January 29, 2021

The Honorable Chair and Members of the
Hawaiʻi Public Utilities Commission
465 South King Street
Kekuanaoʻa Building, First Floor
Honolulu, Hawaiʻi 96813

Dear Commissioners:

Subject: Adequacy of Supply
Hawaiian Electric Company, Inc.

The following information is respectfully submitted in accordance with paragraph 5.3.a 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.*

2021 Adequacy of Supply Report Summary

- Hawaiian Electric Company, Inc's ("Hawaiian Electric" or the "Company") 2021 Adequacy of Supply employs a new Energy Reserve Margin criteria, developed to review adequacy of supply in all hours of the year vs. during the peak hour of the day or peak day of the year and incorporate the reliability contribution of variable and energy-limited resources, such as energy storage and duration limited grid services, such as demand response resources.

- Hawaiian Electric's Energy Reserve Margin target is satisfied from 2021 through 2025 with the addition of Hawaiian Electric's planned generation and storage resource additions. New resources planned for Oʻahu are anticipated to meet energy reserve margin targets to mitigate the expiration of AES power purchase agreement.

- The adjusted peak load experienced on Oʻahu in 2020 was 1,116 MW-net and was served by Hawaiian Electric's total capability of 1,744 MW-net, including firm power purchases. This represents a reserve margin of approximately 59% over the 2020 adjusted system net peak.

Hawaiian Electric has considered a number of actions to minimize the risk of generation-related shortfalls. These include implementing and procuring expanded grid services programs, refinement of maintenance schedules, issuing calls for conservation, and procurement of temporary generation and energy storage.

1. Peak Demand and System Capability in 2020

The adjusted peak load experienced on O'ahu in 2020 was 1,116 MW-net and was served by Hawaiian Electric's total capability of 1,744 MW-net, including firm power purchases. This represents a reserve margin of approximately 59%[1] over the 2020 adjusted system net peak.

The system peak occurred on Thursday, October 2, 2020 at approximately 5:26 p.m., and was 1,087 MW-net based on net Hawaiian Electric generation, net purchased power generation, the peak reduction benefits of energy efficiency programs, and with several co-generators[2] operating at the time. Had these cogenerating units not been operating, the 2020 system peak would have been approximately 1,116 MW-net.

Hawaiian Electric's 2020 total generating capability of 1,744 MW-net includes 456.5 MW net of firm power purchased from (1) Kalaeloa Partners, L.P. ("KPLP"), (2) AES Hawaii, Inc. ("AES"), and (3) H-POWER.

At times during 2020, Hawaiian Electric received energy from seventeen variable generation energy producers. Since these contracts are not for firm capacity, they are not reflected in Hawaiian Electric's total firm generating capability.

2. 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.

The function of a planning criteria is to establish guidelines to manage the risk of insufficient generation capability from a diverse mix of generating resources available to the system in long-range generation expansion studies. Resource plan development is evaluated based on a consistent guideline or criteria to provide adequate generation to meet customer demand, with reasonable reserves to account for routine maintenance or overhauls of units, unexpected outages of

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[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, Sheraton and Pearl Harbor were generating about 29 MW of power for use at their sites.

generating units, growth in customer demand over time, and possibilities of higher than forecasted instantaneous peak demand.

With the increasing quantities of variable renewable wind and solar resources, and future energy storage additions to the system, a capacity planning criteria was developed to address the dynamic nature of energy provided by wind, PV and limited duration storage.[3] For the purposes of this adequacy of supply report, Hawaiian Electric used its Energy Reserve Margin planning criteria. Prior to the development of an Energy Reserve Margin planning criteria, Hawaiian Electric's capacity planning criterion consisted of one rule and one reliability guideline.

2.1. Energy Reserve Margin

The Energy Reserve Margin is the percentage by which the system capacity must exceed the system load in each hour. With the increasing quantities of variable renewable wind and solar resources, Hawaiian Electric has recently developed this capacity planning criteria to account for current and future variable generation resources by addressing the dynamic nature of energy provided by wind, PV and limited duration storage. The hourly evaluation of available energy allows for better integration of resources with possible rapid fluctuations in generating capabilities. The Energy Reserve Margin for Oʻahu is 30%, to maintain reliability, and provide reasonable reserve for emergencies. Details of the Energy Reserve Margin, purpose, concept, and structure are discussed at length in Appendix 2.

2.2. Hawaiian Electric's Previous Capacity Planning Criterion

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.

[3] Refer to Hawaiian Electric's Integrated Grid Planning Technical Advisory Panel documents from December 17, 2020. https://www.hawaiianelectric.com/clean-energy-hawaii/integrated-grid-planning/stakeholder-engagement/technical-advisory-panel and its Solution Evaluation and Optimization Working Group documents from May 22, 2020 https://www.hawaiianelectric.com/clean-energy-hawaii/integrated-grid-planning/stakeholder-engagement/working-groups/solution-evaluation-and-optimization-documents

Reserve Margin:

Consideration will be given to maintaining a reserve margin of approximately 20 percent based on Net Top Load Ratings. Appendix 1 shows the forecasted firm generation reserve margin over the next five years, 2021-2025, based on Hawaiian Electric’s May 2020 Sales and Peak Forecast, and includes estimated energy efficiency impacts and load management impacts. This is based on a forecast Scenario described in Section 4.

Hawaiian Electric’s Reliability Guideline

Loss of Load Probability:

Hawaiian Electric’s generating system reliability guideline takes into account the Loss of Load Probability (“LOLP”) that generating units could be unexpectedly lost from service.

Reliability Guideline:

Hawaiian Electric has a reliability guideline threshold of 4.5 years per day[4]. This means 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. LOLP calculations typically rely on the contributions and outages from traditional firm capacity thermal generators. Variable generation and limited duration resources do not translate accurately to LOLP calculations, and therefore are not included in Hawaiian Electric’s LOLP analysis

2.3. 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] Refer to Appendix 3 of Hawaiian Electric’s 2005 Adequacy of Supply report for additional information related to Hawaiian Electric’s LOLP guideline.

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. Key inputs are described in the following sections.

3. Key Inputs to the 2021 Adequacy of Supply Analysis

3.1. Period Under Review

This report review covers the period 2021 to 2025.

3.2. May 2020 Sales and Peak Forecast

In May 2020 a sales and peak forecast (“May 2020 S&P forecast”) was developed which was subsequently approved by the Company for future planning purposes and used for this analysis.

The sales and peak forecasts used for the analysis herein is the result of detailed analysis of the impacts of the Covid-19 pandemic and anticipated recovery. In 2020, the Covid-19 pandemic resulted in unprecedented disruptions to global travel, local resident behavior, economic activity and as a result, electricity consumption. State and county emergency orders beginning with stay-at-home orders and mandatory post-arrival travel quarantines in March 2020 basically shut down the Hawai‘i economy, especially the tourism industry. Electricity usage was severely impacted, although in different ways depending on the sector. Several economic updates were issued in the following months by the University of Hawai‘i Economic Research Organization (“UHERO”), with the outlook rapidly changing as new emergency orders went into effect.

The Company’s future forecast was informed by multiple types of data to provide numerous sources of insight into this unprecedented time. Customer information was analyzed including available customer-level consumption data from before and after the governments’ emergency orders went into effect, customers’ public announcements regarding closures and reopening plans, feedback from customers to their Hawaiian Electric account managers, distribution circuit data from before and after emergency orders went into effect, and customer billing data. Local economists, organizations and businesses in Hawai’i discussed impacts to the local economy and their perspectives on recovery in multiple public forums. Information from other utilities on Covid-19 related impacts to electricity consumption and methods for projecting recovery was also considered.

The forecast is the result of the above described contributing factors and reflects the Company's most current outlook for customer energy demand for the next five years.

Figure 1 below illustrates Hawaiian Electric's historical system peaks and compares them to the forecasts used in the 2020 and 2021 Adequacy of Supply analyses. The analyses contained in the 2020 Adequacy of Supply report were based on Hawaiian Electric's June 2019 peak forecast.

Figure 1: Recorded Peaks and Future Year Projections

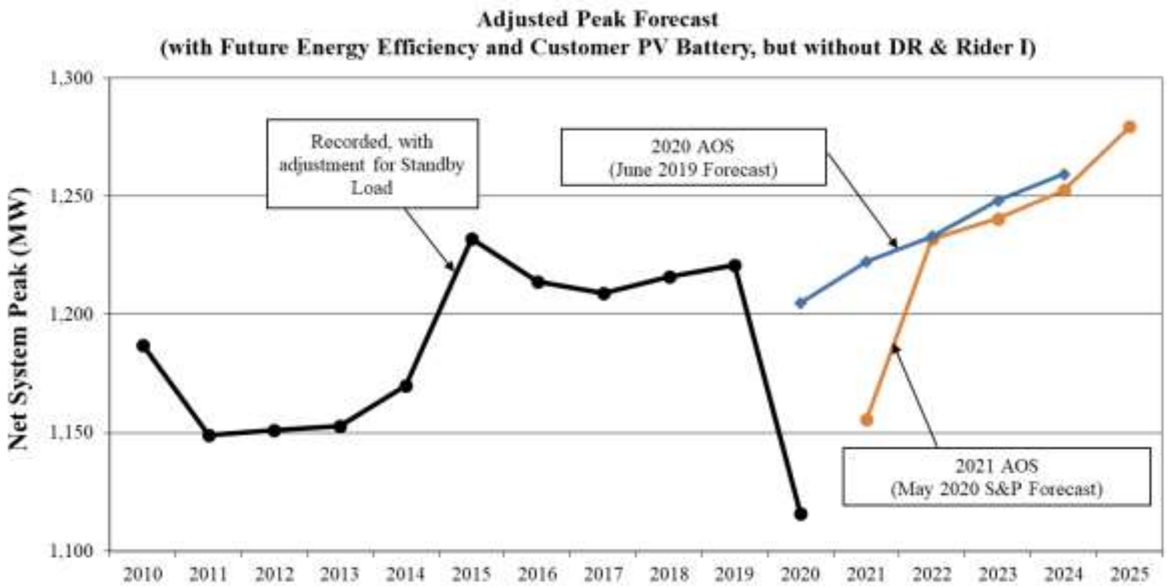

Table 1 below provides the recorded peaks from 2010 and the forecast used in Hawaiian Electric’s 2020 Adequacy of Supply analysis.

Table 1: Recorded Peaks and Future Year Projections

Net System Peak (MW) (with Future Energy Efficiency and Customer PV Battery, but without DR & Rider I)			
Year	Actual	Actual Adj for Standby Load	2021 AOS May 2020 S&P Forecast
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	1,184	1,209	
2018	1,190	1,216	
2019	1,193	1,221	
2020	1,087	1,116	
2021			1,156
2022			1,232
2023			1,241
2024			1,253
2025			1,280

For both the recorded and forecast data (from the May 2020 S&P Forecast), figures reflect an upward (standby) adjustment to account for the potential need to serve certain large customer loads (i.e., Par Hawaii, Sheraton 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 systems (“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 daytime 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.

3.3. Projected Peak Reduction Benefits of Demand Response Programs

Hawaiian Electric is committed to pursuing demand response (“DR”) programs designed to provide cost-effective resource options as identified in the Integrated Demand Response Portfolio Plan. [5]

In 2015, the Hawaiian Electric Companies[6] submitted to the Commission for approval a DR Portfolio Application in Docket 2015-0412. A Revised DR Portfolio was filed on February 10, 2017, which provided modified approval requests and DR program design, and targets (MW) consistent with the DR Portfolio used in the Power Supply Improvement Plan Update Report filing on December 23, 2016. On January 25, 2018, the Commission issued Decision and Order No. 35238, approving the Companies’ Revised DR Portfolio tariff structure framework.

On August 22, 2019, the Hawaiian Electric Companies issued Request for Proposal No. 103119-02 “Grid Services from Customer-sited Distributed Energy Resources”. Final selections were made on January 9, 2020 where aggregators were selected that would offer grid services to the islands. For the purposes of this analysis, Hawaiian Electric’s adequacy of supply was calculated using estimated DR impacts from Table 2, below.

Table 2: DR Impacts for Capacity Planning Purposes (MW)

Year	DR Total	Rider I	Total
2021	33.1	4.3	37.4
2022	40.7	4.3	45.0
2023	45.5	4.3	49.8
2024	45.5	4.3	49.8
2025	38.7	4.3	43.0

3.4. Hawaiian Electric Generating Unit Forced Outages

Forced outages and deratings 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 LOLP planning guideline and resulting reserve capacity shortfall calculations. Lower

[5] Refer to Docket No. 2007-0341.
[6] “Hawaiian Electric Companies” or “Companies” refers collectively to Hawaiian Electric Company, Inc., Maui Electric Company Limited , and Hawai‘i Electric Light Company, Inc.

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 3.

Outages for planned work and maintenance will continue to be more frequent and longer in duration than in previous years. Scheduling maintenance will continue to be a challenge for the existing units. As the generating units age,[7] they need to be maintained more often and for longer periods of time. In addition, in response to the changing resources on the system, such as variable generation resources, the generating units are being operated in ways for which they were not designed. Such operation increases 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 are generally operated for long periods in a derated state as scheduling a maintenance shutdown to restore the units to full power operations may take a long time.

Table 3 below provides the forward looking Hawaiian Electric EFORd data by unit. The forward looking EFORd values utilized in the 2021 analyses are forecasted EFORd expectations for planning purposes based on a combination of historical data, experience, and operational judgment. The EFORd assumption generally reflects the four-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 4 for specific generating unit information on EFORd.

[7] Hawaiian Electric’s generating units (not including the Campbell Industrial Park combustion turbine installed in 2009 and the generating units at the Schofield Generating Station installed in 2018) are between 40 and 74 years old. Firm capacity independent power producer units are between 28 and 30 years old excluding Airport DSG.

Table 3: Forward-looking EFORd

Waiau 3	25.0%
Waiau 4	18.0%
Waiau 5	12.0%
Waiau 6	7.0%
Waiau 7	10.0%
Waiau 8	10.0%
Waiau 9	8.2%
Waiau 10	8.2%
Kahe 1	10.0%
Kahe 2	10.0%
Kahe 3	10.0%
Kahe 4	10.0%
Kahe 5	7.0%
Kahe 6	7.0%
CIP CT-1	4.2%
Schofield 1	2.0%
Schofield 2	2.0%
Schofield 3	2.0%
Schofield 4	2.0%
Schofield 5	2.0%
Schofield 6	2.0%

3.5. 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. A 5-year planned maintenance schedule most recently updated in January 2021 was used in this analysis, and includes planned maintenance schedules for AES, Kalaeloa and H-Power. The maintenance schedule for 2022 includes adjustments to mitigate the ending of AES power purchase agreement in September 2022.

3.6. Additions of Capacity

3.6.1. Firm Capacity Additions

No new firm capacity additions are anticipated from 2021 to 2025.

3.6.2. Non-Firm Additions

In addition to firm generation power projects, Hawaiian Electric purchases energy on an as-available basis from seventeen 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 renewable generation and storage projects have been approved by the Commission or are pending review by the Commission. These are Ho‘ohana Solar 1 (Docket No. 2018-0431, Mililani 1 Solar, LLC (Docket No. 2018-0434), Waiawa Solar Power LLC (Docket No. 2018-0435), AES West Oahu (Docket No. 2019-0050), Kapolei Energy Storage (Docket No. 2020-0136), Kupehau Solar (Docket No. 2020-0138), Mountain View Solar (Docket No. 2020-0139), Waiawa Phase 2 Solar (Docket No. 2020-0137), Barbers Point Solar (Docket No. 2020-0143), and Mahi Solar (Docket No. 2020-0140).

3.7. Reductions of Firm Generating Capacity

3.7.1. Capacity from AES Hawaii, Inc.

The existing Power Purchase Agreement (“PPA”) with AES expires on September 1, 2022. For the purposes of the 2021 Adequacy of Supply analysis, it is assumed that the capacity from AES is 180 MW through the end of the contract term.

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

The existing PPA with Kalaeloa Partners (“KPLP”) expired on May 23, 2016. The PPA, as amended, automatically extends on a month-to-month basis until either party notifies the other in writing that the negotiations have terminated. On November 20, 2020, Hawaiian Electric and Kalaeloa entered into an agreement that neither party will give written notice of termination of the PPA prior to February 5, 2021.

For the purposes of the 2021 Adequacy of Supply analysis, it is assumed that the 208 MW of capacity provided by KPLP stays available for the duration of the analysis period.

4. Scenario Analysis

4.1. Description of Scenarios

In energy planning, uncertainty is an important aspect. Therefore, a range of forecasts was considered in the analysis.

For Energy Reserve Margin analysis, five scenarios were analyzed, all scenarios include the contributions from existing variable renewable resources;

- without planned generation and storage projects described in Section 3.6.2.
- with all planned generation and storage projects.
- with all planned generation and storage projects except for the Kapolei Energy Storage (“KES”) project.
- with the KES project but without all other planned generation and storage projects.
- higher peak forecast (60 MW increase in peak load) with all planned generation and storage projects.

Although the Energy Reserve Margin criteria will be used for future planning purposes, analyses using the company’s previous planning criteria are shown to provide a reference point and added perspective regarding adequacy of supply of the system.

An LOLP scenario consisting of assumptions such as Honolulu Units 8 and 9 remaining deactivated and are not counted towards capacity, no other unit deactivations, AES ending in 2022, and KPLP remaining in service serves as the resource plan to which various scenarios can be compared. The results of LOLP scenario analysis are shown in Section 4.2.2.

4.1.1. Higher Peak Forecast

The Higher Peak 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. For the Energy Reserve Margin analysis, peak loads were increased by 60 MW.

4.2. Results of Analysis

4.2.1 Energy Reserve Margin

The results of the Energy Reserve Margin criteria analysis are shown in Table 4. A 30% Energy Reserve Margin target was used for Oʻahu. The results indicate that the energy reserve margin target is satisfied from 2021 through 2025 with the addition of Hawaiian Electric's planned generation and storage project additions. Sufficient energy supply is anticipated even with a 60 MW increase to peak loads. However, without these anticipated projects, the Energy Reserve Margin target is not achieved from 2023 and the system is at risk of having energy shortfalls.

Table 4: Estimated Energy Reserve Margin

Number of Hours Below Energy Reserve Margin Target (Pass/Fail 30% Criteria)					
Year	**Without** Future Generation and Storage Projects	**With** Future Generation and Storage Projects	**With** Future Generation and Storage Projects **Without** KES	**With** KES **Without** Future Generation and Storage Projects	High Peak Forecast **With** Future Generation and Storage Projects
2021	0 (PASS)	0 (PASS)	0 (PASS)	0 (PASS)	0 (PASS)
2022	0 (PASS)	0 (PASS)	0 (PASS)	0 (PASS)	0 (PASS)
2023	220 (FAIL)	0 (PASS)	0 (PASS)	0 (PASS)	0 (PASS)
2024	67 (FAIL)	0 (PASS)	0 (PASS)	0 (PASS)	0 (PASS)
2025	151 (FAIL)	0 (PASS)	0 (PASS)	0 (PASS)	0 (PASS)

Table 5: Estimated Energy Reserve Margin Percentage

Lowest Estimated Energy Reserve Margin Percentage					
Year	**Without** Future Generation and Storage Projects	**With** Future Generation and Storage Projects	**With** Future Generation and Storage Projects **Without** KES	**With** KES **Without** Future Generation and Storage Projects	High Peak Forecast **With** Future Generation and Storage Projects
2021	36%	36%	36%	36%	30%
2022	32%	46%	34%	44%	40%
2023	22%	44%	34%	32%	44%
2024	22%	48%	38%	32%	46%
2025	18%	42%	34%	30%	40%

4.2.2 Rule 1

Table 6 below 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 forecast scenario for each year through 2024 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. Rule 1 analysis does not include variable resources or future planned generation and storage projects.

Table 6: Rule 1 Analysis

Year	Rule 1 Results (MW)
2021	185
2022	230
2023	96
2024	4
2025	-54

4.2.3 Loss of Load Probability

Table 7 shows the results of the analysis. The system reliability in the scenarios shown varies depending on the firm generating units available, and the planned maintenance schedules. LOLP analysis does not include variable resources or future planned generation and storage projects.

Table 7: Generation System Reliability Guideline (years/day)

Year	Forecast Scenario
2021	7.7
2022	2.5
2023	0.3
2024	0.3
2025	0.2

Table 8, below, shows the reserve capacity surpluses or shortfalls corresponding to the calculated reliability shown in Table 7. 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 forecast scenario for 2023, the number -150 would indicate that about 150 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 8: Reserve Capacity Shortfall for forecast and planning scenarios (MW)

Year	Forecast Scenario
2021	20
2022	-30
2023	-150
2024	-140
2025	-180

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

5. Mitigation Measures for Near-Term Reserve Capacity Shortfall

As a result of projected reserve capacity shortfalls, Hawaiian Electric has considered a number of actions to minimize the risk of generation-related shortfalls. These include implementing expanded DR programs, refinement of maintenance schedules, issuing calls for conservation, and procurement of temporary generation and energy storage.

5.1. Procure Additional Grid Services

Hawaiian Electric is intending to issue a request for proposals to acquire additional grid services.

5.2. 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.

5.3. Call for Conservation

Hawaiian Electric may request voluntary customer curtailment of demand during capacity reserve shortfall conditions. However, because this is strictly voluntary, and the Company has no direct control in the implementation of this measure, it should not be considered as dependable as other measures. Also, the potential benefit of this option is likely to reduce over time, as increased customer participation in demand response programs becomes more common.

5.4. Temporary Generation

In the event that severe or prolonged reserve capacity shortfalls are anticipated, temporary emergency generators could be installed.

5.5. Energy Storage

Hawaiian Electric continues to pursue both paired renewable and grid energy storage opportunities.

6. Conclusions

Energy Reserve Margin criteria results indicate that the energy reserve margin target is satisfied from 2021 through 2025 with the addition of Hawaiian Electric's planned generation and storage project additions. New resources planned for Oʻahu are anticipated to meet energy reserve margin targets to mitigate the expiration of AES PPA.

Under differing scenarios the Energy Reserve Margin criteria are just satisfied in some cases and falls short in other cases. Because of uncertain risks such as project delays or higher loads due to faster economic recovery or warmer and more humid weather than forecasted, the Company is developing mitigation measures to increase the surety of adequate capacity through 2025.

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

Sincerely,

/s/ Kevin M. Katsura

Kevin M. Katsura
Director
Regulatory Non-Rate Proceedings

Attachments

c: Division of Consumer Advocacy (with Attachments)

Table A1:
Projected Reserve Margins for the Forecast 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)
2020	1,744	1,116	21	59%
2021	1,744	1,156	37	56%
2022	1,564	1,232	45	32%
2023	1,564	1,241	50	31%
2024	1,564	1,253	50	30%
2025	1,564	1,280	43	26%

Notes:

I. System Capability includes:

- Hawaiian Electric units at total normal capability in 2020 was 1,279.7 MW-net.
- Airport DSG (8 MW).
- Firm PPAs with a combined net total of 465.5 MW in 2020 from KPLP (208 MW), AES Hawaii (180 MW), and H-POWER (68.5 MW).
- KPLP assumed to continue in service after 2020.
- Schofield Generating Station (“SGS”) (49.4 MW).
- Following the addition of the SGS project in 2018, CIP CT-1 switched its primary fuel to diesel. The unit rating for CIP CT-1 consuming diesel increased from 113 MW to 129 MW.

II. System Peaks

- The 2021-2025 annual forecasted system peaks are based on Hawaiian Electric’s May 2020 S&P Forecast.
- The forecasted System Peaks for 2021-2025 include the estimated peak reduction benefits of third-party energy efficiency programs.
- The peak for 2021-2025 includes approximately 29 MW of stand-by load.
- The Hawaiian Electric annual forecasted system peak is expected to occur in the second half of the year.

III. Interruptible Load:

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

1. Capacity Planning Criteria

Increasing quantities of variable renewable resources, and planned energy storage additions to the system have driven the need to develop a capacity planning criteria that better accounts for the dynamic nature of such resources. The Energy Reserve Margin capacity planning criteria was developed and adopted by the Company in order to plan for our Island's future generation capability needs.

1.1 Energy Reserve Margin

Reliability planning criteria for utilities adequacy of supply evaluation varies among different jurisdictions, and includes criteria such as, but not limited to, loss of largest unit, loss of load expectation, expected unserved energy, loss of load probability, and reserve margin percentages. An Energy Reserve Margin, similar to a capacity reserve margin, was selected to establish guidelines that minimize the risk of insufficient generation capability from a diverse mix of generating resources. The Energy Reserve Margin can be summarized as the percentage by which the system capacity must exceed the system load in each hour. Using an Energy Reserve Margin planning criteria is intended to provide enough energy resources for safe and reliable service to customers and to serve future system needs.

1.2 Definitions

1.2.1 Available Unit

Unit which is capable of providing service, whether or not it is actually in service, regardless of the capacity level that can be provided.

1.2.2 Normal Net Capability Rating: (N1, N2, N3... NN)

a. For applicable firm capacity units such as steam units, combustion turbines, and internal combustion engines, this is the maximum net load the units are capable of carrying continuously on a day-to-day basis. This is the maximum net load to which the unit is normally dispatched.

b. Firm capacity provided by other suppliers is represented as generating units with net capability ratings, consistent with the intent of these definitions and applicable power purchase agreements.

1.2.3 Hourly Dependable Capacity

The Hourly Dependable Capacity ("HDC") is the minimum expected capacity from variable generation resources based on empirical data. In order to calculate an hourly variable renewable resource output with greater dependability for capacity planning purposes, a portion of the variance in the form of standard deviation is removed from historical average hourly production. These empirically derived values, also known as the Hourly Dependable Capacity, have a high probability of being exceeded by the amount of energy actually available to the system from a variable renewable resource in any given hour.

The number of standard deviations deducted is 2 for all solar resources, and 1 for all wind resources. The HDC (MW) is calculated for each hour as follows:

$$HDC_{hr} = \chi - N * \sigma,$$ where

χ = the mean,
σ = a standard deviation,
N = the number of standard deviations

1.2.4 Shifted Load

The energy charged and discharged by energy storage systems in each hour. Energy storage systems that shifts load include but are not limited to utility scale batteries and batteries paired with renewable resources. Shifted load may include customer owned energy storage systems that have the ability shift load per the terms of their particular tariff or distributed energy program.

1.2.5 Interruptible Load

The reduction of customer loads to support system capacity needs, for example, demand response programs that can reduce system load when needed, or tariffs that allow changes in load.

1.2.6 Energy Reserve Margin Target

The Energy Reserve Margin is the percentage of system load in which the system capacity must exceed the system load in each hour. The Energy Reserve Margin target for each island is listed in the table below.

Table A2: Energy Reserve Margin Targets

Island	Energy Reserve Margin
O‘ahu	30%
Hawai‘i	30%
Maui	30%
Moloka‘i	60%
Lana‘i	60%

Energy Reserve Margin targets are derived from an assessment of historical data. Identified at risk hours were evaluated to determine minimum Energy Reserve Margins for planning purposes. The loss of largest unit, multiple forced outages, and unplanned maintenance were some of the largest contributing factors for hours considered to be at-risk. Energy Reserve Margin targets plan for the loss of largest unit and an additional hourly reserve for emergencies.

The size of generating units on each island are contributing factors to energy reserve margin targets. For instance, on Molokai and Lanai, the largest generating units on the island have the capability to produce roughly 60% of each island's average daily energy usage. For comparison to the current planning criteria described above, which is to meet the peak load with the loss of the largest available unit, the 60% energy reserve margin target for Molokai and Lanai is to plan for resources that can generate enough energy throughout the day to meet the island's energy load without the largest available unit.

1.3 Generation Addition Rule

New generation will be added to prevent the violation of the rule listed below. The sum of the amount net capability ratings of all available units minus planned maintenance, plus Hourly Dependable Capacity, plus shifted load by energy storage, plus interruptible loads must be equal to or greater than the system hourly load multiplied by the quantity of one plus the Energy Reserve Margin.

$$\Sigma\,(N_i - \text{Maintenance} + \text{Hourly Dependable Capacity} + \text{Shifted Load} + \text{Interruptible Load}) \geq \text{System Hourly Load} * (1 + \text{Energy Reserve Margin})$$

The rule above, applies to resource planning in long-range generation expansion studies. The timing of generating resource additions should be examined using these rules as guides, with due consideration given to short-term operating conditions, equipment procurement, construction, financial and regulatory constraints.

Equivalent Demand Forced Outage Rate Definition and Formula

As defined in IEEE Std-762-2006,[8] Section 3.8:

Equivalent Demand Forced Outage Rate (EFORd): 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.

EFORd is defined in the North American Electric Reliability Corporation Generating Availability Data System Data Reporting Instructions,[9] Appendix F as:

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

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)

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

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**

[8] http://www.nerc.com/docs/pc/gadstf/ieee762tf/762-2006.pdf
[9] 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, solely based on 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, judgment, issues affecting aging generation including operation outside of original design parameters, and resource constraints. The forwarded looking EFORd are based on the 4 year EFORd averages for unit types with some exceptions as noted below. The 4 year average is appropriate because the majority of the flexible operations (low load operation and higher ramp rates) started in 2016. The units forward looking EFORd are as follows:

<u>Kahe 1-4 and Waiau 7-8:</u> 10%

The above units are all "small" reheat units operating under the same mission profile. These aging units range from 49 to 58 years of age and operate with higher ramp rates, operate under the variable pressure/low load operation, and cycle or will cycle when necessary. 14.4% EFORd represents the average 4 year EFORd average for these units but was adjusted down to 10% due to one time events and impacts on maintenance resulting from the COVID-19 pandemic in 2020.

<u>Kahe 5-6:</u> 7%

The above "large" reheat units operate under the same mission profile. These aging units range from 40 to 47 years of age are base loaded, operate many hours near minimum, and operate with enhanced ramp rates. 12.3% EFORd represents the average 4 year EFORd average for these units. EFORd was adjusted due to impacts on maintenance resulting from the COVID-19 pandemic in 2020.

<u>Waiau 3:</u> 25%

This 74 year old unit still starts over 100 times per year and operates as a "limited use" unit. The unit does not undergo normal overhauls or extensive maintenance. The 39% EFORd is based on the 4 year average EFORd for the unit. The unit is not averaged with other units because it is in materially different condition. EFORd adjusted due to impacts on maintenance resulting from the COVID-19 pandemic in 2020.

<u>Waiau 4:</u> 18%

This 71 year old unit still starts over 100 times per year and operates as a "limited use" unit. The unit does not undergo normal overhauls or extensive maintenance. The 16.1% EFORd is based on the 4 year average EFORd for the unit. The unit is not averaged with other units because it is in materially different condition.

<u>Waiau 5:</u> 12%

This 62 year old unit still starts over 200 times per year. The unit has chronic problems associated with an aging integrated steam chest. Its current forced outage rates are expected to remain the same. The 22% EFORd is based on the 4 year average EFORd for the unit. The unit is not averaged with other units because it is in materially different condition. Turbine steam chest leaks have been impacting unit reliability since 2017. Permanent repairs were completed in 2020 and expected to result in improved reliability. Therefore, EFORd has been adjusted accordingly.

Waiau 6: 7%

This 60 year old unit still starts over 200 times per year. The 6.5% EFORd is based on the 4 year average EFORd for the unit. Waiau 6 was not averaged with the "like unit" (Waiau 5) because of the material condition described under Waiau 5 above.

Waiau 9-10: 8.2%

The above combusting turbines are 48 years old and experience hundreds of starts per year. 10% EFORd represents the average 4 year EFORd average for these units. EFORd adjusted to account for the impacts to maintenance resulting from the COVID-19 pandemic in 2020.

CIP CT-1: 4.2%

This 12 year old unit has been experienced over 300 starts per year. 4.2% EFORd represents the 4 year average EFORd. CT-1 is a unique unit type and therefore not averaged with other units.

SGS Units 1-6: 2.0%

SGS is a new generating station commissioned in June 2018. High reliability is expected especially early commissioning issues have been addressed.