the economy as compared to the forecast occurs in the future. A 60 MW higher peak load is roughly equivalent to one standard deviation over a 20 year period of historical peaks. Table 4 summarizes the Higher Load Scenario peak requirements.

Table 4: Higher Load Scenario

Year	2017 AOS Oct 2016 S&P Forecast Update (MW)	60 MW higher Oct 2016 S&P Forecast Update (MW)	Difference (MW)
2017	1,226	1,286	60
2018	1,240	1,300	60
2019	1,247	1,307	60
2020	1,249	1,309	60
2021	1,247	1,307	60

5.1.2. Revised System Reliability Guideline

Another potential means to address the ever-increasing planning uncertainty and complexity is to revise the capacity planning guideline. As explained in Section 3.1.2, Hawaiian Electric currently uses a reliability guideline threshold of 4.5 years per day. If the existing Loss of Load Probability of 4.5 years per day does not provide an adequate cushion to respond to quickly-changing parameters, such as changes in peak demand and individual unit availability factors, many of which may change rapidly from year to year, then the utility could plan for a higher reliability standard similar to that many mainland utilities. Such an approach would not eliminate quickly-changing parameters, but it would add a measure of conservatism in recognition that the uncertainties undoubtedly exist.

Hawaiian Electric performed a high-level evaluation using a more stringent reliability guideline of 10 years per day. The purpose of this analysis was to determine the amount of firm capacity that would be required to meet this higher reliability guideline. The results of this high level evaluation are shown in Section 5.2.

5.2. Results of Analysis

Table 5 shows the capacity, in MW, in excess of the amount needed to satisfy Rule 1 of the capacity planning criteria. The analysis shows that Rule 1 is satisfied for the reference scenario for each year through 2021 under a reference set of assumptions including, but not limited to: (1) continued residential and commercial load management impacts at the levels described in Table 2; and (2) continued acquisition of third-party energy efficiency. However, as *previously explained, Rule 1 results are deterministic and do not incorporate unit specific* EFORd rates in their calculation.

Table 5: Rule 1 Analysis

Year	Rule 1 Results (MW)
2017	46
2018	48
2019	135
2020	195
2021	167

The LOLP for the reference and planning scenarios were calculated using a production simulation model for each year.

In 2017 and 2018, the generating system reliability is projected to be less than 4.5 years per day in the reference scenario. Based on the Company's October S&P forecast, Hawaiian Electric's firm generating capacity, which does not include intermittent energy sources such as wind and solar may not be sufficient to meet projected peak demand in 2017 and 2018. Reactivation of Honolulu Units 8 and 9 may alleviate, or remove, the future projected reserve capacity shortfalls.

Table 6 shows the results of the Generation System Reliability analysis. The system reliability in the scenarios shown varies depending on the firm generating units available, and the planned maintenance schedules.

Table 6: Generation System Reliability Guideline (years/day)

Generation System Reliability (years/day)			
Year	Reference Scenario	Higher Load (Add 60 MW)	10 yrs/day reliability scenario
2017	2.4	0.7	2.4
2018	3.1	0.9	3.1
2019	8.0	2.1	8.0
2020	29.4	7.0	29.4
2021	17.2	4.5	17.2

Table 7 shows the reserve capacity surpluses or shortfalls corresponding to the calculated reliability shown in Table 6. Reserve capacity shortfall, shown as a negative number is the approximate amount of additional firm capacity needed to restore the generating system LOLP to be greater than the 4.5 years per day reliability guideline. A positive number indicates the amount of capacity over and above that amount needed to satisfy the 4.5 years per day reliability guideline. For example, in the reference scenario for 2018, the number -20 would indicate that about 20 MW of firm generating capacity would have to be added, in order for the expectation of not being able to satisfy demand due to insufficient generation occurs no more than once every 4.5 years.

Table 7: Reserve Capacity Shortfall for reference and planning scenarios (MW)

Year	Reference Scenario	Alternate Scenarios	
		Higher Load (Add 60 MW)	10 yrs/day reliability scenario
2017	-30	-90	-60
2018	-20	-80	-60
2019	20	-40	-10
2020	80	20	40
2021	50	-10	20

(Note: Negative values indicate a shortfall of generating capacity; positive values indicate a surplus of generating capacity)

The forecasts and analysis for 2017 and 2018 indicate that there may be insufficient generation available for reasonable emergencies and reserve capacity.

The results indicated for the 2017-2021 timeframe are based on present day assumptions, and will change as the Hawaiian Electric system transforms into the future. The capacity shortfalls identified in this period are influenced by a set of assumptions, including but not limited to: (1) continued implementation of third party energy efficiency, (2) forward-looking maintenance schedules and unit availability that will change in the years ahead, and (3) the extent to which new generating capacity is added.

The analysis shows that the reserve capacity shortfall is sensitive to the load forecast. In the case of the Higher Load Scenario, a nominal 60 MW increase in the forecasted load resulted in a 60 MW reduction to projected reserve capacity for all years (2017-2021). Expectations regarding future loads can change quickly, and Hawaiian Electric may not be able to respond quickly to increases in demand. This illustrates the importance of using scenario analysis as a planning tool.

Table 7 further projects that approximately 60 MW of firm capacity would have to be added to the Hawaiian Electric system to achieve a higher reliability guideline of 10 years/day in the near term. The approximate 30 to 40 MW difference between the 4.5 years/day reference scenario and the 10 years/day Scenario to achieve higher levels of reliability is a non-linear relationship between MW capacity added and improvement in LOLP.

6. Mitigation Measures for Near-Term Reserve Capacity Shortfall (2017-2018)

As a result of the projected reserve capacity shortfalls, Hawaiian Electric has considered a number of actions to minimize the risk of generation-related shortfalls. These include implementing expanded demand response programs once approved, refinement of maintenance schedules, issuing calls for conservation, reactivation of the Honolulu 8 and Honolulu 9 units, and procurement of temporary generation.

6.1. Implement Demand Response Programs

Hawaiian Electric will implement its DR portfolio plan in accordance with Docket No. 2015-0412, and as discussed in Section 4.3 above.

6.2. Refinement of Maintenance Schedule

Scheduling maintenance requires consideration of many different operational factors. Maintenance scheduling can be expected to be adjusted several times over the year due to changing operational factors. In the event of reserve capacity shortfalls, rearranging maintenance schedules should be considered as a mitigation measure.

6.3. Call for Conservation

Hawaiian Electric may request voluntary customer curtailment of demand during capacity reserve shortfall conditions.

6.4. Reactivation of Honolulu 8 & 9

The Honolulu 8 and Honolulu 9 generating units are currently in a deactivated state. Hawaiian Electric may consider reactivation of these steam units in the event that system conditions warrant such measures. In the units' current deactivated state, the generating units would require several months to restore them to operating conditions.

6.5. Temporary Generation

In the event that severe or prolonged reserve capacity shortfalls are anticipated, temporary emergency distributed generation could be installed. In the mid-2000s, Hawaiian Electric experienced significant reserve capacity shortfalls and installed 30 MW of distributed generation at substation and other sites. These temporary units were removed after the installation of CIP CT-1.

7. Conclusions

Hawaiian Electric's reserve capacity may not be sufficient to meet the Company's generating system reliability guideline of 4.5 years per day in 2017 and 2018. The anticipated reserve capacity shortfalls are relatively small and Hawaiian Electric can implement mitigation measures. This assumes the Schofield Generating Station is in service from 2018.

As indicated in Section 4.5, Hawaiian Electric is anticipating the addition of approximately 50 MW of utility owned and operated, firm, dispatchable generation (SGS Project) in 2018.

The scenario analysis indicates that depending on system conditions, Hawaiian Electric may experience anywhere from a 30 MW reserve capacity shortfall under the reference scenario to a 90 MW reserve capacity shortfall in the Higher Load Scenario in the timeframe analyzed. Hawaiian Electric may seek to mitigate future capacity needs in 2018 and beyond by increasing Demand Response Programs, refining maintenance schedules, reactivating units that are currently deactivated, or acquiring additional firm capacity.

Hawaiian Electric will continue its portfolio approach to meet its obligation to serve, which includes increased renewable energy contributions, demand-side management programs, energy storage resources and the pursuit of firm capacity and non-firm supply side options. Hawaiian Electric also recognizes that the environment for resource planning has increased in complexity and uncertainty.

Very truly yours,

Joseph P. Viola
Vice President
Regulatory Affairs

Attachments

c: Division of Consumer Advocacy (with Attachments)

Table A1:
Projected Reserve Margins for the Reference Case

Year	System Capability at Annual Peak Load (net MW) [A] (I)	System Peak (net MW) [B] (II)	Interruptible Load (net MW) [C] (III)	Reserve Margin (%) [A-(B-C)] / (B-C)
2016	1,671	1,214	21	40%
2017	1,679	1,226	11	38%
2018	1,745	1,240	31	44%
2019	1,745	1,247	47	45%
2020	1,745	1,249	77	49%
2021	1,745	1,247	87	50%

Notes:

I. System Capability includes:
- Hawaiian Electric central station units at total normal capability in 2016 was 1,214.3 MW-net.
- Firm power purchase contracts with a combined net total of 456.5 MW in 2016 from Kalaeloa (208 MW), AES Hawaii (180 MW), and H-POWER (68.5 MW).
- Expected addition of Airport DSG in 2017 (8 MW)
- Honolulu Units 8 and 9 were deactivated in 2014 (-107.3 MW)
- Kalaeloa assumed to continue in service after 2016
- Expected addition of the SGS Project in 2018 (48.8 MW)
- Following the addition of the SGS Project in 2018, CIP-1 is anticipated to switch its primary fuel to diesel. The unit rating for CIP-1 consuming diesel is expected to increase from 113 MW to 130 MW subject to testing.

II. System Peaks
- The 2017-2021 annual forecasted system peaks are based on Hawaiian Electric's October 2016 S&P Forecast.
- The forecasted System Peaks for 2017-2021 include the estimated peak reduction benefits of third-party energy efficiency DSM programs.
- The peak for 2017-2021 includes approximately 27 MW of stand-by load
- The Hawaiian Electric annual forecasted system peak is expected to occur in the month of October.

III. Interruptible Load:
- Interruptible Load impacts are at the net-to-system level, and are approximate impacts at the system peak.

Equivalent Demand Forced Outage Rate Definition and Formula

As defined in IEEE Std-762-2006,[7] Section 3.8:

Equivalent Demand Forced Outage Rate ($EFOR_d$): A measure of the probability that a generating unit will not be available due to forced outages or forced deratings when there is demand on the unit to generate.

$EFOR_d$ is defined in the NERC GADS Data Reporting Instructions,[8] Appendix F as:

$$EFORd = \frac{[FOHd + (EFDHd)] \times 100\%}{[SH + FOHd]}$$

where

FOHd = f x FOH

EFDHd = (EFDH – EFDHRS) *if reserve shutdown events reported, or*

= (fp x EFDH) if no reserve shutdown events reported – an approximation.

fp = (SH/AH)

$$f = \left(\frac{1}{r} + \frac{1}{T}\right) \Big/ \left(\frac{1}{r} + \frac{1}{T} + \frac{1}{D}\right)$$

r=Average Forced outage deration = (FOH) / (# of FO occurrences)
D=Average demand time = (SH) / (# of unit actual starts)
T=Average reserve shutdown time = (RSH) / (# of unit attempted starts)

An example of the application of the EFORd formula to Hawaiian Electric's Waiau 9 generating unit in 2012 is shown below:

	Service Hours	Reserve Shutdown Hours	Available Hours				Equivalent Forced Derated Hours	Forced Outage Hours	
Capacity	SH	RSH	AH	Actual Starts	Attempted Starts	Failed Starts	EFDH	FOH	FO Events
53	67	7002.14	7069	26	27	1	0.00	1,067.26	5

=1/ (1067/5)	=1/(7002/27)	=1/(67/26)		=0.021397 *1067	=67/7069	=0.009416*0		=(22.84/(67+22.84)) *100	=(1067/(1067+67)) *100
1/r	1/T	1/D	f	fxFOH	fp	fp x EFDH	EFORd x MW	**EFORd**	**EFOR**
0.004685	0.003856	0.390625	0.021397	22.83591142	0.009416	0	1,353.87	**25.54**	**94.1**

7 http://www.nerc.com/docs/pc/gadstf/ieee762tf/762-2006.pdf

8 http://www.nerc.com/page.php?cid=4|43|45

Hawaiian Electric Equivalent Demand Forced Outage Rate ("EFORd") Discussion

It is extremely difficult to predict unit-specific EFORd rates, as indicated by the variation in historical data. Nonetheless, for planning purposes it is necessary to estimate forward-looking EFORd rates. This is accomplished using a blend of historical data, experience, and judgment. Hawaiian Electric has used a few different methods in determining unit specific EFORd numbers. Generating units are, at any giving time, in various stages of their maintenance plan. Different outage rates are expected following unit overhauls compared to the period prior to unit overalls. Similarly due to changing system needs, Hawaiian Electric responds differently to forced outages/derates. When forced outages or derates occur, Power Supply evaluates the impacts to the system and responds accordingly. For example, when forced outages or derates do not impact system reliability, Power Supply will not expend significant amount of overtime to restore the unit. These decisions impact actual EFORd, but not actual material condition of the plants. Therefore, Hawaiian Electric has attempted to normalize variations by comparing similar generating units over a five year period, with some exceptions, consider the cause/remedy of actual events, and consider actual unit material condition. Hawaiian Electric retains the ability to respond to forced outages/derates as has been done historically. Therefore, from an adequacy of supply perspective, historic EFORd alone does not represent an appropriate forward looking number for planning purposes. Table A2 provides recorded Hawaiian Electric EFORd data used as the basis for forward looking EFORd. The rationalization for the selection of EFORd numbers to be used in the 2017 AOS analysis is discussed below:

Table A2:
Historical EFORd

	Recorded EFORd				
	2012	**2013**	**2014**	**2015**	**2016**
Honolulu 8	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Honolulu 9					
Waiau 3	4.4%	13.7%	33.2%	37.4%	4.4%
Waiau 4	2.2%	1.7%	5.0%	5.5%	11.2%
Waiau 5	1.9%	1.4%	3.5%	6.3%	7.2%
Waiau 6	6.5%	2.4%	7.2%	24.2%	4.9%
Waiau 7	0.4%	1.6%	0.0%	1.0%	12.0%
Waiau 8	3.7%	4.7%	6.7%	5.0%	7.2%
Waiau 9	25.5%	2.1%	0.9%	12.5%	12.0%
Waiau 10	4.8%	7.1%	3.4%	3.1%	9.4%
Kahe 1	0.5%	0.6%	2.8%	5.1%	3.3%
Kahe 2	7.2%	3.1%	10.6%	8.4%	11.4%
Kahe 3	2.5%	1.3%	2.2%	9.3%	5.3%
Kahe 4	2.7%	2.3%	9.0%	4.1%	2.6%
Kahe 5	4.6%	2.3%	6.1%	14.1%	4.0%
Kahe 6	3.4%	12.8%	1.8%	29.1%	3.9%
CIP CT-1	3.9%	0.7%	9.0%	0.6%	3.2%
HECO	**4.1%**	**3.4%**	**5.9%**	**10.2%**	**6.0%**

1. Honolulu Units 8 and 9

In the 2015 AOS, the forward looking EFORd of 8.5% included the actual average of 5 years for both Honolulu Units 8 and 9. Honolulu Unit 8 and Honolulu Unit 9 are similar units at a similar juncture in their maintenance strategy. Honolulu 8 and 9 are in a deactivated state. It is assumed that if they were to be reactivated they would operate and be maintained in a similar to that of pre-deactivation. Therefore, Honolulu 8 and 9 will have an EFORd of 8.5% for forwarding looking analysis and are shown for comparison purposes.

2. Waiau Units 3 and 4

In the 2016 AOS, the forward looking EFORd for Waiau Unit 3 was 6.7%. The actual EFORd for 2016 for Waiau Unit 3 was 4.4 %. In the 2016 AOS, the forward looking EFORd for Waiau Unit 4 was 4.7%. The actual EFORd for 2016 for Waiau Unit 4 was 11.25%.

Waiau units 3 and 4 are classified as limited use units under our compliance plan with Mercury and Air Toxic Standards (MATS) compliance plans. Hawaiian Electric attempts to keep the capacity factors of Waiau units 3 and 4 below 8%. This status can and will be changed if system requirements dictate. Nonetheless, with the limited use intentions, material condition of these units and planned deactivation, Hawaiian Electric believes a forward looking EFORd of 6% is appropriate.

3. Waiau Units 5 and 6

In the 2016 AOS, the forward looking EFORd rate for Waiau Units 5 and 6 was 3.6%. The actual EFORd for 2016 for Waiau Units 5 and 6 were 7.18% and 4.88%, respectively. For previous year AOS analysis, it was decided to use the average of the actual EFORd rates for the past 5 years. The 2017 AOS recognized that Waiau Units 5 and 6 are similar units under the same maintenance strategy. After reviewing historic performance, material condition, and with recognition that the units have lower service factors year over year, Hawaiian Electric believes a forward looking EFORd of 3.6% is appropriate.

4. Waiau Unit 7, Waiau Unit 8, Kahe Unit 3, and Kahe Unit 4

These four units are of similar size, design, and vintage, and are dispatched as baseloaded units with similar duty cycles. They also have a similar maintenance strategy. With each unit at various stages of the maintenance plans it is recommended that averaging all four units provides the best indication of EFORd to be used for the 2016 AOS analysis. Accordingly, in the 2016 AOS, the forward looking EFORd rate of 3.5% was used for these four units. The actual EFORd for 2016 for Waiau Unit 7, Waiau Unit 8, Kahe Unit 3, and Kahe Unit 4 were 11.97%, 7.22%, 5.34%, 2.62%, respectively, with an average of 6.79%. For the 2016 AOS analysis, it was recognized Waiau 7 and Kahe 4 had overhauls in 2016 and that Kahe 3 returned from overhaul at the very end of 2015. Waiau 8 is scheduled for overhaul in early 2017. Significant work during these outages coupled with 2017 maintenance plans will improve reliability on those units. With that planned overhaul and maintenance outage work and similar operation of the four units it was decided that 3.5% is an appropriate number for 2017 AOS planning purposes.

5. Waiau Units 9 and 10

In the 2016 AOS, the forward looking EFORd rate for Waiau Units 9 and 10 was 7.8%. The actual EFORd in 2016 for Waiau Units 9 and 10 were 12.1% and 9.36%, respectively, and averaged 10.7% for the two units. For the 2017 AOS analysis, it was decided to use a forward looking EFORd of 6%. Hawaiian Electric places higher degree of focus on reliably of CTs as a result of changing system needs. Hawaiian Electric expects improved performance of these units based on current material condition and focus on these units.

6. Kahe Units 1 and 2

In the 2016 AOS, the forward looking EFORd for Kahe Units 1 and 2 was 4.3%. The actual EFORd in 2016 for Kahe Unit 1 and 2 were 3.34% and 11.37%, respectively, and averaged to be 7.4% for both units. For the 2017 AOS analysis, it was decided to continue to use 4.3% as the forward looking EFORd. The Kahe 1 and 2 remain reliable units in a good material condition. Hawaiian Electric believes that the historic EFORd represents the material condition of the units. As previously mentioned, Power Supply responds to unit forced outages/derates differently depending on actual system needs. Therefore with material condition of this plant, for planning purposes the 4.3% EFORd is appropriate for forward looking adequacy of supply analysis. It should be recognized that while Kahe 2 does not have an overhaul this year, a singular incident greatly affected Kahe 2's EFORd in 2016, and that two maintenance outages are scheduled for 2017. Kahe 1 will have an overhaul starting at the end of 2017.

7. Kahe Units 5 and 6

In the 2016 AOS, the forward looking EFORd for Kahe Units 5 and 6 was 4.7%. The actual EFORd for 2016 for Kahe Units 5 and 6 were 4.0% and 3.88% respectively, and averaged to be 3.9% for both units. Kahe Units 5 and 6 are similar units and are operated and maintained in similar manner. For the 2017 AOS a forward looking EFORd of 4.0% was chosen for Kahe 5 and 4.7% for Kahe 6. It is recognized that Kahe 5 will have an overhaul midway through 2017. Kahe 6, while having lower EFORd in 2016 is expected to normally have a higher EFORd based on challenges associated with the unit, duration to the next overhaul, and the approach to forced outages/derates previously discussed.

8. CIP CT-1

On August 3, 2009, CIP CT-1 was placed in service (e.g. tied into the electrical grid and producing power). In the 2016 AOS, the forward looking EFORd for CIP CT-1 was 2.5%. The actual EFORd for 2016 for CIP CT-1 was 3.18%. For the 2017 AOS analysis, it was recognized that CTs play an increasingly important role in system reliability. After considering material condition and focus on CTs, Hawaiian Electric believes the forward looking 2.5% EFORd for adequacy of supply purposes is appropriate.