January 29, 2021

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

Dear Commissioners:

Subject: Adequacy of Supply
Hawaiʻi Electric Light Company, Inc.

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.*

2021 Adequacy of Supply Report Summary

- Hawaiʻi Electric Light Company, Inc's ("Hawaiʻi Electric Light" 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.

- Hawaiʻi Electric Light's Energy Reserve Margin target is satisfied for the next five years (2021-2025) and its generation capacity will be sufficient to meet reasonably expected demands for service and provide reasonable reserves for emergencies.

- The peak load experienced on Hawaiʻi Island in 2020 was 183.0 MW net, and was served by Hawaiʻi Electric Light's total firm generating capability of 235.3 MW net, including firm power purchases. This represents a firm generating reserve margin of approximately 28.6% over the 2020 system net peak.

1.0 Peak Demand and System Capability in 2020

Hawai‘i Electric Light’s 2020 system peak occurred on January 9,[1] at approximately 6:28 pm and was 183.0 MW-net based on system demand remaining after contribution from distributed generation.

Hawai‘i Electric Light’s 2020 total firm generating capability of 235.3 MW-net includes 58 MW from Hamakua Energy LLC (“HEP”) and 0 MW from Puna Geothermal Venture (“PGV”)[2].

The Hawai‘i Electric Light system had a generating reserve margin of approximately 28.6% over the 2020 system peak net demand based on firm generation resources[3]. This calculation does not include any variable generation sources (hydro, wind, solar).

2.0 Criteria to Evaluate Hawai‘i Electric Light’s Adequacy of Supply

Hawai‘i Electric Light’s capacity planning criteria are applied to determine the adequacy of supply – whether or not there is enough generating capacity on the system. Hawai‘i Electric Light’s capacity planning criteria take into account that the Company 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 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 variable resources and limited duration storage.[4] For the

[1] Hawai‘i Electric Light’s system peak in 2020 occurred in the month of January. Typically, Hawai‘i Electric Light’s system peaks have occurred in the month of December. For the purposes of this report, it is assumed that Hawai‘i Electric Light’s future annual system peak will occur in December.
[2] PGV had been offline since May 2018 due to volcanic activity that surrounded the facility and returned on November 5, 2020 with the expectation to be at full capacity by the middle of 2021.
[3] Refer to section 3.6., Table of Generating Unit Capacities, and Appendix 1, Table A1 for additional details.
[4] 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

purposes of this adequacy of supply report, Hawai‘i Electric Light used the Energy Reserve Margin planning criteria. Previous criteria is also presented, however, as discussed further below. Calculations for the previous criteria rely mainly on capacity contribution from traditional firm capacity thermal generators, since variable generation and limited duration resources do not translate accurately to criteria that focus on an annual system peak.

2.1 Energy Reserve Margin

The Energy Reserve Margin is the percentage by which the system capacity exceeds the system load in each hour. With the increasing quantities of variable renewable wind and solar resources, Hawai‘i Electric Light 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 target for Hawai‘i Electric Light 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 Previous Capacity Planning Criteria

In addition to the Energy Reserve Margin criteria, the following capacity planning criteria are used to determine the need for additional generation:

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 estimated system peak load, less the total amount of interruptible loads;

b. the capacity of the unit(s) scheduled for maintenance; and

c. the capacity that would be lost by the forced outage of the largest unit in service.

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% based on net ratings.

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 Hawai‘i Electric Light 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. the uncertainties surrounding new energy and generation resources;
5. transmission system considerations;
6. meeting environmental compliance standards; and
7. system reliability considerations for Hawai‘i Electric Light's isolated electrical system.

While meeting the planning criteria indicates a reasonable adequacy of supply, it is not equivalent to a guaranteed supply. As firm capacity resources are displaced to accommodate variable renewable energy, resource planning may need to include resource characteristics to mitigate adequacy of supply risks by having large amounts of offline reserves. This may include consideration of minimum fast-start capability and/or means to curtail demand on short notice. For example, in 2016, despite adequate supply based on the present criteria, Hawai‘i Electric Light experienced a generation shortfall when generation units at Keahole experienced forced outages while HEP was out of service for maintenance. There was insufficient time to bring online an additional unit such as the Puna steam unit to meet the evening peak, resulting in outages to certain customers for a two-hour period.

In the application of Hawai‘i Electric Light's capacity planning criteria, the inputs drive the results. Key inputs are described in the following sections.

3.0 Key Inputs to the 2021 Adequacy of Supply Analysis

3.1 Period Under Review

This adequacy of supply 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 Hawai‘i Electric Light'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 Hawai‘i Electric Light's June 2019 peak forecast

Figure 1: Recorded Peaks and Future Year Projections
(with Future Energy Efficiency and Customer PV Battery, but without DR & Rider M)

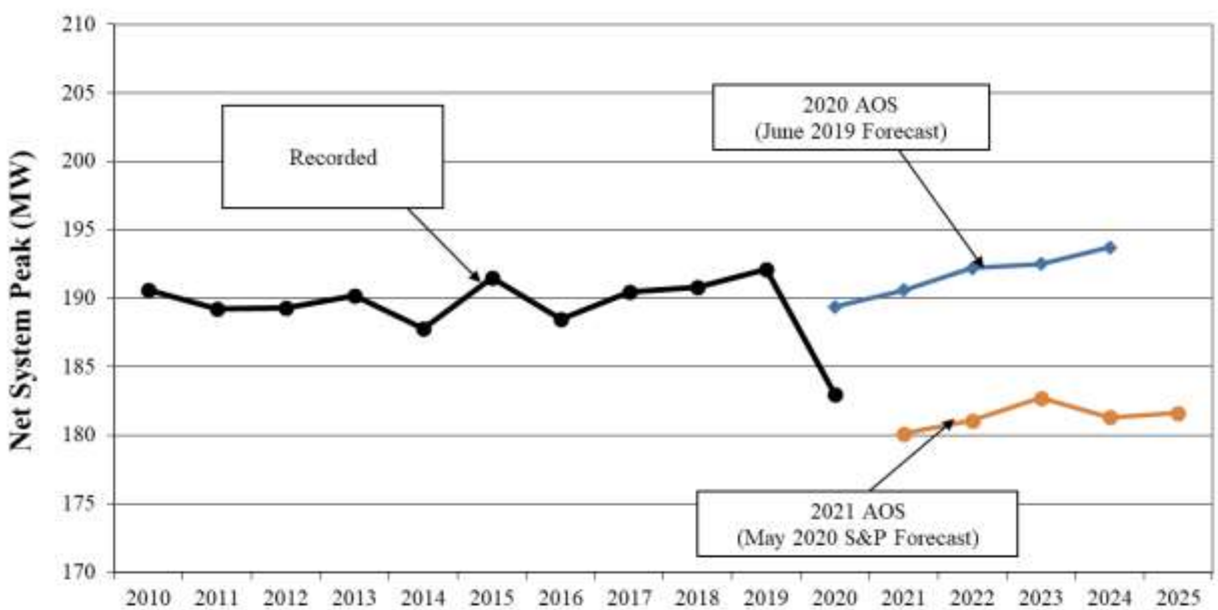

Figure 1 also includes estimated peak reduction benefits of energy efficiency programs and naturally occurring conservation. With the advent of storage technology (i.e., battery energy storage systems ("BESS")) for the consumer market, impacts of customer-sited PV paired with batteries were included 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.

Table 1 below provides the recorded peaks from 2010 and the forecasts used in Hawai‘i Electric Light’s 2020 and 2021 Adequacy of Supply analyses.

Table 1: Recorded Peaks and Future Year Projections

Net System Peak (MW) (with Future Energy Efficiency and Customer PV Battery, but without DR & Rider M)			
Year	Actual	June 2019 S&P	May 2020 S&P
2010	190.6		
2011	189.2		
2012	189.3		
2013	190.2		
2014	187.8		
2015	191.5		
2016	188.5		
2017	190.5		
2018	190.8		
2019	192.1		
2020	183.0	189.4	
2021		190.6	180.1
2022		192.2	181.1
2023		192.5	182.7
2024		193.7	181.3
2025			181.6

3.3 Projected Peak Reduction Benefits of Demand Response Programs

Hawai‘i Electric Light is committed to pursuing demand response (“DR”) programs designed to provide cost-effective resource options to meet capacity needs and support the reliable operation of the system, as identified in the Hawaiian Electric Companies Integrated Demand Response Portfolio Plan.[5]

In 2015, the Hawaiian Electric Companies submitted to the Commission an application for approval of a DR Portfolio in Docket No. 2015-0412. A Revised DR Portfolio was filed on February 10, 2017, which provided modified approval requests and DR program design and targets consistent with the DR Portfolio used in the *PSIP Update Report: December 2016*. On January 25, 2018 the

[5] Refer to Docket No. 2007-0341.

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, Hawai‘i Electric Light's adequacy of supply was calculated using the estimated DR impacts shown in Table 2 below.

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

Year	DR Total at Year End
2021	1.6
2022	3.3
2023	4.0
2024	4.0
2025	4.0

3.4 Planned Maintenance Schedules for the Generating Units on the System

Planned overhauls 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, or unplanned outages impact the available margins, the Planned Maintenance Schedule is revised with outages deferred (or reduced) to the extent possible, to meet the operational planning criteria of having sufficient available capacity, including offline capacity available within two hours or less, to serve anticipated demand, after loss of the largest operating unit. For this analysis, the 5-year planned maintenance schedule was developed in 2020 for company planning purposes, with some updates made in January 2021.

3.5 Additions of Capacity

3.5.1 Firm Capacity Additions

On July 9, September 9, and October 1, 2020 in Decision and Order Nos. 37205, 37306, and 37335 respectively, the Commission denied Hawai‘i Electric Light's request for a waiver from the Competitive Bidding Framework in Docket 2017-0122 for Approval of an Amended and Restated Power Purchase Agreement with Hu Honua, denied its motion for reconsideration, and closed the docket. The capacity from Hu Honua was not included in the analysis.

On December 31, 2019, Hawaiʻi Electric Light filed an application For Approval of an Amended and Restated Power Purchase Agreement for Firm Capacity Renewable Dispatchable Generation with Puna Geothermal Venture, in Docket 2019-0333. As of January 29, 2021, the Commission has not made a decision on this application. Among other things, this application includes an increase in the capacity of PGV by 8 MW. This additional capacity was not included in the analysis. PGV is presently returning to service from the lava flow outage that occurred in 2018. For the purposes of this analysis, the PGV facility was assumed to start 2021 rated at 15 MW, and ramp up to its full capability (38 MW) by July 2021.

3.5.2 Non-Firm Resource Additions

In January 2017, Hawaiʻi Electric Light filed a letter with the Commission requesting to open a docket to solicit proposals for new renewable generation. The Commission subsequently issued Order No. 34856 and opened Docket No. 2017-0352 to receive filings, review approval requests, and resolve disputes, if necessary, related to the plan to proceed with competitive procurement of this generation. Request for Proposals ("RFPs") for the above docket were separated into 2 phases.

In phase 1, on December 31, 2018 the Company submitted to the Commission applications for approval of power purchase agreements for two solar projects with storage on Hawaiʻi Island. On March 25, 2019, in Decision and Order Nos. 36233 and 36234 under Docket 2018-0430 and Docket 2018-0432 respectively, the Commission approved two Power Purchase Agreements, between the Company, AES Waikoloa Solar, and Hale Kuawehi Solar, LLC, for two 30 MW/120 MWh PV/BESS projects. These systems are anticipated to be installed and operational by the end of 2022.

In phase 2, on November 13, 2020 under Docket 2020-0189, the Company submitted to the Commission an application for approval of power purchase agreement between the Company and ENGIE 2020 ProjectCo-HI1, LLC, for a 60 MW/240 MWh PV/BESS project which is anticipated to be operational by end of 2023.

RFP projects can provide additional energy and capacity on the system. Although these RFP projects were not included in the calculation of Rule 1, they are included in Energy Reserve Margin calculations.

3.6 Table of Generating Unit Capacities

Table 3: Hawai‘i Electric Light Adequacy of Supply 2020 Unit Ratings
(Firm Capacity at ACTUAL System Peak in January 2020)
(Net MW)

Unit	**Net Rating (MW)**
Hill 5	13.80
Hill 6	20.20
Puna	15.70
Kanoelehua D11	2.00
Waimea D12	2.50
Waimea D13	2.50
Waimea D14	2.50
Kanoelehua D15	2.50
Kanoelehua D16	2.50
Kanoelehua D17	2.50
Keahole D21	2.50
Keahole D22	2.50
Keahole D23	2.50
Kanoelehua CT1	10.25
Keahole CT2	13.80
Puna CT3	20.00
Keahole CT4/CT-5/ST-7	54.00
Panaewa D24	1.25
Ouli D25	1.25
Punaluu D26	1.25
Kapua D27	1.25
HELCO total	**177.25**
PGV	0.00
HEP	58.00
IPP Total	**58.00**
System total	**235.25**

4.0 Results of Analysis

4.1 Description of Scenarios

In capacity planning, uncertainty is an important aspect. Therefore, for Energy Reserve Margin analysis, two scenarios were analyzed, and both scenarios include the contributions from existing variable renewable resources

- without planned generation and storage projects described in Section 3.5.2.
- 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.

4.2 Energy Reserve Margin

With the assumed return of PGV in 2021, Hawaiʻi Electric Light's target of 30% Energy Reserve Margin is met for 2021-2025, with Hourly Dependable Capacities applied to all variable renewable resources. As shown in Tables 4 and 5 below, the Energy Reserve Margin criteria is met with or without the addition of Stage 1 or 2 RFP resources.

Table 4: Energy Reserve Margin Shortfall Hours

Number of Hours Below ERM Target (Pass/Fail 30% Criteria)		
Year	**With** Future Generation and Storage Projects	**Without** Future Generation and Storage Projects
2021	0 (PASS)	0 (PASS)
2022	0 (PASS)	0 (PASS)
2023	0 (PASS)	0 (PASS)
2024	0 (PASS)	0 (PASS)
2025	0 (PASS)	0 (PASS)

Table 5: Estimated Reserve Margin %

Lowest Estimated Energy Reserve Margin Percentage		
Year	**With** Future Generation and Storage Projects	**Without** Future Generation and Storage Projects
2021	30%	30%
2022	30%	30%
2023	64%	40%
2024	66%	34%
2025	66%	42%

4.3 Rule 1

With the assumed return of PGV in 2021, Rule 1 is met for 2021-2025, without assuming any capacity credit from variable generation, or the peak reduction benefits of DR.

4.4 Reserve Margin

Table A1 in Appendix 1 shows the expected generation reserve margins over the next five years, 2021-2025. Reserve margin values are calculated with estimated capacity credit for variable generation and peak reduction benefits of DR.

5.0 Conclusion

Hawai‘i Electric Light’s generation capacity for the next five years (2021-2025) will be sufficient to meet reasonably expected demands for service and provide reasonable reserves for emergencies.

Sincerely,

/s/ Kevin M. Katsura

Kevin M. Katsura
Director
Regulatory Non-Rate Proceedings

Attachments

c: Division of Consumer Advocacy (with Attachments)

Table A1: Reserve Margin

Year	System Capability at Annual Peak Load (net MW) [A] III, IV, V, VI	System Peak (net MW) [B] I, II	Demand Response (DR) (net MW) [C]	Variable Generation (net MW) [D]	Reserve Margin w/DR & Var. Gen. (%) [A+D-(B-C)] / (B-C)
2020	235.3	183.0	0.0	2.62	30.0%
2021	273.3	180.1	1.6	2.62	54.5%
2022	273.3	181.1	3.3	2.62	55.2%
2023	273.3	182.7	4.0	2.62	54.4%
2024	273.3	181.3	4.0	2.62	55.6%
2025	273.3	181.6	4.0	2.62	55.3%

Notes:

(I) System Peaks – The 2021-2025 annual forecasted system peaks are based on:

- Hawai‘i Electric Light's May 2020 Forecast. The annual forecasted system peak is expected to occur in the month of December.

(II) System Peaks (Recorded):

- The recorded system peak for 2020 includes the actual peak reduction benefit of the acquired energy efficiency programs and the Rider M and Schedule U contracts.

(III) System Capability for 2020 included:

- Hawai‘i Electric Light units at a total of 177.25 MW net.
- Firm independent power purchase contracts with a net total of 58 MW, from HEP and 0 MW from PGV at the time of system peak.

(IV) System Capability for 2021 includes:

- Hawai‘i Electric Light units at a total of 177.25 MW net.
- Firm independent power purchase contracts with a combined net total of 96.0 MW, from HEP (58.0 MW) and PGV (38.0 MW).

(V) System Capability for 2022 thru 2025 includes:

- Hawaiʻi Electric Light units at a total of 177.25 MW net.

- Firm independent power purchase contracts with a combined net total of 96.0 MW, from HEP (58.0 MW) and PGV (38.0 MW).

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 Net Rating: (N_1, N_2, N_3... N_N)

a. For applicable firm capacity units such as steam units, combustion turbines, and internal combustion engines, this is the maximum net load which the units are capable of carrying continuously on a day-to-day basis, and the maximum net load to which the unit is normally dispatched.
b. Firm capacity provided by independent power producers 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 by which the system capacity exceeds it 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 Margins 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 allow for the loss of largest unit and provide 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.