Stage 3 O‘ahu & Maui Request for Proposals

Technical Conference
August 5, 2022

Mahalo for joining us! We’ll start promptly at 1 p.m.

Stage 3 O‘ahu & Maui Request For Proposals

Technical Status Conference

August 5, 2022

Your input is important

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Click "Raise Hand"

***5 by phone**

Please mute your audio when not speaking.

REC This meeting is being recorded.

Purpose and Objective

- Provide information to prospective proposers regarding the Stage 3 O‘ahu & Maui Request for Proposals
- Review O‘ahu and Maui Grid Needs Assessment
- Answer questions and receive feedback

Agenda

- Scope of RFPs
- O‘ahu and Maui Grid Needs Assessment
- RFP Process
- Next Steps
- Questions

Hawaiian Electric

Stage 3 O‘ahu & Maui

Scope of the RFPs

O‘ahu Stage 3 RFP Highlights

O‘ahu Island

Firm and Variable Renewable Projects

- Minimum 928 Gigawatt hours of Renewable Dispatchable Generation (RDG)
- 500-700 Megawatts of firm capacity

- RDG in operation by 2027
- Firm in operation by 2029 and 2033

Maui Stage 3 RFP Highlights

Maui Island

Firm and Variable Renewable Projects

- Minimum 349 Gigawatt hours of Renewable Dispatchable Generation (RDG)
- 40 Megawatts of firm capacity

- RDG in operation by 2027
- Firm in operation by 2027 or later

Hawaiian Electric

Grid Needs Assessment

Executive Summary – Near-term GNA Objectives

Objectives of this assessment include:

- Develop resource portfolios that meet near-term RPS and GHG reduction goals and put Maui and Oahu in an advantageous position to meet longer-term RPS and GHG goals
- Add new low-cost renewable dispatchable generation (wind, solar, battery energy storage) to further decarbonize the electric sector
- Improve generation reliability through the careful replacement of existing firm generation with the right mix of variable renewables and energy storage backed by renewable firm generation
    - On O‘ahu, aging generation infrastructure needs to be modernized with a fleet of more flexible resources to complement wind, solar, and battery energy storage projects
    - On Maui, a balanced portfolio of resources is needed to be in service by 2027 to ensure system reliability and mitigate the removal of up to 80 MW of firm thermal generation
- Acquire more flexibility for the current and future generation system, building upon the recently acquired renewable dispatchable solar generation and aggregated grid services
- Diversify the type and geography of the resource portfolio to be more resilient
- Inform Stage 3 procurement and Company contingency plans

Stage 3 RFP Targets

Stage 3 RFP Energy or Variable Renewable Target[1] (GWh)	O‘ahu	Hawai‘i Island	Maui
Proposed Target in RFP Draft	475 GWh by 2027 – remaining replacement energy for AES Coal	325 GWh by 2030	180 GWh by 2027
Adjustment for GNA results	544 (+69 GWh) by 2027 – increased for Land Constrained resource potential of 270 MW; also provides buffer to offset AES energy	N/A – already includes upward adjustment for Puako Solar which was declared null and void	240 GWh (+60 GWh) by 2027 – increased for latest Maui base case results, 60 MW of wind selected by RESOLVE by 2030
Adjustments for Existing or Withdrawn S1/S2 Projects	Mahi – 272 GWh Kupehau – 112 GWh	Puako Solar already included	Pulehu – 109 GWh
Revised Target	**928 GWh** (544 + 272 + 112 GWh)	**No change** to 325 GWh target.	**349 GWh** (240 + 109 GWh)

Stage 3 RFP Capacity or Renewable Firm Target[1] (MW)	O‘ahu	Hawai‘i Island	Maui
Proposed Target in RFP Draft	300 to 500 MW by 2029 200 MW by 2033	65 MW by 2030	40 MW by 2027

Firm generation refers to a synchronous machine based technology that is available at any time under system operator dispatch for as long as needed, except during periods of outage and deration, and is not energy limited or weather dependent.

1. O‘ahu and Maui have specific targets for variable renewable and renewable firm resources. Hawai‘i Island has targets for energy and capacity that could be met with a broader resource portfolio.

Stakeholder feedback on the O‘ahu draft was addressed in the final O‘ahu and Maui GNAs

Clarify the near-term action plan and include references to other related proceedings.

- References were included to the appropriate dockets where certain actions in the Action Plan would take place

Focus on renewables and discuss the role of new dispatchable generation including offshore wind.

- Targets for new low cost, renewable dispatchable generation in the Stage 3 RFP that were identified in the GNA analyses were emphasized

Clarify the role of customer resources to meet grid needs including how new resources and programs such as distributed energy resources and demand response can provide capacity.

- Additional discussion of the customer technology adoption that is forecasted to reduce grid needs, including DER that was modeled as a flexible resource, was added

Clarify how the technical analyses were used to inform the procurement targets

- Clear explanation was provided to link the ERM and probabilistic resource adequacy technical analyses to the procurement targets
- Additional probabilistic resource adequacy analyses were performed to specifically analyze varying amounts of new paired renewable, new firm capacity, long and short duration storage, adjusted thermal unit removal schedules, frozen DER and EE levels (O‘ahu), and offshore wind (O‘ahu).

Oahu Grid Needs Assessment

O‘ahu GNA Overview

- Near-Term Action Plan
- Bookend Modeling Scenarios
- Customer Technology Forecast
- RESOLVE Resource Plan
- ERM Reliability Analysis
- Probabilistic Resource Adequacy Analysis
- Unserved Energy Heat Map

O‘ahu GNA: Near-term Action Plan

- Continue to displace fossil-fuel
- Continue to pursue customer adoption of DER
- Pursue generation modernization
  - Acquisition of firm generation must start today given the length of time required to develop projects.
- Pursue development of renewable energy zones
- Consider procurement of energy efficiency to accelerate adoption in amounts up to the forecasted target to reduce supply side needs.
- Continue to pursue managed EV charging programs, time-of-use rates, DER, and energy efficiency.
- Incorporate system security and system stability analyses as part of IGP
- Pursue procurement(s) as part of the IGP solution sourcing process

O'ahu GNA: A variety of scenarios were modeled in RESOLVE to capture load and resource availability bookends.

- **Base Scenario Assumptions**–
  - The base set of IGP sales and fuel price forecasts, in-service of the Stage 1 and 2 RFPs, CBRE RFP and GSPA projects.
  - Existing power purchase agreements terminate at the end of their current contract term.
  - New variable renewable resources are allowed to be built up to the NREL Alt-1 resource potential.
  - Certain existing fossil-fuel generating units are assumed to be removed from service.
- **Low Load Scenario Assumptions**–
  - The set of IGP sales forecasts that reduce customer demand including the high Distributed Energy Resource (DER), high Energy Efficiency (EE), and low Electric Vehicle (EV) forecasts.
  - Together, these forecast layers provide a low load to bookend or bound future, plausible demand that Hawaiian Electric should plan to serve.
  - Other planning assumptions follow the Base Scenario.
- **High Load Scenario Assumptions**–
  - The set of IGP sales forecasts that increase customer demand including the low DER, low EE, and high EV forecasts.
  - Together, these forecast layers provide a high load to bookend or bound future, plausible demand that Hawaiian Electric should plan to serve.
  - Other planning assumptions follow the Base Scenario.
- **Land Constrained Scenario Assumptions**–
  - Reduced resource capacities in this scenario are based on stakeholder feedback and represent what the Company believes can be added before needing additional infrastructure for REZ that will require an extensive community engagement process.
  - Using the Base Case, future grid-scale solar was assumed to have a reduced resource potential capacity of 270 MW and offshore wind was assumed to have a potential capacity of 400 MW. Biomass and onshore wind are assumed to be unavailable.

O‘ahu GNA: Customer-sited and grid-scale renewables were analyzed in the bookend cases.

Driver	Base and Land Constrained	High Load	Low Load
EE	Base	Low	High
DER/DBESS	Base	Low	High
EV	Base	High	Low
EV Charging Shape	Managed	Unmanaged	Managed
Non-DER, Non-EV TOU	Base	Low	High

Resource (MW)	Base High Load Low Load	Land Constrained
Solar	3,300	270
Onshore Wind	164	0
Offshore Wind	600	400
Biomass	No Limit	0
Biofuel	No Limit	No Limit

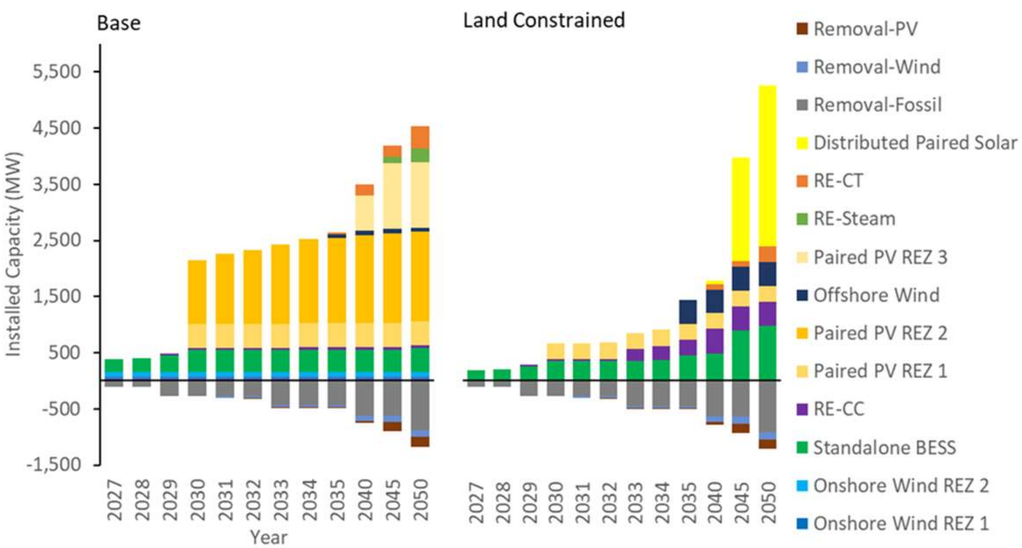
O‘ahu GNA: Customer adoption of EE, EV, DER, and TOU rates continues to be a priority to meet grid needs.

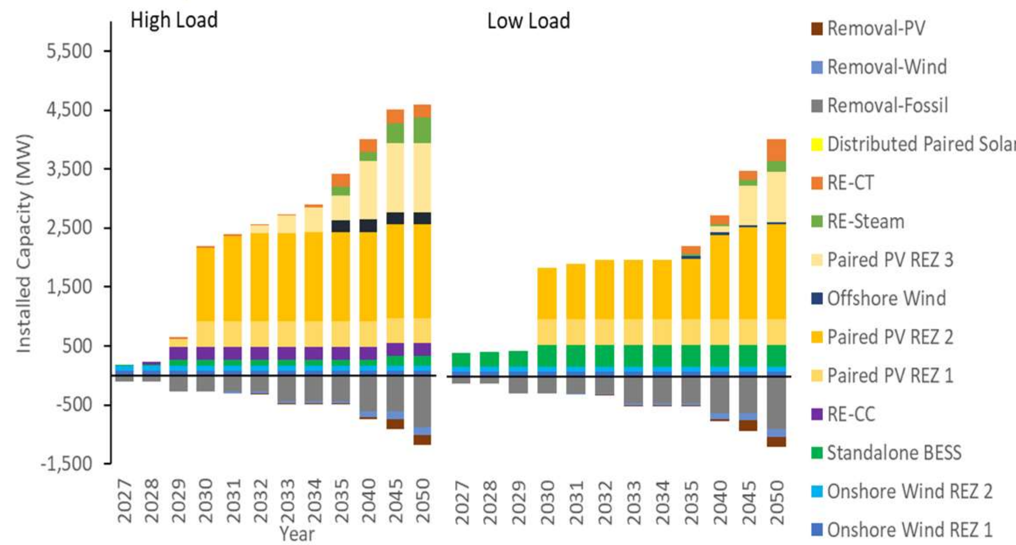
2030 Customer Technology (incremental from 2021 levels)	Peak Load Impact (MW)	Impact to Sales (GWh)	Approximate Quantity
Energy Efficiency	145	1,014	N/A
Electric Vehicles	29	183	43,536 EVs
Private Rooftop Solar	253 (Installed Capacity)	437	26,292 systems
Private BESS	149 MW / 394 MWh (Installed Capacity)	-14	26,261 systems
Non-DER/EV Time-of-Use	4	N/A	N/A

Customer technology adoption is considered first in meeting grid needs. Procurement targets identified through the GNA analyses are to meet the residual grid needs after accounting for forecasted EE, EV, DER, and non-DER/EV TOU. Battery bonus, grid services aggregation, and future DER programs will provide additional flexibility to contribute to grid energy and capacity needs. These customer resources when acquired cost-effectively are critical to meeting the needs of the grid.

Further analyses can be completed during the solution sourcing phase of IGP to identify appropriate incentives to design new programs that achieve the forecasted amounts of DER and EE, i.e., evaluate the “freeze” cases.

O‘ahu GNA: New renewable resources are consistently selected in high amounts over the near term.
Renewable firm additions increase with higher assumed load.

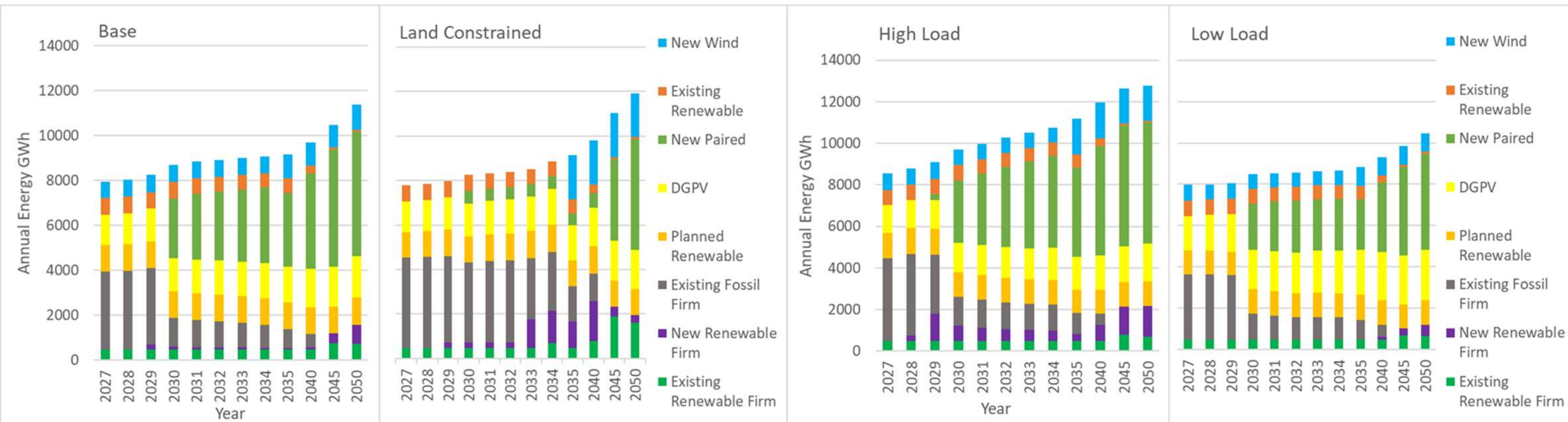




Cumulative Incremental Installed Capacity

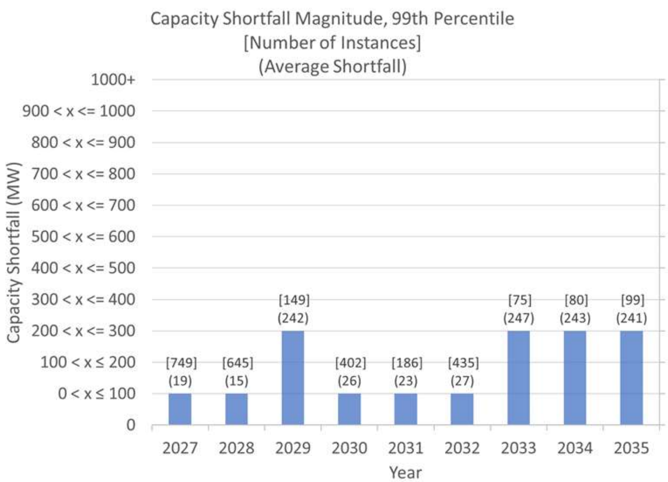
IGP utilizes a market-based approach for solution sourcing that integrates procurements with programs. As the Consumer Advocate stated, “any resulting plan is meant to represent a strategy or general plan and that, depending on facts (e.g., system needs, market prices, etc.) available at the time that any resource decision needs to be made, the adopted IGP plan would only represent a guide”

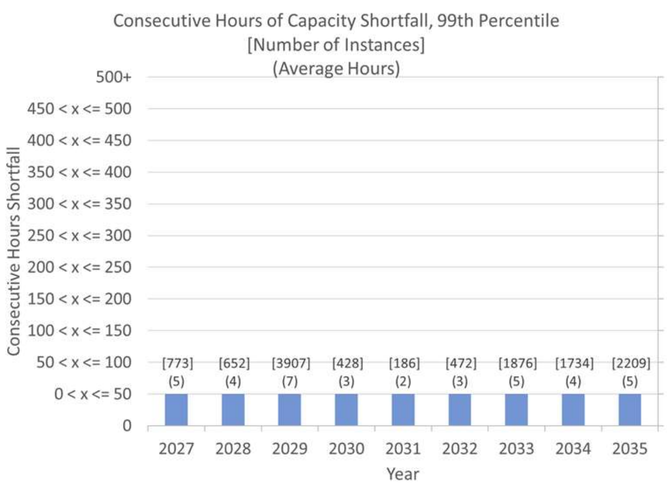
O'ahu GNA: DER, planned, and future renewables plus storage serve the majority of load and new renewable firm resources are dispatched minimally, except in the Land Constrained scenario where resource options are more limited.



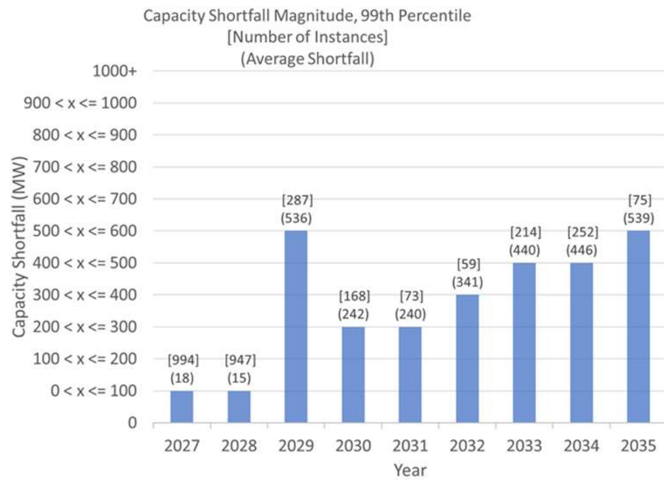
O'ahu GNA: The ERM criteria identified long duration shortfalls that worsened with the removal of KPLP and Mahi.

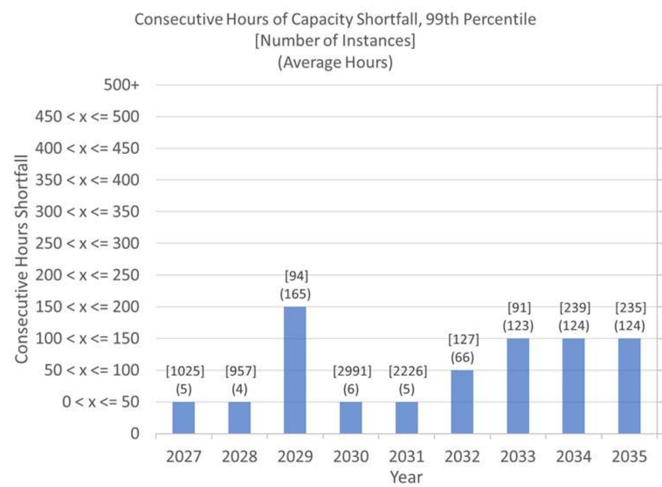
Base





Base_NoKPLP_NoMahi



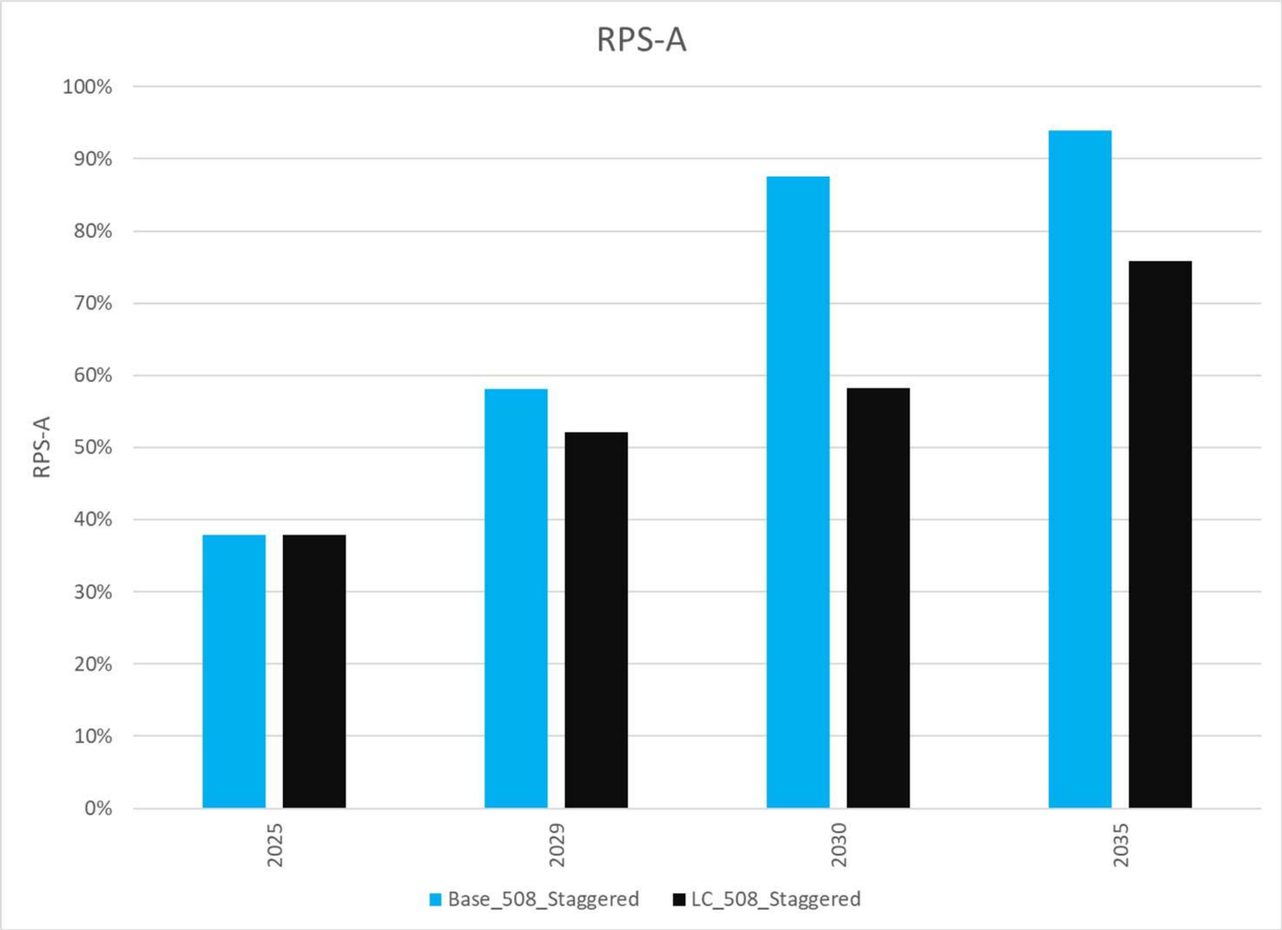


Based on the magnitude and duration of the ERM shortfalls, 500 – 700 MW of firm generation was added to the resource plan to achieve resource adequacy.

The timing of the firm generation was staggered, 300 – 500 MW was added in 2029 and 200 MW in 2033, to reduce execution and contracting risks.

These resource plans were tested using a probabilistic resource adequacy analysis to validate the firm generation additions.

O‘ahu GNA: High levels of RPS are achieved above mandates, even in the Land Constrained scenario.



O‘ahu GNA: A wide range of probabilistic analyses were conducted to examine the reliability impact of various resource types.

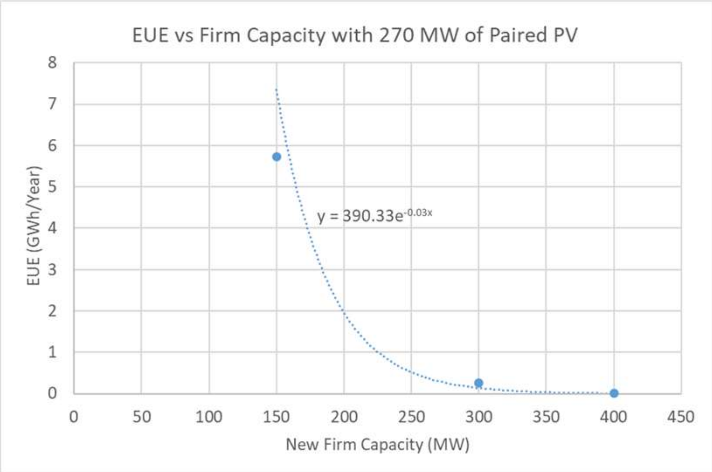
- **Recent Outage Rates Trend Analysis**
- **Firm Generation Sensitivity**
- **Firm Capacity Based on Paired Renewable**
- **Long-Duration Energy Storage**
- **Deactivation Sensitivity**
- **Load Sensitivity**
- **DER/DR Freeze Sensitivity**
- **Additional DER/DR Resource**
- **Accelerated Offshore Wind**
- **Planning for Extreme Events**

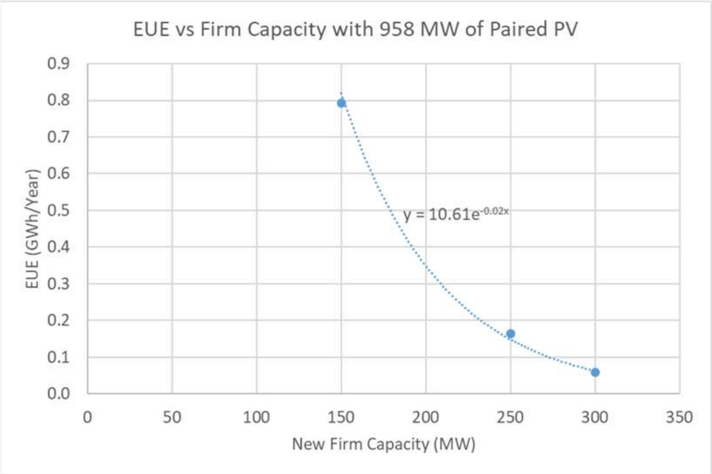
O‘ahu GNA: The amount of new firm generation needed varied with assumed PV+BESS amounts and was less than a 1:1 replacement.

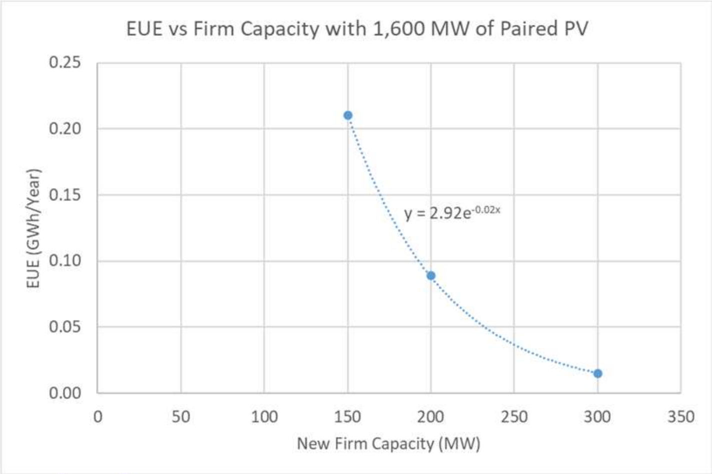
Green = LOLE ≤ 0.10 Days/Yr (US Mainland), LOLH ≤ 3 hrs (Belgium, France, GB, Poland), EUE ≤ 0.002% of load/0.137 GWh (AEMO)

Year 2029	Existing Firm (MW)	New Firm (MW)	New Paired PV (MW)	New Onshore Wind (MW)	New Offshore Wind (MW)	LOLE (Days/Yr)	LOLEv (Events/Yr)	LOLH (Hours/Yr)	EUE (GWh/Yr)
270 MW Paired PV+BESS									
Base_150_270PVB_0Wnd_Mar22Out	970	150	270	0	0	9.25	17.75	42.42	5.74
Base_300_270PVB_0Wnd_Mar22Out	970	300	270	0	0	0.66	1.18	2.47	0.26
Base_400_270PVB_0Wnd_Mar22Out	970	400	270	0	0	0.04	0.05	0.09	0.01
Curve Fit – 270PVB	**970**	**300**	**270**	**0**	**0**	**N/A**	**N/A**	**N/A**	**0.137**
958 MW Paired PV+BESS									
Base_150_958PVB_Mar22Out	970	150	958	163	0	0.98	1.98	4.12	0.79
Base_250_958PVB_Mar22Out	970	250	958	163	0	0.18	0.42	0.87	0.16
Base_300_958PVB_Mar22Out	970	300	958	163	0	0.08	0.20	0.37	0.06
Curve Fit – 958PVB	**970**	**255**	**958**	**163**	**0**	**N/A**	**N/A**	**N/A**	**0.137**
1600 MW Paired PV+BESS									
Base_150_1600PVB_Mar22Out	970	150	1,600	163	0	0.22	0.49	0.84	0.21
Base_200_1600PVB_Mar22Out	970	200	1,600	163	0	0.08	0.18	0.34	0.09
Base_300_1600PVB_Mar22Out	970	300	1,600	163	0	0.01	0.04	0.07	0.02
Curve Fit – 1600PVB	**970**	**175**	**1,600**	**163**	**0**	**N/A**	**N/A**	**N/A**	**0.137**

O‘ahu GNA: A curve fit of the probabilistic results to an EUE standard still identified a need for new firm resources, even with 1,600 MW of PV+BESS above planned S1/S2/CBRE projects.



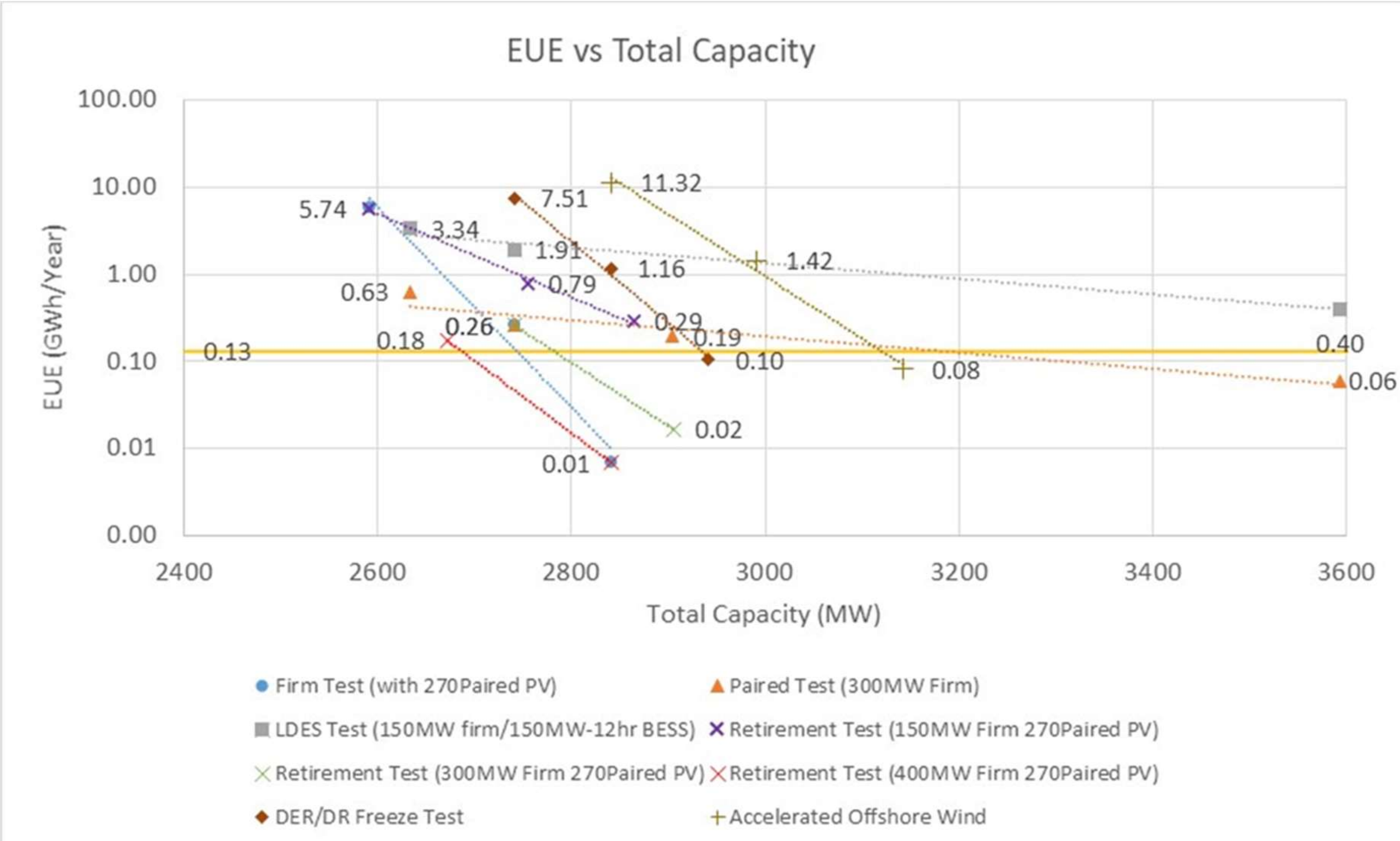




Since the curve fit is an approximation of the firm need based on results of the explicitly modeled cases, it may overstate/understate the firm need e.g. 300 MW of firm generation with 270 MW of paired PV will be unreliable according to results from the explicitly modeled case. Also, curve fitting using LOLE will likely be a more stringent standard and require additional firm capacity. However, the curve fitting provides directional guidance on the trends in firm capacity needed at different PV+BESS levels.

Year 2029	Existing Firm (MW)	New Firm (MW)	New Paired PV (MW)	New Onshore Wind (MW)	New Offshore Wind (MW)	EUE (GWh/ Yr)
Curve Fit – 270PVB	970	300	270	0	0	0.137
Curve Fit – 958PVB	970	255	958	163	0	0.137
Curve Fit – 1600PVB	970	175	1,600	163	0	0.137

O‘ahu GNA: All resources additions improved reliability but to varying degrees based on resource type and installed amount.



O‘ahu GNA: Reliable resource plans generally included some amount of new firm thermal generation. Higher amounts of firm generation may be reasonable to address uncertainty in load and timely in-service of variable renewable projects.

Green = LOLE ≤ 0.10 Days/Yr (US Mainland), LOLH ≤ 3 hrs (Belgium, France, GB, Poland), EUE ≤ 0.002% of load/0.137 GWh (AEMO)

Year 2029	Existing Firm (MW)	New Firm (MW)	New Paired PV (MW)	New Onshore Wind (MW)	New Offshore Wind (MW)	LOLE (Days/Yr)	LOLEv (Events/Yr)	LOLH (Hours/Yr)	EUE (GWh/Yr)
Base_300_270PVB_0Wd_170HE_Mar22Out	1,135	300	270	0	0	0.09	0.16	0.22	0.02
Base_400_270PVB_0Wnd_Mar22Out	970	400	270	0	0	0.04	0.05	0.09	0.01
Base_300_958PVB_Mar22Out	970	300	958	163	0	0.08	0.20	0.37	0.06
Base_200_1600PVB_Mar22Out	970	200	1,600	163	0	0.08	0.18	0.34	0.09
Base_300_1600PVB_Mar22Out	970	300	1,600	163	0	0.01	0.04	0.07	0.02
Base_250_958PVB_Mar22Out	970	250	958	163	0	0.18	0.42	0.87	0.16
Base_300_270PVB_400OSW_Mar22Out	970	300	270	0	400	0.18	0.34	0.74	0.08

O‘ahu GNA: The freeze case for DER and EE, long and short duration energy storage, and offshore wind were also examined in the same probabilistic framework.

Green = LOLE ≤ 0.10 Days/Yr (US Mainland), LOLH ≤ 3 hrs (Belgium, France, GB, Poland), EUE ≤ 0.002% of load/0.137 GWh (AEMO)

Year 2029	Existing Firm (MW)	New Firm (MW)	New Paired PV (MW)	New Onshore Wind (MW)	New Offshore Wind (MW)	New Standalone BESS (MW/MWh)	LOLE (Days/Yr)	LOLEv (Events/Yr)	LOLH (Hours/Yr)	EUE (GWh/Yr)
DER / DR Freeze Sensitivity										
Base_300_270PVB_0Wd_ Fze_Mar22Out	970	300	270	0	0	287 / 539	10.08	19.78	54.84	7.51
Base_400_270PVB_0Wd_ Fze_Mar22Out	970	400	270	0	0	287 / 539	2.31	4.30	10.28	1.16
Base_500_270PVB_0Wd_ Fze_Mar22Out	970	500	270	0	0	287 / 539	0.31	0.58	1.12	0.10
Long / Short-Duration Energy Storage										
Base_300_270PVB_ 0Wd_Mar22Out	970	300	270	0	0	287 / 539	0.66	1.18	2.47	0.26
Base_150_ 150MW2hrSaB_ 270PVB_0Wd_Mar22Out	970	150	270	0	0	437 / 839	6.96	13.37	31.32	4.49
Base_150_ 150MW12hrSaB_ 270PVB_0Wd_Mar22Out	970	150	270	0	0	437 / 2,339	2.48	5.16	12.17	1.91
Accelerated Offshore Wind										
Base_270PVB_400OSW_ Mar22Out	970	0	270	0	400	287 / 539	12.14	21.96	69.56	11.32
Base_400_270PVB_ 0Wnd_Mar22Out	970	400	270	0	0	287 / 539	0.04	0.05	0.09	0.01

O‘ahu GNA: Additional cases were run at the high and low load bookend with 300 MW of new firm generation.

Green = LOLE ≤ 0.10 Days/Yr (US Mainland), LOLH ≤ 3 hrs (Belgium, France, GB, Poland), EUE ≤ 0.002% of load/0.137 GWh (AEMO)

Year 2029	Existing Firm (MW)	New Firm (MW)	New Paired PV (MW)	New Onshore Wind (MW)	New Offshore Wind (MW)	New Standalone BESS (MW/MWh)	LOLE (Days/Yr)	LOLEv (Events/Yr)	LOLH (Hours/Yr)	EUE (GWh/Yr)
Load Sensitivity (300 MW New Firm)										
High Load										
Base_300_270PVB_0Wd_Mar22Out_HiLd	970	300	270	0	0	287 / 539	10.10	19.42	48.01	6.95
Base_300_270PVB_0Wd_170HE_Mar22Out_HiLd	1,135	300	270	0	0	287 / 539	2.63	4.61	11.04	1.56
Base_300_270PVB_0Wd_280HE_Mar22Out_HiLd	1,243	300	270	0	0	287 / 539	1.00	1.82	4.02	0.54
Low Load										
Base_300_270PVB_0Wd_Mar22Out_LwLd	970	300	270	0	0	287 / 539	0.26	0.48	0.99	0.12
Base_300_270PVB_0Wd_wo170HE_Mar22Out_LwLd	801	300	270	0	0	287 / 539	1.51	3.012	5.91	0.66

O‘ahu GNA: Additional cases were run at the high and low load bookend with 400 MW of new firm generation.

Green = LOLE ≤ 0.10 Days/Yr (US Mainland), LOLH ≤ 3 hrs (Belgium, France, GB, Poland), EUE ≤ 0.002% of load/0.137 GWh (AEMO)

Year 2029	Existing Firm (MW)	New Firm (MW)	New Paired PV (MW)	New Onshore Wind (MW)	New Offshore Wind (MW)	New Standalone BESS (MW/MWh)	LOLE (Days/Yr)	LOLEv (Events/Yr)	LOLH (Hours/Yr)	EUE (GWh/Yr)
Load Sensitivity (400 MW New Firm)										
High Load										
Base_400_270PVB_0Wd_Mar22Out_HiLd	970	400	270	0	0	287 / 539	2.52	4.63	10.49	1.37
Base_400_270PVB_0Wd_170HE_Mar22Out_HiLd	1,135	400	270	0	0	287 / 539	0.65	1.12	2.59	0.30
Base_400_270PVB_0Wd_280HE_Mar22Out_HiLd	1,243	400	270	0	0	287 / 539	0.19	0.30	0.78	0.11
Low Load										
Base_400_270PVB_0Wd_Mar22Out_LwLd	970	400	270	0	0	287 / 539	0.03	0.04	0.09	0.00
Base_400_270PVB_0Wd_wo170HE_Mar22Out_LwLd	801	400	270	0	0	287 / 539	0.12	0.19	0.30	0.02

O‘ahu GNA: Unserved energy is more likely to occur in late night – early morning hours in April and May driven by lower PV availability (seasonal and time of day).

Unserved Energy (MWh)

Hours Beginning	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0.00	0.00	0.00	0.45	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	1.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	0.00	0.00	0.00	0.17	0.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	0.00	0.00	0.00	2.96	0.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	0.00	0.00	0.00	1.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22	0.00	0.00	0.00	4.43	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23	0.00	0.00	0.00	3.41	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00

The Base_300_270PVB_0Wd_170HE_Mar22Out adds 270 MW of new paired PV, no onshore wind, and 300 MW of new firm generation with the delayed removal of an additional 170 MW of existing thermal generation.

As shown on the previous slide, this resource plan has an LOLE near the US Mainland standard of 0.1.

Pictured are heatmaps of unserved energy to show likelihood of when unserved energy may occur based on probabilistic resource adequacy analysis.

Shortfalls are shown during the months of April and May and during the evening to morning hours where available PV generation is lower due to time of day but also season.

Hawaiian Electric

Maui Grid Needs Assessment

Maui GNA Overview

- Near-Term Action Plan
- Bookend Modeling Scenarios
- Customer Technology Forecast
- RESOLVE Resource Plan
- ERM Reliability Analysis
- Probabilistic Resource Adequacy Analysis
- Unserved Energy Heat Map

Maui GNA: Near-Term Action Plan

- Continue to displace fossil fuel
- Continue to pursue customer adoption of DER (i.e., Battery Bonus)
- Pursue generation modernization
  - Acquisition of firm generation must start today given the length of time required to develop projects.
- Pursue development of renewable energy zones
- Consider procurement of energy efficiency in amounts up to the forecasted target to reduce supply side needs
- Continue to pursue managed EV charging programs, time-of-use rates, DER, and energy efficiency
- Incorporate system security and system stability analyses

Maui GNA: A variety of scenarios were modeled in RESOLVE to capture load bookends and faster customer technology adoption.

- **Base Scenario Assumptions**–
  - The base set of IGP sales and fuel price forecasts from the PUC approved March 2022 Inputs and Assumptions, in-service of S1/S2/CBRE projects.
  - Existing power purchase agreements terminate at the end of their current contract term.
  - Certain existing fossil-fuel generating units will be removed from service.
  - New variable renewable resources are allowed to be built up to the NREL Alt-1 resource potential.
- **Low Load Scenario Assumptions**–
  - The set of IGP sales forecasts that reduce customer demand including the high Distributed Energy Resource (DER), high Energy Efficiency (EE), and low Electric Vehicle (EV) forecasts.
  - Together, these forecast layers provide a low load to bookend or bound future, plausible demand that Hawaiian Electric should plan to serve.
  - Other planning assumptions follow the Base Scenario.
- **High Load Scenario Assumptions** –
  - The set of IGP sales forecasts that increase customer demand including the low DER, low EE, and high EV forecasts.
  - Together, these forecast layers provide a high load to bookend or bound future, plausible demand that Hawaiian Electric should plan to serve.
  - Other planning assumptions follow the Base Scenario.
- **Faster Customer Technology Adoption Scenario Assumptions**–
  - The set of IGP sales forecasts for high adoption levels of customer technologies including DER, EE, and EV.
  - As a result, this sales forecast trends between the base and high load bookend.

Maui GNA: Customer-sited and grid-scale renewables were analyzed in the bookend cases.

Driver	Base	Low Load	High Load	Faster Tech
EE	Base	High	Low	High
DER/DBESS	Base	High	Low	High
EV	Base	Low	High	High
EV Charging Shape	Managed	Managed	Unmanaged	Managed
Non-DER, Non-EV TOU	Base	High	Low	High

Resource (MW)	Potential
Solar + Onshore Wind	1,432
Biomass	No Limit
Biofuel	No Limit

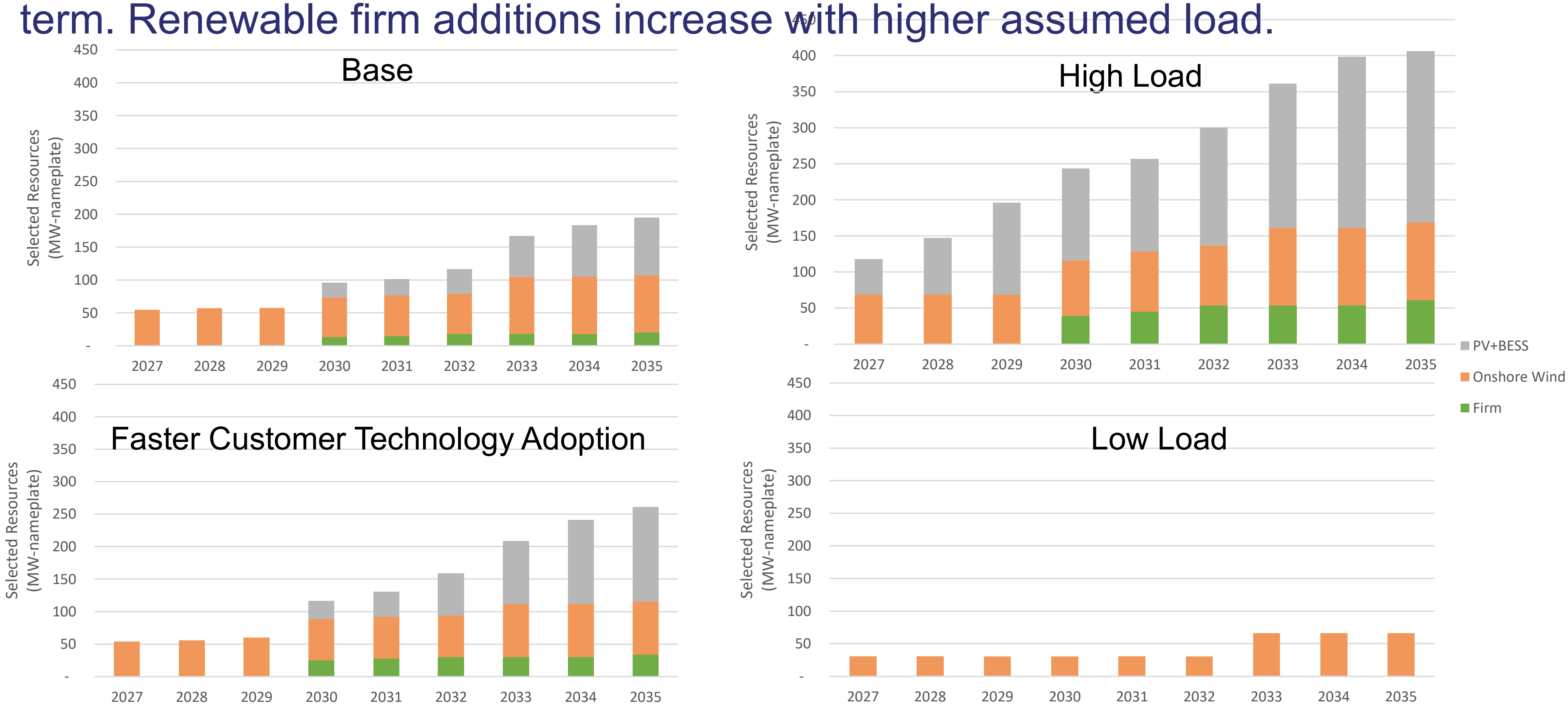
Maui GNA: Customer adoption of EE, EV, DER, and TOU rates continues to be a priority to meet grid needs.

2030 Customer Technology (incremental from 2021 levels)	Peak Load Impact (MW)	Impact to Sales (GWh)	Approximate Quantity
Energy Efficiency	24	170	N/A
Electric Vehicles	10	52	17,466 EVs
Private Rooftop Solar	56 (Installed Capacity)	95	7,114 Systems
Private BESS	43 MW / 114 MWh (Installed Capacity)	-5	7,275 Systems
Non-DER/EV Time-of-Use	1.2	N/A	N/A

Customer technology adoption is considered first in meeting grid needs. Procurement targets identified through the GNA analyses are to meet the residual grid needs after accounting for forecasted EE, EV, DER, and non-DER/EV TOU. Battery bonus, grid services aggregation, and future DER programs will provide additional flexibility to contribute to grid energy and capacity needs. These customer resources when acquired cost-effectively are critical to meeting the needs of the grid.

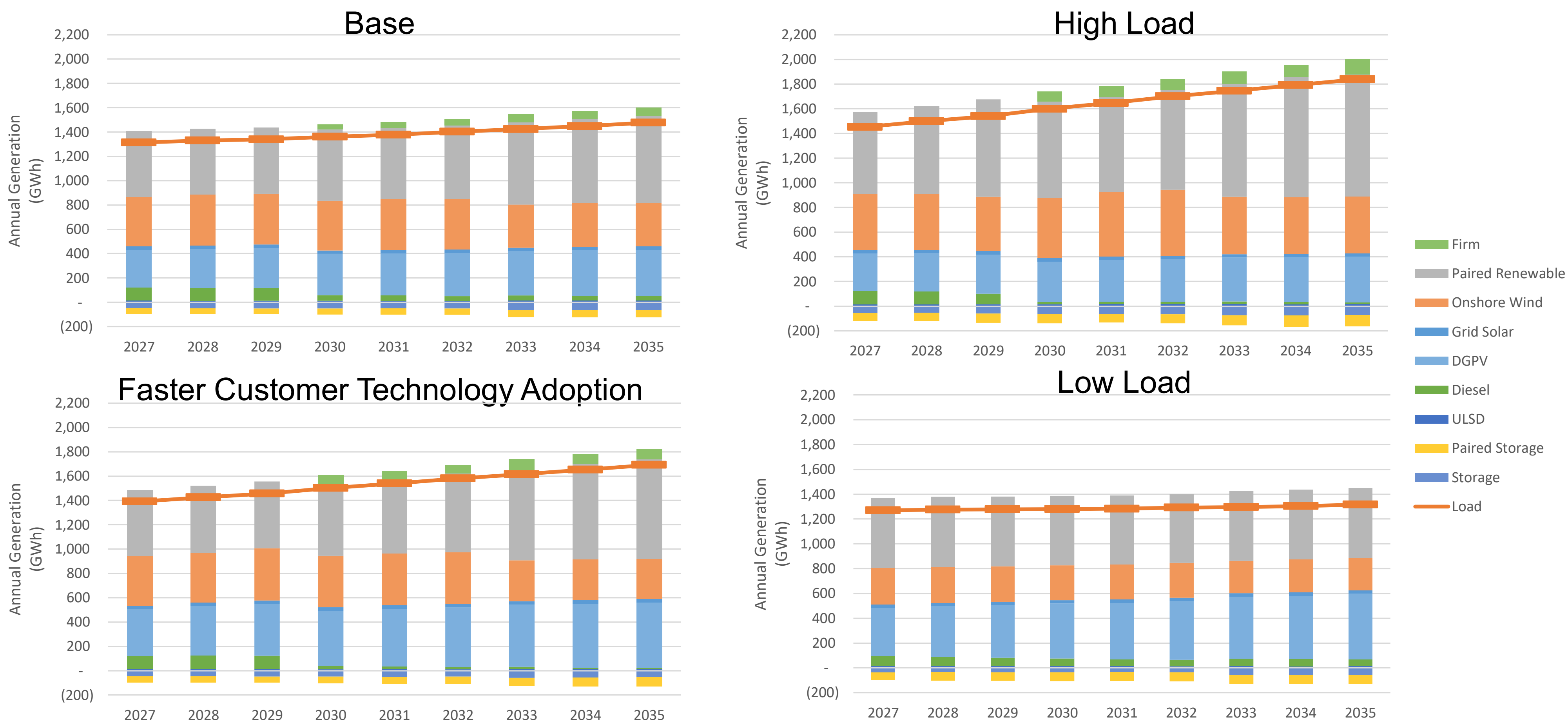
Further analyses can be completed during the solution sourcing phase of IGP to identify appropriate incentives to design new programs that achieve the forecasted amounts of DER and EE, i.e., evaluate the “freeze” cases.

Maui GNA: New renewable resources are consistently selected over the near term. Renewable firm additions increase with higher assumed load.

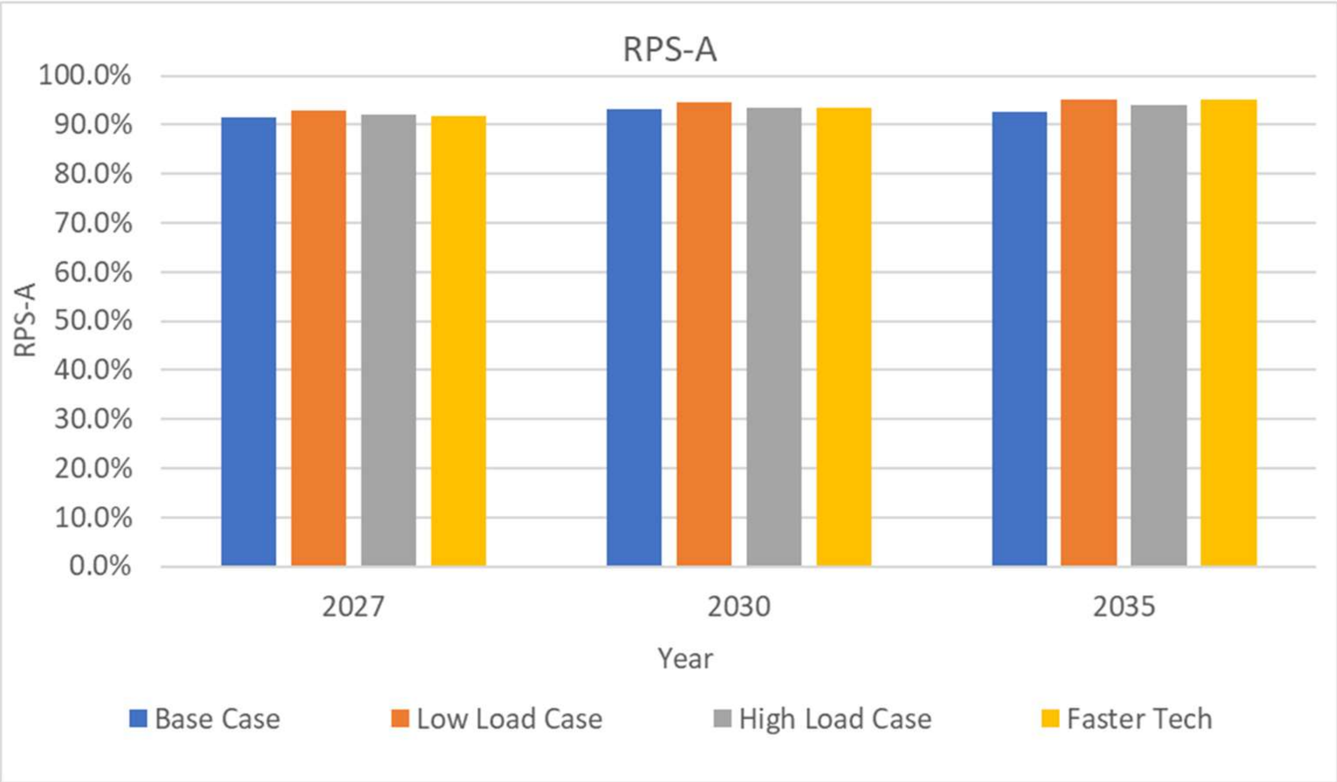


IGP utilizes a market-based approach for solution sourcing that integrates procurements with programs. As the Consumer Advocate stated, "any resulting plan is meant to represent a strategy or general plan and that, depending on facts (e.g., system needs, market prices, etc.) available at the time that any resource decision needs to be made, the adopted IGP plan would only represent a guide"

Maui GNA: DER, planned, and future renewables plus storage serve the majority of load and new renewable firm resources are dispatched minimally.



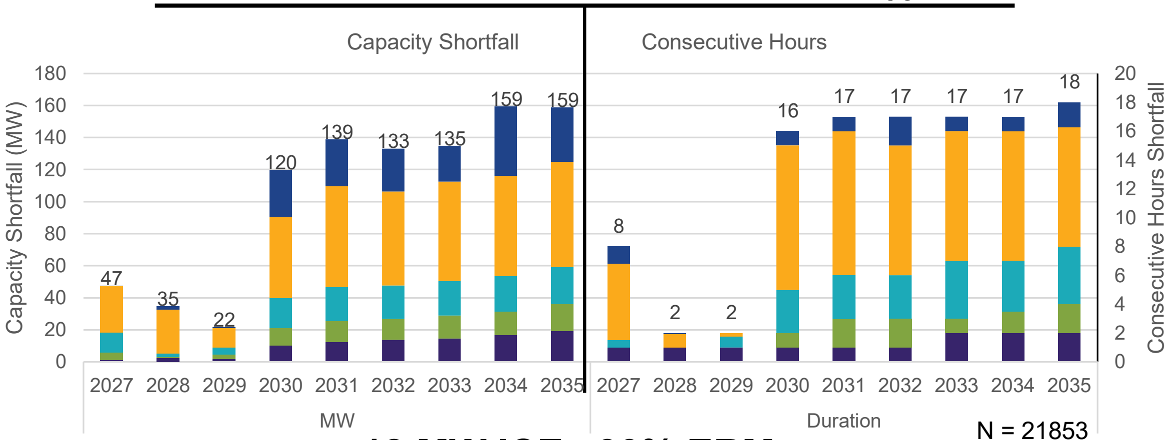
Maui GNA: High levels of RPS are achieved above mandates.



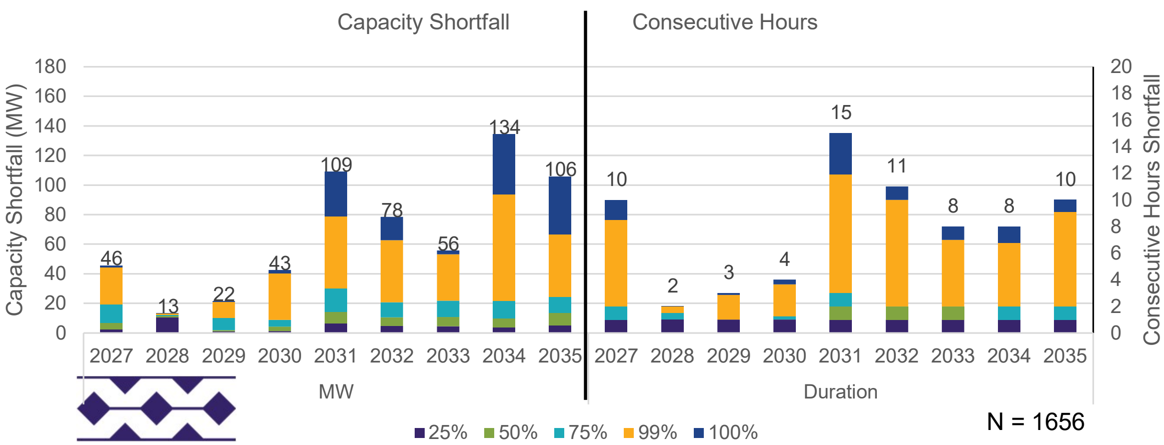
Despite the change in forecasted loads and resource selection across the Base, Low Load, High Load, and Faster Customer Tech cases, the resulting RPS-A is consistently high and ahead of mandated targets. This indicates that the favorable economics of adding low-cost renewables is driving their selection in the resource plans ahead of RPS mandates.

Maui GNA: The ERM criteria identified long duration shortfalls that increased with the removal of Maalaea 4-9 in 2030.

No RESOLVE Selected Resources – 30% ERM



18 MW ICE– 30% ERM



2027-2029

- Capacity shortfalls are due to the removal of Maalaea 10-13 and maintenance of the dual train combined cycles

2030-2035

- Capacity shortfalls are due to the removal of Maalaea 4-9
- The addition of 18 MW ICE in 2030 reduces 2030+ shortfalls relative to the no RESOLVE resources case

These resource plans were tested using a probabilistic resource adequacy analysis to validate the firm generation additions.

Maui GNA: A wide range of probabilistic analyses were conducted to examine the reliability impact of various resource types.

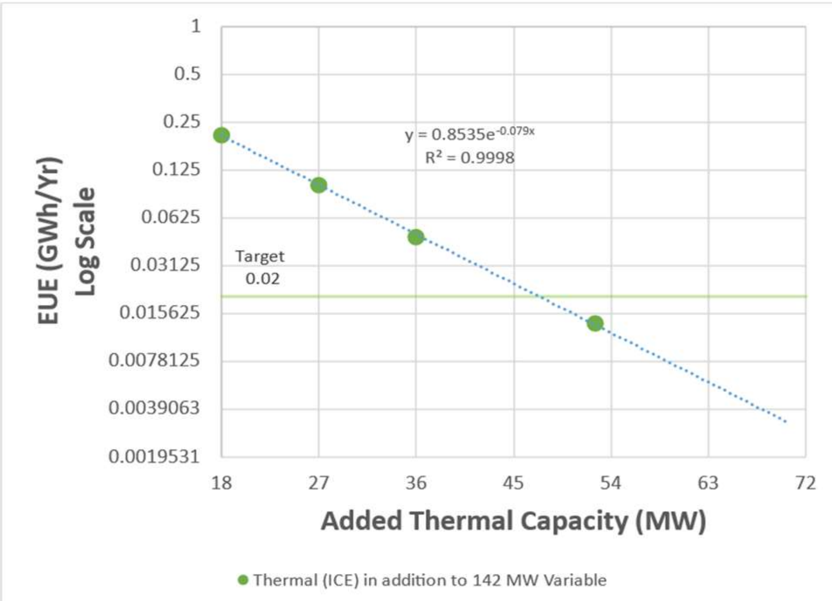
- **Firm Capacity Based on Paired Renewable**
- **Paired PV Sensitivity**
- **Additional cases were run to assess the reliability impact of adjusting the PV and wind capacity and removal of the steam turbines at Maalaea.**

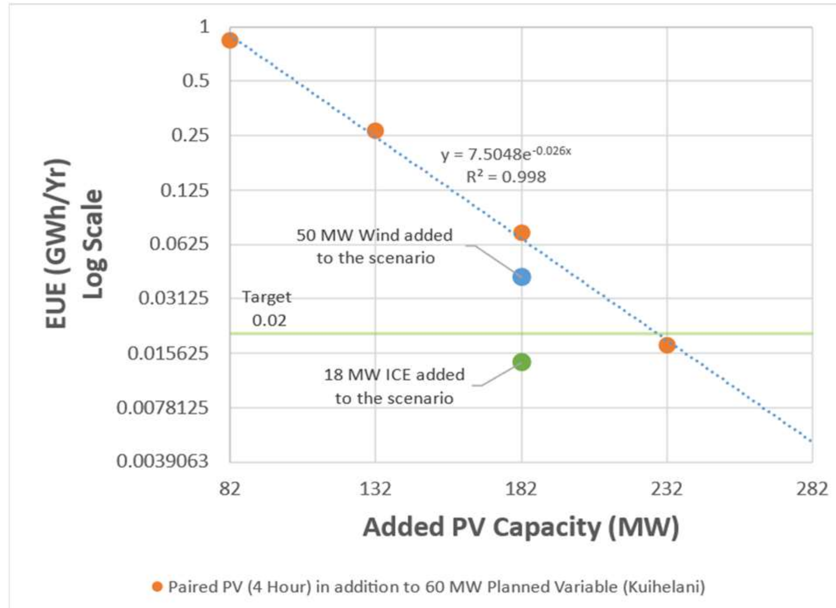
Maui GNA: The amount of new firm generation needed varied with assumed PV+BESS amounts and was less than a 1:1 replacement.

Green = LOLE ≤ 0.10 Days/Yr (US Mainland), LOLH ≤ 3 hrs (Belgium, France, GB, Poland), EUE ≤ 0.002% of load/0.02 GWh (AEMO)

Year 2030	Existing Firm (MW)	Planned Variable (MW)	New Firm (MW)	New Paired PV (MW)	New Onshore Wind (MW)	LOLE (Days/Yr)	LOLEv (Events/Yr)	LOLH (Hours/Yr)	EUE (GWh/Yr)
Additional Firm									
Base Case - remove S1/S2/CBRE Ph2, include Kuihelani Solar	126	60	0	22	60	**8.27**	13.83	**38.37**	**0.83**
Add 18 MW ICE	126	60	18	22	60	**2.26**	3.57	**9.97**	**0.21**
Add 27 MW ICE	126	60	27	22	60	**1.17**	1.84	**4.70**	**0.10**
Add 36 MW ICE	126	60	36	22	60	**0.58**	0.91	**2.41**	**0.05**
Add 36 MW ICE, not retired: M4, M7, M9	142.5	60	36	22	60	**0.22**	0.33	**0.73**	**0.01**
Curve Fit – Additional Firm	**126**	**60**	**48**	**22**	**60**	**N/A**	**N/A**	**N/A**	**0.02**
Additional Paired PV									
Base Case – w/o S1/S2/CBRE Ph2, w/ Kuihelani	126	60	0	22	60	8.27	13.83	38.37	0.83
Add 50 MW PV+BESS	126	60	0	72	60	2.66	4.90	10.85	0.26
Add 100 MW PV+BESS	126	60	0	122	60	0.80	1.44	2.72	0.07
Add 150 MW PV+BESS	126	60	0	172	60	0.21	0.38	0.67	0.02
Curve Fit – Additional Paired PV	**126**	**60**	**0**	**172**	**60**	**N/A**	**N/A**	**N/A**	0.02

Maui GNA: A curve fit of the probabilistic results to an EUE standard still identified a need for new firm resources.





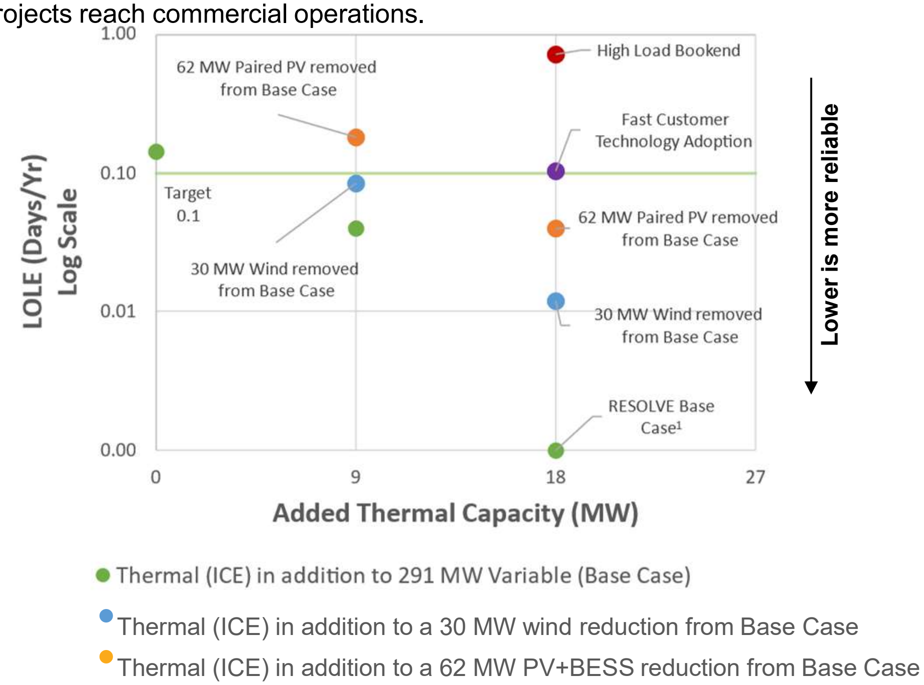
Year 2029	Existing Firm (MW)	Planned Variable (MW)	New Firm (MW)	New Paired PV (MW)	New Onshore Wind (MW)	EUE (GWh/Yr)
Curve Fit – Additional Firm	126	60	48	22	60	0.02
Curve Fit – Additional Paired PV	126	60	0	172	60	0.02

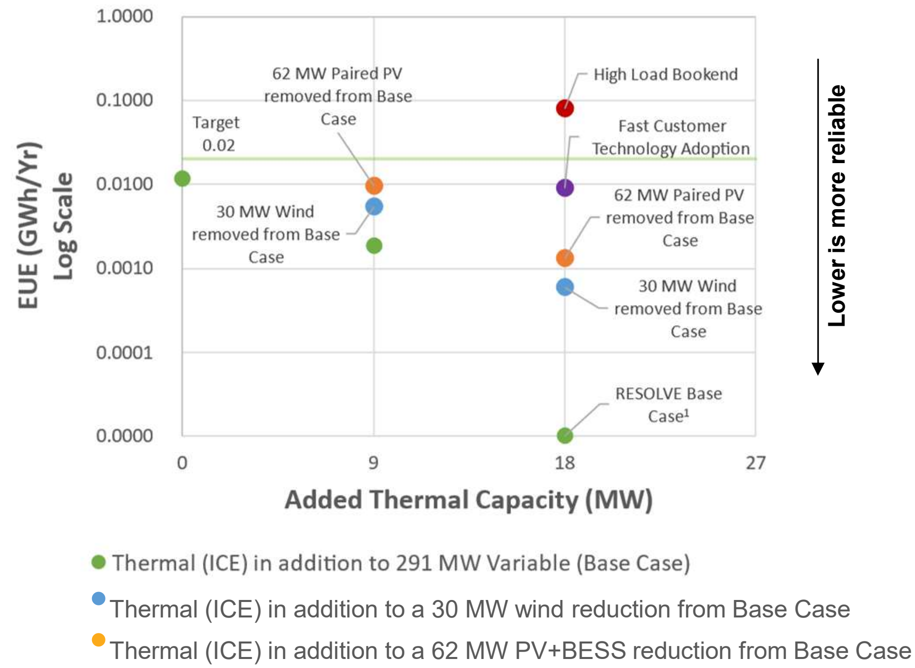
Since the curve fit is an approximation of the firm need based on results of the explicitly modeled cases, it may overstate/understate the firm need. However, it still provides useful directional guidance on the equivalent capacity of paired PV to firm generation.

Maui GNA: All resources additions improved reliability but to varying degrees based on resource type and installed amount.

Probabilistic Resource Adequacy Analysis of the RESOLVE Base Case Sensitivities: Incremental changes to wind, PV+BESS, firm generation
Planned Resources: 209 MW of PV+BESS from Stage 1 and 2, and 40 MW standalone BESS
Future resources beyond planned: 82 MW of variable generation

Incremental additions of internal combustion engines (ICE) firm (thermal) generation of 9-18 MW meets both LOLE and EUE targets as shown in the green data points. In orange and blue data points are removals of wind or PV+BESS capacities from the base RESOLVE (optimized) case to simulate market conditions where not all projects reach commercial operations.





1. RESOLVE Base case selected 13 MW combined cycle by 2030, in addition to 60 MW onshore wind and 22 MW PV+BESS, which is roughly equivalent to the 18 MW ICE addition evaluated here.

Maui GNA: Reliable resource plans generally included some amount of new firm thermal generation. Higher amounts of firm generation may be reasonable to address uncertainty in load and timely in-service variable renewable projects.

Green = LOLE ≤ 0.10 Days/Yr (US Mainland), LOLH ≤ 3 hrs (Belgium, France, GB, Poland), EUE ≤ 0.002% of load/0.02 GWh (AEMO)

Year 2029	Existing Firm (MW)	Planned Variable (MW)	New Firm (MW)	New Paired PV (MW)	New Onshore Wind (MW)	LOLE (Days/Yr)	LOLEv (Events/Yr)	LOLH (Hours/Yr)	EUE (GWh/Yr)
Add 9 MW ICE	126	208.5	9	22	60	0.04	0.07	0.13	0.00
Add 9 MW ICE, remove 30 MW wind	126	208.5	9	22	30	0.08	0.15	0.33	0.01
Add 18 MW ICE	126	208.5	18	22	60	0	0	0	0
Add 18 MW ICE, remove 62 MW PV [1]	126	208.5	18	0	60	0.04	0.08	0.12	0.00
Add 18 MW ICE, remove 30 MW wind	126	208.5	18	22	30	0.01	0.03	0.04	0.00
Add 9 MW 12-Hour BESS	126	208.5	0	22	60	0.10	0.22	0.49	0.01
Add 18 MW ICE, retire M15	113	208.5	18	22	60	0.04	0.04	0.12	0.00
Add 36 MW ICE, retire M15 & M18	100	208.5	36	22	60	0.02	0.03	0.06	0.00
Add 36 MW ICE retire M15 & M18, no Future Variable	100	208.5	36	0	0	0.03	0.03	0.04	0.00

208.5 MW of planned variable includes Kuihelani (60 MW), Kahana (20 MW), Kamaole (40 MW), Paeahu (15 MW), Pulehu (40 MW), and CBRE Ph 2 (33.5 MW). Waena BESS (40 MW) was also assumed in these cases.

Maui GNA: Unserved energy is more likely to occur in late night – early morning hours in March, April, and May driven by lower PV availability (seasonal and time of day).

Base Case with 0 MW Firm Generation

Unserved Energy (MWh)

Hours Beginning	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0.00	0.00	0.00	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.10	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.07	0.22	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.25	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.37	0.32	0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.13	0.25	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.52	0.22	0.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.27	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	0.00	0.00	0.16	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	0.00	0.00	0.13	0.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	0.00	0.00	0.33	0.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	0.00	0.00	0.02	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	0.00	0.00	0.09	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22	0.00	0.00	0.48	1.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23	0.00	0.00	0.28	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Base Case with 9 MW Firm Generation

Unserved Energy (MWh)

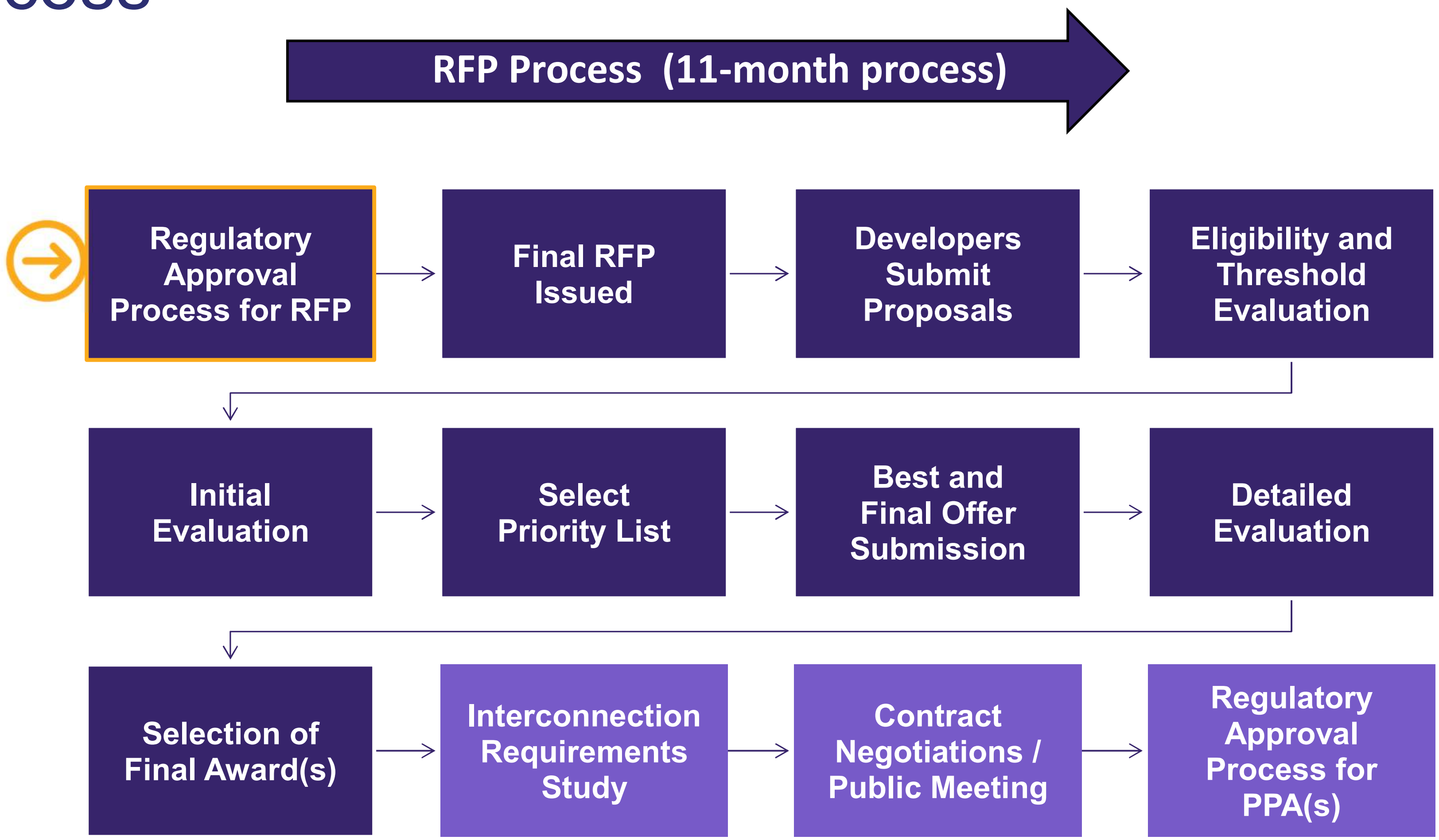
Hours Beginning	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.18	0.06	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.12	0.05	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.02	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.27	0.17	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	0.00	0.00	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22	0.00	0.00	0.01	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23	0.00	0.00	0.25	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Pictured are heatmaps of unserved energy to show likelihood of when unserved energy may occur based on probabilistic resource adequacy analysis. Shortfalls are shown during the months of March, April and May where wind has a lower capacity factor and the PV+BESS do not have enough energy to load shift and meet unserved demand.

Hawaiian Electric

RFP Process

RFP Process



Dates subject to Public Utilities Commission approval.

Hawaiian Electric

Next Steps

Next Steps

- August-September 2022
  - July 29, 2022: Near-Term Grid Needs Assessment for both O‘ahu and Maui were filed
  - Draft RFP is available for review
    - www.hawaiianelectric.com/competitivebidding
  - Incorporate revisions and modifications to O‘ahu and Maui RFPs after resolution of Motion for Reconsideration/Clarification
  - File Final RFP (Subject to PUC approval)

RFP Information

- RFP e-mail address

  oahurenewablerfp@hawaiianelectric.com

  mauirenewablerfp@hawaiianelectric.com

- RFP webpage

  www.hawaiianelectric.com/Stage3OahuRFP

  www.hawaiianelectric.com/Stage3MauiRFP

Mahalo

Questions?