Hawai'i Powered

Integrated Grid Plan
Action Plan Annual Update

Hawaiian Electric

2024

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1 IGP Action Plan Summary and Status

The Integrated Grid Plan provides a short-term action plan and long-term strategy to meet the energy needs of our customers up to and beyond 2045. The short-term action plan includes immediate actions that must be taken within the next five years from 2023-2027 to achieve our 2030 goals and set a path toward 2045 net-zero decarbonization. In meeting these goals, the action plan provides foundational actions that retain the flexibility to realize the benefits of technological advances, respond to changing customer and community needs, and adapt to evolving environmental conditions.

This section provides an update to the Action Plan provided in the May 2023 IGP Final Report.

1.1 Key Finding and Recommendation: Stabilize Utility Rates and Advance Energy Equity

To stabilize rates and advance energy equity, we will need to:

- Pursue the least costly pathway, which maximizes solar, wind and energy storage
- Provide at least $3,000 per megawatt in community benefits packages per year to host communities of large-scale projects
- Keep rates lower than the status quo of fossil fuel reliance
- Examine forms of relief for LMI customers
- Pursue federal funding to expand customer access to renewable technologies and reduce the cost of grid modernization

Actions we can take within the next five years to stabilize rates:

1. Use competitive procurements to the extent possible for all types of renewable generation as a means to attract lowest pricing possible for customers
2. Pursue federal funding with up to 50% match for climate adaptation program and Phase 2 grid modernization
3. Work with stakeholders to address affordability through the Energy Equity docket

1.1.1 Use competitive procurements to the extent possible for all types of renewable generation as a means to attract lowest pricing possible for customers

Competitive procurements through Requests For Proposals ("RFP") continue to be the preferred vehicle for the acquisition of all types of large-scale generation and storage. On April 30, 2024, we issued a draft IGP RFP for O'ahu and Hawai'i Island and requested that the Commission open a new proceeding for the proposed RFP.

1.1.2 Pursue federal funding with up to 50% match for climate adaptation program and Phase 2 grid modernization

Hawaiian Electric pursued federal funds (Grid Resilience and Innovative Partnerships ("GRIP") Round 1, Topic Area 1) in April 2023 to match customer funds requested as part of Docket No. 2022-0135 "Climate Adaptation T&D Resilience Program" in the application filed on June 30, 2022. Hawaiian Electric received notification from the U.S. Department of Energy ("DOE") of successful selection for award on October 17, 2023, and is currently engaged in negotiations with DOE. Hawaiian Electric subsequently received approval for the cost-matching funds from the Hawai'i Public Utilities Commission ("PUC") in Docket No. 2022-0135 (see Decision and Order No. 40566 issued on January 31, 2024). The award amount approved by both the DOE and the PUC was $95 million each, resulting in a total of $190 million of funding to implement high-priority resilience investments in utility infrastructure primarily for wildfire risk mitigation.

Additionally, Hawaiian Electric is pursuing federal funds (GRIP Round 2, Topic Area 1) to match our planned internal investments in resilience (again, primarily for wildfire risk mitigation). We submitted an application to the DOE in April 2024 and expect a decision in summer/fall 2024.

Hawaiian Electric has also pursued federal funds for GRIP Round 2, Topic Area 2, to match the other planned internal investments to increase the reliability, resilience, and safety of Hawai'i's grids by integrating a holistic distribution management solution.

Hawaiian Electric is partnering with the Hawai'i State Energy Office, Kaua'i Island Utility Cooperative, and the Hawai'i Department of Defense to pursue federal funds for GRIP Round 2, Topic Area 3, which will help to match investments in installing innovative technologies that will help prevent spark risks through better detection and response to broken and downed conductors.

1.1.3 Work with stakeholders to address affordability through the Energy Equity docket

Feedback from the Commission's draft report in Docket No. 2022-0250 (the "Energy Equity Docket") was incorporated into the draft IGP RFP filed on April 30, 2024.

1.2 Key Finding and Recommendation: Grow the Marketplace for Customer-scale and Large-scale Renewable Generation

To grow a thriving, competitive marketplace for customer-scale and large-scale renewable generation, we will need:

- Greater customer participation in energy generation and storage
- Widespread adoption of energy efficiency
- Rapid development of low-cost renewables and transmission

Actions we can take to begin increasing customer participation:

1. Implement new distributed energy resources (DER) programs to use deployed advanced metering infrastructure (AMI): Smart DER Tariff and bring-your-own-device options, targeting 1,186 MW of private rooftop solar capacity by 2030
2. Implement community-based renewable energy projects for low- and moderate-income customers and the Tranche 1 procurement
3. Implement advanced rate designs and conduct time-of-use (TOU) study to use deployed AMI
4. Procure energy efficiency and other grid services to meet grid needs and reduce supply-side requirements
5. Review lessons learned from the Phase 2 Tranche 1 community-based renewable energy procurement, and propose changes, if necessary, for a more robust program

Actions we can take to start developing low-cost renewables and transmission:

6. Update key assumptions based on current market conditions (i.e., fuel forecasts) during and following the Stage 3 request for proposals (RFP)
7. Complete Stage 3 procurement and work with stakeholders to execute the projects that are selected
8. Complete Land Request for Information to identify potential sites for large-scale renewable generation and development of REZs in concert with communities
9. Issue an additional competitive procurement for renewable dispatchable generation after Stage 3 and determine market for long lead renewable resources (i.e., offshore wind and other technologies to achieve commercial operations by 2035) and REZs for each island
10. Continue finding solutions to improve the interconnection process, including working with State and county agencies

1.2.1 Implement new distributed energy resources (DER) programs to use deployed advanced metering infrastructure (AMI): Smart DER Tariff and bring-your-own-device options, targeting 1,186 MW of private rooftop solar capacity by 2030

Smart Renewable Energy (also known as Smart DER) and Bring Your Own Device ("BYOD") Level 1 programs initiated on April 1, 2024 for all islands in Docket No. 2019-0323. With the start of the new programs, all interim DER programs were closed at the end of March 2024. The BYOD Level 1 program is similar to Battery Bonus where there is no control signal dispatched from the utility and the battery is responding every day on a scheduled dispatch.

The Commission hosted a Technical Conference on April 4, 2024 to discuss controllability and the path required to activate BYOD Level 2 and Level 3 programs. Pending Commission Order, we will work diligently to create more customer options for grid services participation.

1.2.2 Implement community-based renewable energy projects for low- and moderate-income customers and the Tranche 1 procurement

Community-Based Renewable Energy (also known as Shared Solar) commenced a Phase 2 of the program on April 9, 2020 in Docket No. 2015-0389. This led to the development and procurement of dedicated low-and-moderate-income ("LMI") and Tranche 1 projects, as well as small projects. Dedicated LMI project subscriber organizations commit to subscribing LMI customers defined by the Federal Housing and Urban Development ("HUD"), geographic location by zip code, or by participating in comparable programs as defined by Tariff Rule 29. Further, commercial subscribers can participate if they are a 501(c)(3) organization or government entity. Five such projects were awarded capacity for a combined total of 23 MW across O'ahu, Maui and Hawai'i Island with guaranteed commercial operations by the end of 2025. However, one Maui project (3 MW) subsequently withdrew.

We procured five additional projects with a combined capacity of over 14 MW across O'ahu, Hawai'i Island and Moloka'i for Tranche 1 projects which are open to any eligible customer on those islands. These projects were planned to achieve guaranteed commercial operations in 2026 but are no longer in development.

1.2.3 Implement advanced rate designs and conduct time-of-use (TOU) study to use deployed AMI

The Advanced Rate Design Time-of-Use Rate Pilot commenced on February 1, 2024 in Docket No. 2019-0323. This one-year study includes randomly selected customers on O'ahu and Hawai'i islands who have AMI meters and are served on residential Schedule R or commercial Schedules G and J. Customers on all five islands who have AMI meters and who are currently served on Schedules R, G, or J may elect to be served on these time-of-use rates, although such opt-in customers are not included in the study population. All customers served on these time-of-use rates have the option to return to non-time-of-use rate schedules at any time.

1.2.4 Procure energy efficiency and other grid services to meet grid needs and reduce supply-side requirements

In Docket No. 2022-0041, the Commission issued Decision and Order No. 40082 on July 12, 2023, approving the third procurement of an aggregator on O'ahu with modifications to the contract. Hawaiian Electric filed an amendment to the Grid

Services Purchase Agreement ("GSPA") on December 29, 2023. Subsequently, the Commission closed the docket on January 26, 2024. We will proceed to the next phase to work with the aggregator to integrate and begin accepting customer enrollment.

In Docket No. 2017-0352, two GSPA contracts remain active and are working to catch up on their customer enrollment.

Currently, we do not administer Energy Efficiency ("EE") programs for electric utility customers in Hawai'i, however, we support collaboration with Hawai'i Energy, the Commission's third party administrator that promotes EE savings across the state. The EE savings forecasts are and will continue to be an essential input in the IGP process.

1.2.5 Review lessons learned from the Phase 2 Tranche 1 community-based renewable energy procurement, and propose changes, if necessary, for a more robust program

Community-Based Renewable Energy (also known as Shared Solar) will incorporate Phase 2 Tranche 1 lessons learned in Docket No. 2015-0389, following the final award of projects and prior to the commencement of Tranche 2. Since the final award of Tranche 1 projects on February 22, 2023, we have gathered feedback from customers, developers and stakeholders on ways to expand the number of projects available, increase subscription opportunities, and reduce administrative burden.

1.2.6 Update key assumptions based on current market conditions (i.e., fuel forecasts) during and following the Stage 3 request for proposals (RFP)

We have continued to update assumptions since the inputs and assumptions were approved for the first IGP cycle. Subsequent planning work has incorporated the 2023 fuel price forecast from the Energy Information Administration ("EIA"). We have also re-examined assumptions for forced and maintenance outages of existing thermal units based on recent outage data. See Section 2.2 Developing Grid Needs based on Recent Outage Data for additional details.

1.2.7 Complete Stage 3 procurement and work with stakeholders to execute the projects that are selected

Hawaiian Electric selected 16 renewable energy projects in December 2023 and January 2024 from the Stage 3 RFPs on O'ahu, Hawai'i Island, and Maui. Contract negotiations are ongoing to produce long-term contracts for approximately 517 megawatts (MW) of variable generation, 694 MW of firm generation, and 2.1 gigawatt-hours (GWh) of storage. Estimated completion dates for the projects range from 2026 to 2033.

1.2.8 Complete Land Request for Information to identify potential sites for large-scale renewable generation and development of REZs in concert with communities

Hawaiian Electric completed a Land Request For Information ("RFI") in April 2023, and provided an initial assessment of the land available for renewable energy development and transmission expansion to support renewable development. The response to the Land RFI was not robust;

however, it provided us initial input into the land being made available by developers. We intend to further this by incorporating a process in the Long-Term RFP to identify areas that are common to multiple potential developments, and identifying transmission infrastructure required to enable larger tranches of renewable energy development. This concept is yet to be determined at this time, but is needed to enable long-term, higher capacity resources to interconnect to the system.

1.2.9 Issue an additional competitive procurement for renewable dispatchable generation after Stage 3 and determine market for long lead renewable resources (i.e., offshore wind and other technologies to achieve commercial operations by 2035) and REZs for each island

On April 30, 2024, the Companies requested the Commission to open a docket to procure additional Renewable Dispatchable Generation ("RDG") resources for O'ahu and Hawai'i Island, and included the Companies' draft IGP RFP:

- O'ahu: 589 GWh annually of renewable energy to be in service no later than December 1, 2029 and 50 MW of firm capacity to be in service no later than December 1, 2032. A stability target of 270 MW of Grid Forming resources was also included.
- Hawai'i Island: 134 GWh annually of renewable energy to be in service no later than December 1, 2029 in this round and 60 MW of firm capacity to be in service no later than December 1, 2031.

In addition, we are developing a separate RFP (i.e., IGP Long-Term RFP) to seek long-term resources that require extended project development time or long-lead infrastructure to complete. It is intended to incorporate the planning and development of transmission infrastructure required to support Renewable Energy Zones in this process to minimize the risk of initiating and building infrastructure that is not utilized for renewable energy development.

1.2.10 Continue finding solutions to improve the interconnection process, including working with State and county agencies

Hawaiian Electric continues to improve the information provided in the most recent draft RFP. Standardized interconnections with standard equipment and design templates have been created and Company specifications were updated.

1.3 Key Finding and Recommendation: Create a Modern and Resilient Grid

To create a resilient grid with enough capacity to meet the State's policy goals, we will need:

- Investment of $59.4 million in distribution upgrades over the next 10 years
- Investment of $1.33 billion through 2035 to expand or create new transmission interconnection points between renewable projects
- Initial investment of $190 million to improve the resilience of the transmission and distribution grid

Near-term actions to upgrade the distribution system:

1. Issue expressions of interest for qualified distribution non-wires alternatives opportunities
2. Prepare extraordinary project recovery mechanism requests to implement distribution upgrades needed to support electrification and expansion of private rooftop solar hosting capacity, and other requests to support expanded distribution capacity for new housing and commercial developments

Near-term actions to develop REZs:

3. Continue community engagement to determine feasibility of developing REZs
4. Create a transmission siting and routing process in collaboration with communities, State, county, landowners, and project developers

Near-term actions to improve grid resilience:

5. Pending Public Utilities Commission approval, implement and execute a 5-year, $190 million climate adaptation program to harden our grid and implement other resilience measures
6. Develop resilience modeling and performance target levels of resilience to inform future hardening and other resilience investments
7. Leverage an energy transition initiative partnership program and Resilience Working Group to identify other microgrid opportunities
8. Execute North Kohala microgrid and RFP, apply lessons learned, and pursue additional microgrid opportunities to enhance community resilience
9. Complete rollout of AMI and obtain approval of phase 2 grid modernization to enhance system reliability and resilience

1.3.1 Issue expressions of interest for qualified distribution non-wires alternatives opportunities

Hawaiian Electric issued the following Non-Wires Alternatives ("NWA") RFP/Expressions of Interest ("EOIs") since 2023:

- North Kohala Energy Storage RFP[1]
- Kakaʻako/Kewalo Non-Wires Alternative EOI[2]
- CEIP Non-Wires Alternative EOI[3]
- ʻEwa Nui Non-Wires Alternative EOI[4]
- Waikoloa EOI[5]

With the exception of the Waikoloa EOI (currently in-progress), all the EOIs and the North Kohala RFP did not produce a viable NWA.

1.3.2 Prepare extraordinary project recovery mechanism requests to implement distribution upgrades needed to support electrification and expansion of private rooftop solar hosting capacity, and other requests to support expanded distribution capacity for new housing and commercial developments

We are continuing to monitor the timing and need for circuit upgrades to increase DER hosting capacity. Examples of recent projects that were initiated or installed within the past year include:

1. Voltage Regulators as part of Grid Mod Phase 2 (and being submitted under the DOE's Infrastructure Investment Jobs Act ("IIJA") grant).
2. LTC settings modifications.
3. Phase balance circuit loads.
4. Reconductoring subtransmission lines to increase capacity.
5. Initiated a voltage conversion project.

Hawaiian Electric is evaluating whether to package future projects and upgrades together as part of an application for cost recovery to the Commission.

[1] See https://www.hawaiianelectric.com/clean-energy-hawaii/selling-power-to-the-utility/competitive-bidding-for-system-resources/north-kohala-energy-storage-rfp

[2] See https://www.hawaiianelectric.com/clean-energy-hawaii/selling-power-to-the-utility/competitive-bidding-for-system-resources/competitive-bidding-archived-rfp-information/updated-non-wires-alternative-eoi-kakaako-and-kewalo

[3] *See* https://www.hawaiianelectric.com/clean-energy-hawaii/selling-power-to-the-utility/competitive-bidding-for-system-resources/competitive-bidding-archived-rfp-information/oahu-non-wires-alternative-utility-scale-or-distributed-energy-resource-grid-services-eois

[4] *See* https://www.hawaiianelectric.com/clean-energy-hawaii/selling-power-to-the-utility/competitive-bidding-for-system-resources/competitive-bidding-archived-rfp-information/oahu-non-wires-alternative-utility-scale-or-distributed-energy-resource-grid-services-eois

[5] *See* https://www.hawaiianelectric.com/documents/clean_energy_hawaii/selling_power_to_the_utility/competitive_bidding/20240405_waikoloa_eoi.pdf

In addition, the following projects were initiated or are in-progress to increase capacity primarily due to load forecast increases:

1. Kewalo T4 (Docket No. 2023-0212) – A new transformer and associated equipment is being installed to serve the load growth in the Kaka'ako and Kewalo areas.
2. Waikoloa T2 (Docket No. 2024-0137) – A new transformer and associated equipment is being installed to serve the load growth in the Waikoloa area on Hawaii Island.
3. Waipi'o Tsf 3 (Docket No. 2023-0303) – A new transformer and associated equipment is being installed to serve the load growth because of the Koa Ridge development.
4. Auiki Substation (Docket No. 2018-0185) – A new substation and associated equipment is being constructed to serve the load growth in the DoT harbors area.
5. Kulanihakoi Substation (Docket No. 2020-0182) – A new substation was energized to serve the Ho'opili expansion.

1.3.3 Continue community engagement to determine feasibility of developing REZs

The Commission hosted a series of five public meetings between October 2023 and February 2024 regarding equity issues related to the RFP process, pursuant to Order No. 40290 in the Energy Equity Docket (Docket No. 2022-0250). The REZ concept was discussed in these meetings.

In connection with our draft IGP RFP filing on April 30, 2024 referenced in Section 1.2.9 above, we hosted a virtual community meeting on March 11, 2024 and a more developer-focused meeting on March 20, 2024. Community feedback in response to the posted draft RFP was accepted during the meetings, via e-mail and is continuing to be accepted through the our online feedback survey.

1.3.4 Create a transmission siting and routing process in collaboration with communities, State, county, landowners, and project developers

As described in 1.2.9 above, we plan to initiate major transmission upgrades to support larger tranches of large-scale development by first obtaining input from the market in the initial stages of the long-term RFP process. It is within this process that we will develop grid solutions to enable multiple developments sited in similar areas of the islands.

We plan to engage with communities prior to the submittal of the long-term RFP to start to obtain input into this routing process.

1.3.5 Pending Public Utilities Commission approval, implement and execute a 5-year, $190 million climate adaptation program to harden our grid and implement other resilience measures

The Commission approved a five-year, $190 million, Climate Adaptation T&D Resilience Program in Docket No. 2022-0135 on January 31, 2024. Execution of this program is currently pending successful negotiations with the U.S. Department of Energy on scope of work for the matching funds granted in October 2023 as part of the GRIP Round 1, Topic Area 1, federal funding opportunity.

In the meantime, we have been implementing Interim Wildfire Safety Measures, which includes initiatives to mitigate wildfire risk such as grid hardening (e.g., pole replacements, conductor replacements, replacement of equipment with fire-safe alternatives) and enhanced vegetation management practices.

Additional federal funds (totaling $100 million) are being pursued as part of GRIP Round 2, Topic Area 1, to fund resilience efforts.

We are engaging stakeholders for input on its wildfire mitigation initiatives as part of its Wildfire Safety Strategy. We held a Wildfire Safety Symposium in Hilo, Hawai'i, on April 10-11, 2024, and are planning to hold multiple working group meetings throughout the remainder of 2024.

1.3.6 Develop resilience modeling and performance target levels of resilience to inform future hardening and other resilience investments

Hawaiian Electric has contracted with the Pacific Northwest National Laboratory ("PNNL") to develop resilience performance models leveraging PNNL's Electric Grid Resilience and Assessment System ("EGRASS") framework. Originally developed for Puerto Rico following the aftermath of Hurricane Maria, EGRASS is a modeling framework used to "assess the impact on infrastructure as a result of natural hazard, estimate the probability of failure for different components of the electrical infrastructure, such as towers, transmission lines and substations, and analyze the associated risk and impact of their failures on system reliability."[6] This model will provide key insights to inform storm hardening priorities and cost-benefit analysis of hardening alternatives. The project is currently in the initial stages of data collection and analytics.

In parallel, Hawaiian Electric is also planning to develop wildfire risk modeling capabilities to enable quantitative risk-informed decision making for wildfire mitigation efforts. This will include advanced tools and methods to better understand ignition risk, wildfire consequences to communities, and the risk reduction potential of various wildfire mitigation activities.

Once wildfire risk modeling capabilities are developed, we plan to leverage modeling outputs and engage stakeholders to further refine the results. We anticipate using risk modeling to prioritize inspections, system hardening, and vegetation management, to assist in determining the risk-spend efficiency of various investment options, and to inform operational decision-making.

1.3.7 Leverage an energy transition initiative partnership program and Resilience Working Group to identify other microgrid opportunities

In April 2021, we were selected as a recipient of the DOE's Energy Transitions Initiative Partnership Project ("ETIPP"), which provided National Lab support to develop a community-informed map of potential hybrid microgrid locations on O'ahu. The project is nearing completion, and we plan to make these maps and deliverables available publicly. The data and information from this project will also be used to assess potential microgrid locations.

1.3.8 Execute North Kohala microgrid and RFP, apply lessons learned, and pursue additional microgrid opportunities to enhance community resilience

In October 2021, Hawaiian Electric filed a draft RFP with the Commission for the BESS portion of the microgrid, seeking a 5 megawatt (MW) / 30

[6] https://www.pnnl.gov/news-media/strengthening-puerto-ricos-power-grid

megawatt-hours (MWh) standalone energy storage system for integration with a microgrid controller system owned and operated by Hawaiian Electric. The final RFP was approved and opened to bidders on March 24, 2023. Proposals were due by May 31, 2023. On August 29, 2023, the RFP was closed without an award. Following a comprehensive evaluation process, Hawaiian Electric concluded that the proposals did not meet the criteria set forth in the RFP. On March 6, 2024, the Commission closed the docket, Docket No. 2022-0012. Hawaiian Electric conducted community engagement in Q2 2024 and is determining the appropriate next steps.

1.3.9 Complete rollout of AMI and obtain approval of phase 2 grid modernization to enhance system reliability and resilience

On February 28, 2022, in Docket No. 2018-0141, the Commission ordered the us to deploy Advanced Metering Infrastructure ("AMI") to all customers, excluding opt-outs, by Q3 2024. As of the end of May 2024, we have deployed more than 430,000 AMI meters and are on-track to complete the project by the Commission's deadline.

While we were unsuccessful in pursuit of round one DOE IIJA grant funding for Grid Modernization Strategy ("GMS") Phase 2, the DOE encouraged us to apply GMS Phase 2 for IIJA grant funding during the second-round funding opportunity. We applied for IIJA grant funding on May 23, 2024, seeking the maximum award size of $100.0 million for any one individual award.

On May 31, 2024, we filed an updated and supplemented application in Docket No. 2019-0327, requesting PUC approval for the Companies' matching portion of an IIJA project to implement GMS Phase 2. This $115.2M request seeks approval to implement an Advanced Distribution Management System ("ADMS"), field devices ("Field Devices"), expansion of Supervisory Control and Data Acquisition ("SCADA"), expansion of the Private LTE ("PLTE") network, and Operational Technology ("OT") Cybersecurity Monitoring ("Cybersecurity"). We expect to receive a DOE decision on grant funding in late summer, and requests that the PUC provide approval of the GMS Phase 2 application within 90 days of grant award.

1.4 Key Finding and Recommendation: Secure Reliability through Diverse Energy Sources and Technologies

Creating a reliable clean energy grid will require:

- Developing renewable firm generation that is modern and flexible
- Adoption of emerging technologies

Near-term actions to secure reliability:

1. Continue to monitor the condition of an aging generation fleet and prepare contingency plans as necessary; manage prudent and essential capital investments in generating units that could potentially be retired or deactivated in the near future, balanced with ensuring short-term reliability
2. Acquire new firm generation and solar, wind and energy storage projects through the Stage 3 procurement to facilitate deactivation and retirement of existing fossil-fuel generation through 2035
3. Complete a resource adequacy study to review reliability planning methods and renewable resource accreditation methodologies

Near-term actions to adopt emerging technologies:

4. Continue to require grid-forming technology for inverter-based resources, including for large-scale standalone wind and solar when technology is commercially available
5. Continue to monitor and evaluate the performance of new solar and storage projects, including continued assessment of system security risks as more renewable systems are brought online
6. Continue to monitor and invest in advanced technologies to operate the high inverter-based grids and seek new grid technologies to improve the reliability of the grid
7. Implement IEEE 2800-2022 in future large-scale inverter-based resource projects
8. Continue engagement with the DER industry to improve inverter performance to address system security concerns
9. Continue evaluating advanced equipment for providing system stability (e.g., grid-forming STATCOM)
10. Develop interconnection standards for grid interface of electric vehicles to get ahead of potential system security risks seen today with rooftop solar systems

1.4.1 Continue to monitor the condition of an aging generation fleet and prepare contingency plans as necessary; manage prudent and essential capital investments in generating units that could potentially be retired or deactivated in the near future, balanced with ensuring short-term reliability

Hawaiian Electric continues to maintain and make appropriate investments in generating units, completing necessary maintenance outages and overhauls on each unit. Similarly, we continue to make capital investments in existing generating units and completed about 50 capital projects in 2023.

Generating units are monitored continuously by operators and notifications of maintenance needs are made as necessary. In addition to continuous monitoring by operators, we manage and maintain existing generating units by executing a maintenance basis program which includes preventative and predictive maintenance with engineering oversight. Electrical, boiler, and turbine subject matter experts ("SMEs") also monitor equipment and help specify maintenance needs. Through this comprehensive system, all critical components receive maintenance based on monitoring (predictive maintenance technologies such as vibration monitoring) and/or time. When corrective needs are identified, they are planned into the units' maintenance schedules. This maintenance basis is executed by a team of maintenance personnel, planners, engineers, and SMEs.

We continue to develop the Waena BESS (Docket No. 2020-0132) and Waiau Repowering projects, in addition to developing contingency plans on Maui, Hawaiʻi Island, and Oʻahu. As part of the contingency planning, we are also evaluating critical spares and making investments in long-term lead items such as spare transformers.

We plan to deactivate Waiau 3 and 4 in the summer of 2024 and retire the units at the end of 2024.

1.4.2 Acquire new firm generation and solar, wind and energy storage projects through the Stage 3 procurement to facilitate deactivation and retirement of existing fossil-fuel generation through 2035

As described in Section 1.2.7 above, projects were selected from the Stage 3 RFPs for Oʻahu, Maui, and Hawaiʻi Island in December 2023 and January 2024. These projects, once in service, will help to facilitate the deactivation and retirement of existing fossil fuel resources at Waiau and Māʻalaea Power Plants, by providing additional renewable capacity and energy.

1.4.3 Complete a resource adequacy study to review reliability planning methods and renewable resource accreditation methodologies

E3, a consultant to Hawaiian Electric, recently completed an independent resource adequacy study that examined different capacity planning criteria and resource accreditation methodologies. The study found that the different criteria and methodologies could produce resource portfolios with similar installed capacity, reliability, and cost. Possible next steps were also outlined for the Commission's consideration regarding reliability standards. The study was filed as an exhibit to our April 8, 2024 letter providing comments on Commission Order No. 40651 in Docket No. 2018-0165.

1.4.4 Continue to require grid-forming technology for inverter-based resources, including for large-scale standalone wind and solar when technology is commercially available

We have continued to require grid-forming ("GFM") technology for the battery energy storage system ("BESS") inverter component in the Stage 3 and IGP RFP resource procurements. An improvement made starting in the Stage 3 RFP is more specific GFM requirements, particularly regarding short-term overcurrent capability and alignment with certain performance requirements from IEEE 2800-2022. In the preliminary analysis from the Stage 3 RFP portfolio evaluation, it is observed that the GFM component of the selected Stage 3 portfolio improves system stability. We will continue to require GFM technology for the BESS inverter component in future resource procurements.

We have yet to receive a proposal with commercially available GFM technology for a large-scale standalone wind or solar plant.

In addition, we have also been working with existing project owners to explore the option of retrofitting existing grid-following ("GFL") BESS inverters with GFM technology to improve overall system stability.

1.4.5 Continue to monitor and evaluate the performance of new solar and storage projects, including continued assessment of system security risks as more renewable systems are brought online

Several new solar and storage projects went into service recently: on O'ahu, Waiawa Solar in January 2023, West O'ahu Solar in March 2024, and Kūpono Solar in May 2024, and on Hawai'i Island, Waikoloa Solar in April 2023. While we are continuing to gain operational experience with these new projects, the management of these resources is expected to become more complex as more projects are added in the near future. As noted in Section 1.4.9 below, future contingency resources may also be needed for system security.

1.4.6 Continue to monitor and invest in advanced technologies to operate the high inverter-based grids and seek new grid technologies to improve the reliability of the grid

We continue to monitor and evaluate advanced technologies that support the planning and operation of high inverter-based grid systems. To improve the reliability of its grids with increasing inverter-based renewable energy and storage systems, we are currently working with research and industry partners in various research projects to develop and evaluate new grid solutions. This is being done through collaborative engagements that leverage industry expertise and external funding (e.g., federal grants).

In July 2023, we initiated a project with the Electric Power Research Institute ("EPRI") to evaluate the feasibility of using power electronic technologies such as solid-state transformers as an alternative to oil-filled distribution transformers. Laboratory testing of solid-state transformer design will be performed to understand its capabilities as a distribution transformer and as a voltage regulation device. Results of this testing will inform decisions on the need to further evaluate the next generation of solid-state transformers.

In March 2024, the DOE Solar Energy Technologies Office awarded the National Renewable Energy Laboratory ("NREL") $3.3 million for a project entitled "Digital Twin Addressing Multi-Scale Operational Needs of IBR-rich Grids (DIAMOND)," in which we will team with NREL and other industry partners to develop a high-fidelity, multi-scale, digital twin that provides a real-time and comprehensive view of the grid status and advise grid operators of the optimal dispatch of resources.

In April 2024, we commissioned a project with EPRI to evaluate EPRI's radio frequency wireless monitors on insulators at a substation on Maui. This research will continuously monitor, analyze, and send automated alarms to notify utility personnel when actions, such as washing, may be needed or warn when flashover potential should trigger proactive maintenance, thus reducing risk and cost of failure and improve reliability.

1.4.7 Implement IEEE 2800-2022 in future large-scale inverter-based resource projects

In the Stage 3 RFP contract performance standards, we partially adopted IEEE 2800-2022 standard and merged it with our existing RDG project performance standards, and generated the latest version of RDG project performance standard. These requirements have also been included in the IGP RFP performance standards.

1.4.8 Continue engagement with the DER industry to improve inverter performance to address system security concerns

We have been working with NREL to perform DER inverter testing to better understand DER inverter ride-through capability and characteristics, such as momentary cessation. Meanwhile, we have been sharing the findings of the inverter testing results with industry and are participating in the IEEE 1547 revision working group, proposing a new category of inverter performance requirements for isolated system, such as Hawai'i. Currently, the proposal is under review by the standard revision working group.

1.4.9 Continue evaluating advanced equipment for providing system stability (e.g., grid-forming STATCOM)

We have been evaluating system stability needs. Currently, we believe that system stability needs can be met by continuing to require GFM technology in the near-term resource procurements and GFM resource MW headroom and MWh energy reserve during daily operation. It should be noted however, that active management of these resources continues to grow in complexity with the continued addition of resources. Such increased complexities may lead to the addition of future contingency resources (e.g., GFM STATCOM, standalone FFR) to supplement the security of the system.

1.4.10 Develop interconnection standards for grid interface of electric vehicles to get ahead of potential system security risks seen today with rooftop solar systems

We have worked with EPRI to understand how existing EV chargers perform under fault conditions. Electromagnetic Transient ("EMT") models were created in this process to incorporate the aggregated behaviors of EV chargers on the system for future analyses. A key takeaway was that EV chargers' behaviors under fault conditions vary and have the potential to mitigate impact to the system if standard requirements are developed. We will continue to analyze these behaviors and anticipate developing standard requirements in the future.

2 Grid Needs Assessment for IGP RFP

This section of the Action Plan provides an update to the grid needs identified in the May 2023 IGP Final Report that incorporates changes to the resource plans and planning assumptions including the addition of the final award groups for the Stage 3 RFP. At the time of the May 2023 IGP Final Report, each island's resource portfolio was shown to be reliable assuming the long-term generator outage assumptions made as a part of the IGP process. However, recent generator outage trends on O'ahu and Hawai'i Island have prompted an update to generator outage rates to better reflect the current state of the generator fleet. As a result, we made two primary changes to the outage assumptions:

1. Generator outage rates are based on outage data from 2022 and 2023 instead of longer term historical timeframes. This allows the outage rates to reflect a more current state of the existing thermal generators.
2. Partial outages or derates are modeled as partial outages instead of equivalent full outages. This will better reflect the characteristics of the recent outage events which included both full outages and partial outages happening concurrently.

The results of the resource adequacy analyses using these new assumptions informed the IGP RFP targets below.

2.1 Proposed Targets for IGP RFP

We first updated the IGP resource plans to include the awarded projects in recent CBRE and Stage 3 RFPs, changes in expected commercial operations dates for planned projects, and adjustments in planned removal from service for Company-owned thermal generation. These changes are described in Section 3: 2024 IGP Plan. These updates then formed the basis to refresh the probabilistic resource adequacy analyses with recent outage data to identify any grid needs for the IGP RFP.

The IGP RFP set forth the following procurement targets:

Table 2-1: IGP RFP Procurement Targets

Rolling Procurement	Project GCOD	O'ahu	Hawai'i	Maui
Round 1	No later than December 1, 2029	Energy: 589 GWh Stability: 270 MW grid forming resources	Energy:134 GWh	N/A
	December 1, 2031, with preference for December 1, 2030 or earlier	N/A	Firm Capacity: 60 MW	N/A
	No later than December 1, 2032	Firm Capacity: 50 MW	N/A	N/A
Round 2	No later than December 1, 2032	Energy: 232 GWh, plus any remaining Round 1 needs, plus consideration for other projects withdrawn in previous procurements	TBD, based on any remaining Round 1 needs plus consideration for other projects withdrawn in previous procurements	Energy: 176 GWh plus consideration for other projects withdrawn in previous procurements

The IGP RFP targets are based on the following factors:

- Unmet capacity and energy targets from the Stage 3 RFP
- Existing Power Purchase Agreements ("PPAs") with Independent Power Producers ("IPPs") that are set to expire in the near-term
- Recent performance issues with aging existing firm generation and the need for more frequent maintenance
- Updated probabilistic resource adequacy analysis results presented in this section that incorporate recent outage data and better modeling of partial outages for thermal units

Based on the updated resource plans in Section 3 2024 IGP Plan, updated reliability analysis are shown for years 2029 and 2033 in Table 2-2 and Table 2-3.

Table 2-2: 2029 System Reliability

Year 2029	O'ahu 2024 IGP Plan O_Y29LC_Out24_w285HS	Hawai'i Island 2024 IGP Plan H_Y29B_Out24	Maui 2024 IGP Plan M_Y29B_Out24
Outage Rate	Updated Rates with Derate	Updated Rates with Derate	Updated Rates with Derate
Existing Firm	1,450 MW	124 + 46 (PGV) + 58 (HEP) MW	159 MW
Existing PV	188 MW	0 MW	6 MW
Existing Wind	123 MW	11 MW	42 MW
Existing Hydro	0 MW	3.35 MW	0 MW
CBRE	92 MW[7]	23 MW[8]	21 MW[9]
Stage 1 Hybrid Solar	140 MW	60 MW	60 MW
Stage 2 Hybrid Solar	79 MW	0 MW	0 MW
Stage 3 Hybrid Solar	206 MW	115 MW	80 MW[10]
Stage 3 Wind	0 MW	0 MW	30 MW
Stage 3 Firm	130 MW	0 MW	40 MW
IGP RFP Hybrid Solar	285 MW	0 MW	0 MW
IGP RFP Onshore Wind	0 MW	30 MW	0 MW
IGP RFP Firm	0 MW	0 MW	0 MW
Total	**2,693 MW**	**470 MW**	**437 MW**
Stage 1 BESS	140 MW / 558 MWh	60 MW / 240 MWh	60 MW / 240 MWh
Stage 2 BESS (incl. Standalone BESS)	214 MW / 983 MWh	0 MW	40 MW / 160 MWh
Stage 3 BESS	206 MW / 990 MWh	115 MW / 460 MWh	80 MW / 320 MWh
IGP RFP BESS	285 MW / 1,140 MWh	0 MW	0 MW
Total	**845 MW / 3,671 MWh**	**175 MW / 700 MWh**	**180 MW / 720 MWh**
LOLE (days/year)	**0.00**	**0.00**	**0.00**
LOLEv (events/year)	**0.00**	**0.00**	**0.00**
LOLH (hours/year)	**0.00**	**0.00**	**0.00**
EUE (GWh/year)	**0.00**	**0.00**	**0.00**

[7] KHLS was terminated on 10/20/23. The project was reinstated on 3/26/2024 as noted in the Docket No. 2021-0024 April 2024 Monthly Update but was not included in the analysis. Savio Solar Māʻili withdrew from the Phase 2 Tranche 1 RFP process on June 14, 2024 as noted in Docket No. 2015-0389. The project was assumed in service in the analysis.

[8] Ka Lae Solar Farm and Ka Lae 2 Solar Farm M2 Phase 2 projects were disqualified on 5/13/2024. Waikoloa Community Solar 1 and Waikoloa Community Solar 2 withdrew on 10/18/2023.

[9] Lipoa Solar + Battery withdrew from the CBRE program on May 9, 2024 as noted in Docket No. 2015-0389. The project was assumed in service in the analysis.

[10] Pu'u Hao Solar withdrew from the Stage 3 RFP on May 24, 2024 as noted in Docket No. 2017-0352. The project was assumed in service in the analysis.

Table 2-3: 2033 System Reliability

Year 2033	O'ahu 2024 IGP Plan O_Y33LC_Out24_w(285HS_RFP2_50CT)	Hawai'i Island 2024 IGP Plan H_Y33B_Out24	Maui 2024 IGP Plan M_Y33B_Out24
Outage Rate	Updated Rates with Derate	Updated Rates with Derate	Updated Rates with Derate
Existing Firm	800 MW	100 + 46 (PGV) MW	119 MW
Existing PV	177 MW	0 MW	6 MW
Existing Wind	24 MW	11 MW	0 MW
Existing Hydro	0 MW	3.35 MW	0 MW
CBRE	92 MW[11]	23 MW[12]	21 MW[13]
Stage 1 Hybrid Solar	140 MW	60 MW	60 MW
Stage 2 Hybrid Solar	79 MW	0 MW	0 MW
Stage 3 Hybrid Solar	206 MW	201 MW	80 MW[14]
Stage 3 Wind	0 MW	0 MW	30 MW
Stage 3 Firm	590 MW	60 MW + 7.5 MW BESS	40 MW
IGP RFP Hybrid Solar	285 MW	0 MW	0 MW
IGP RFP Standalone Solar	11 MW	0 MW	0 MW
IGP RFP Onshore Wind	99 MW	30 MW	40 MW
IGP RFP Firm	50 MW	60 MW	0 MW
Total	**2,553 MW**	**594 MW**	**437 MW**
Stage 1 BESS	140 MW / 558 MWh	60 MW / 240 MWh	60 MW / 240 MWh
Stage 2 BESS (incl. Standalone BESS)	214 MW / 983 MWh	0 MW	40 MW / 160 MWh
Stage 3 BESS	206 MW / 990 MWh	201 MW / 804 MWh	80 MW / 320 MWh
IGP RFP BESS	285 MW / 1,140 MWh	0 MW	0 MW
Total	**845 MW / 3,671 MWh**	**261 MW / 1,044 MWh**	**180 MW / 720 MWh**
LOLE (days/year)	**0.06**	**0.00**	**0.00**
LOLEv (events/year)	**0.10**	**0.00**	**0.00**
LOLH (hours/year)	**0.16**	**0.00**	**0.00**
EUE (GWh/year)	**0.01**	**0.00**	**0.00**

While the O'ahu, Hawai'i Island, and Maui systems are shown to attain a level of reliability better than a 0.1 days/year LOLE ("Loss of Load Expectation"), it is contingent upon all of the planned resources in the near-term achieving commercial operations and existing resources performing at their historical capability.

The figures below summarize the effect both rounds of the IGP RFP are expected to have on system reliability for O'ahu, Hawai'i Island and Maui in both ideal and contingency scenarios. Cases with the IGP RFP include proxy resources for both the firm renewable and variable renewable targets unless otherwise noted.

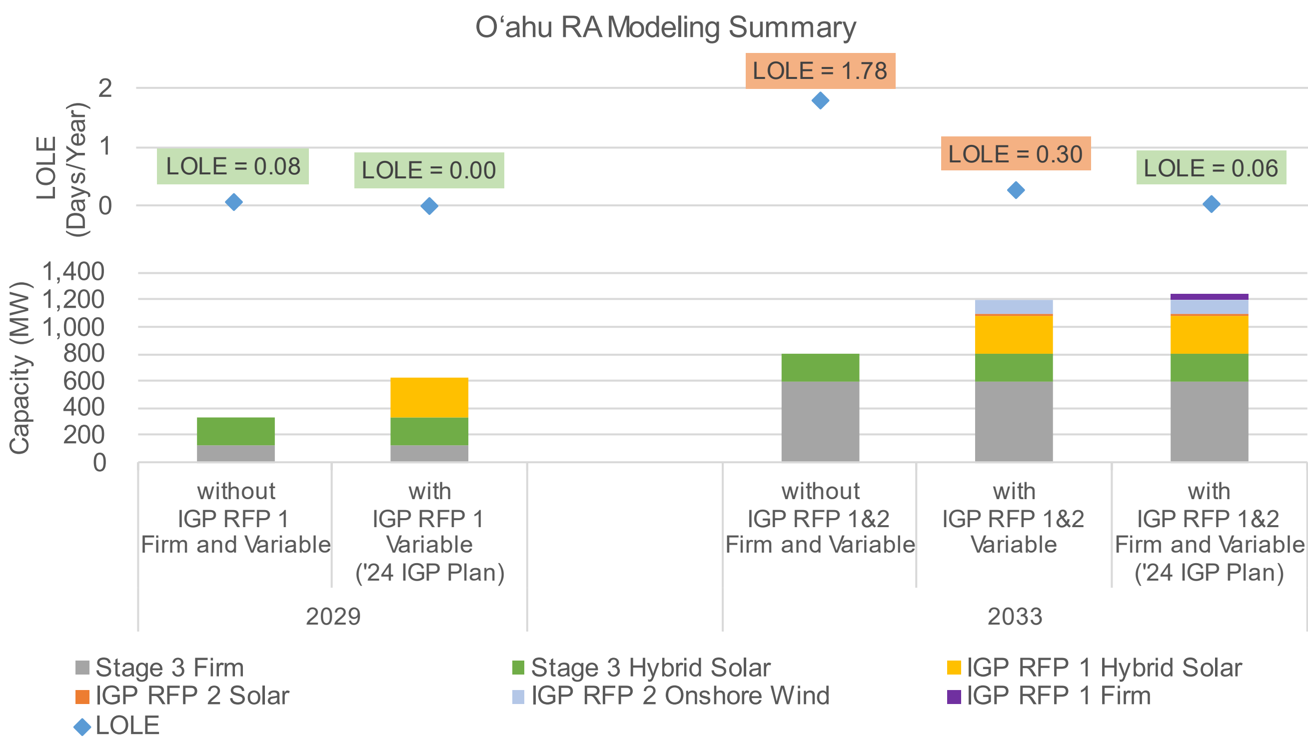

Figure 2-1: O'ahu RA modeling summary.

[11] KHLS was terminated on 10/20/23. The project was reinstated on 3/26/2024 as noted in the Docket No. 2021-0024 April 2024 Monthly Update but was not included in the analysis. Savio Solar Māʻili withdrew from the Phase 2 Tranche 1 RFP process on June 14, 2024 as noted in Docket No. 2015-0389. The project was assumed in service in the analysis.

[12] Ka Lae Solar Farm and Ka Lae 2 Solar Farm M2 Phase 2 projects were disqualified on 5/13/2024. Waikoloa Community Solar 1 and Waikoloa Community Solar 2 withdrew on 10/18/2023.

[13] Lipoa Solar + Battery withdrew from the CBRE program on May 9, 2024 as noted in Docket No. 2015-0389. The project was assumed in service in the analysis.

[14] Pu'u Hao Solar withdrew from the Stage 3 RFP on May 24, 2024 as noted in Docket No. 2017-0352. The project was assumed in service in the analysis.

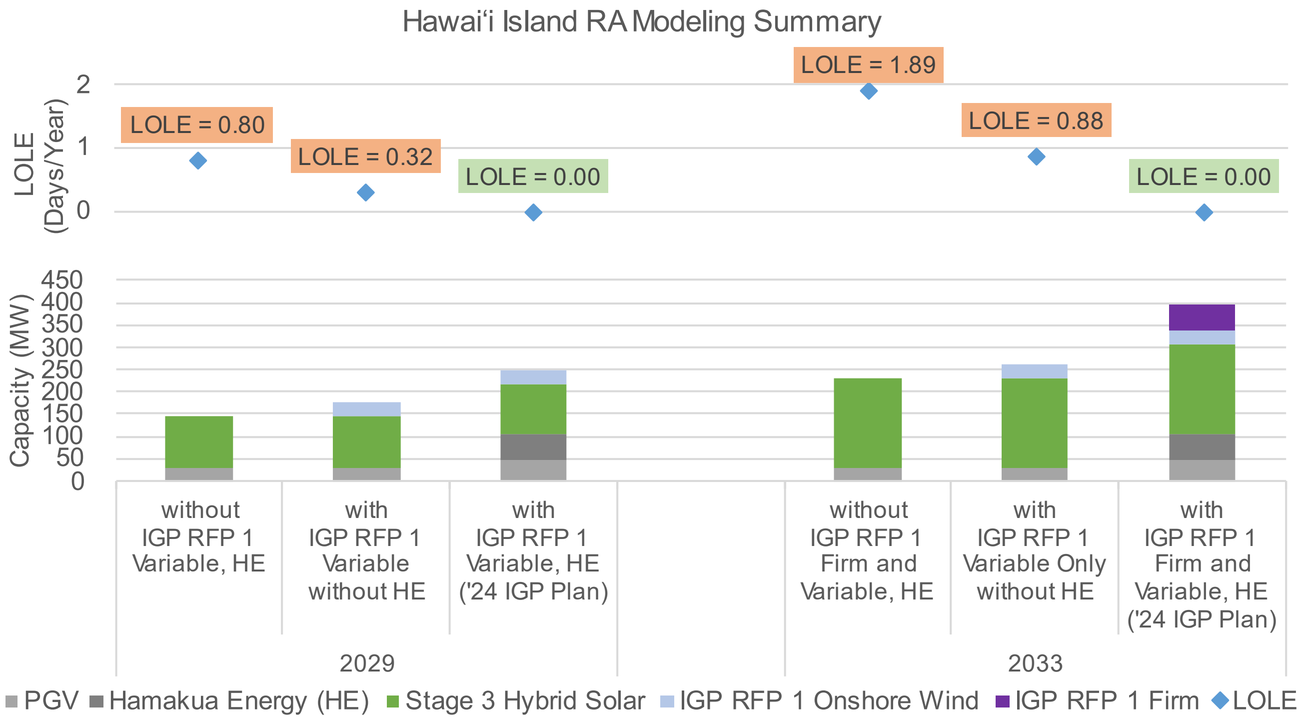

Figure 2-2: Hawaiʻi Island RA modeling summary.

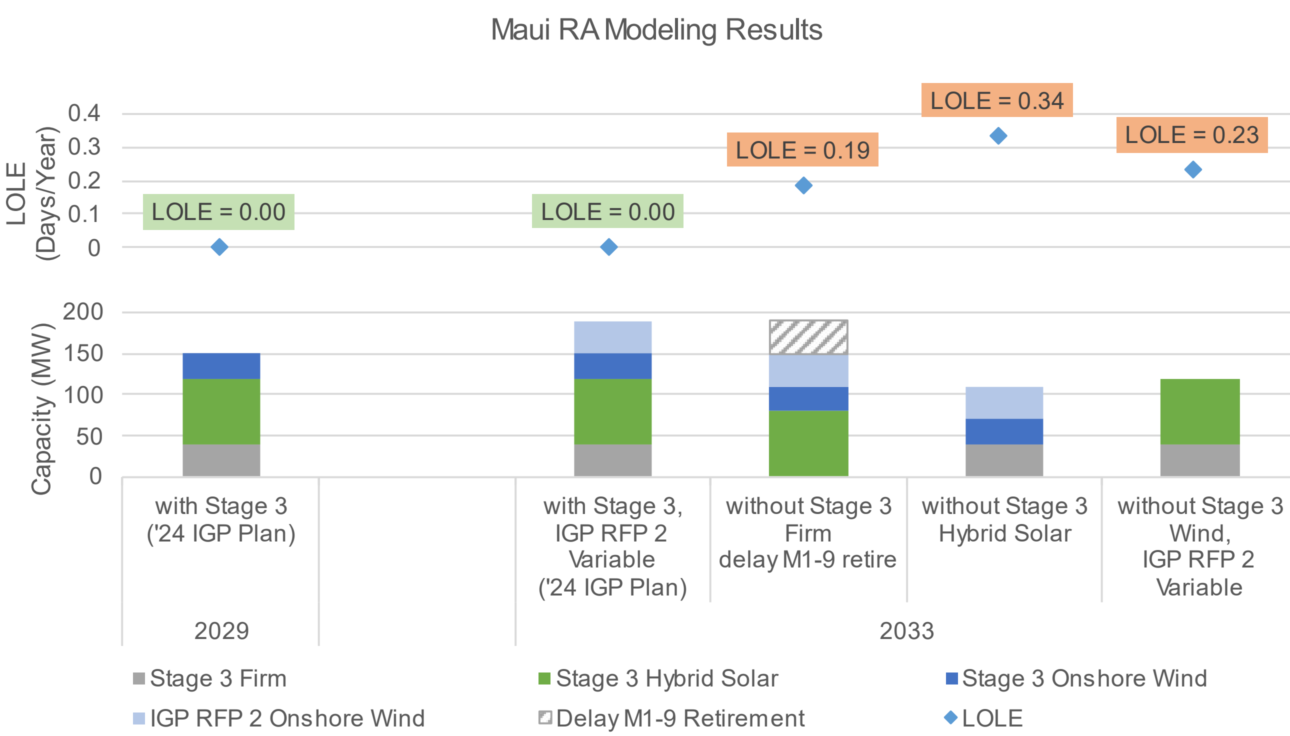

Figure 2-3: Maui RA modeling summary.

2.2 Developing Grid Needs based on Recent Outage Data

The recently accepted IGP Final Report was based on a collaborative stakeholder effort from 2019 through 2024 using approved inputs and assumptions that were developed in 2021.[15] The process and assumptions used to develop the IGP Final Report were then applied to evaluate projects in the Stage 3 RFP. The Commission acknowledged this as best practice in their order where they noted that the IGP Final Report "provides a useful framework for evaluating pending and future operational decisions and resource acquisition alternatives."[16] However, the Commission also encouraged the Companies to "evaluate how the IGP process can be more flexible to reflect new information and developments."[17]

In the grid needs assessment for the IGP RFP contained herein, updated probabilistic resource adequacy analyses reflect recent generator outage trends on O'ahu and Hawai'i Island, consistent with the Commission's guidance to incorporate new information and developments. The following generally describes the new information and developments that we incorporated into the updated resource adequacy analysis.

- The existing firm units have seen higher forced outage rates in recent years, compared to the generator outage assumptions used in IGP. Therefore, we updated the forced and maintenance outage rates for the existing firm units to the average outage rates observed in 2022-2023.
- In IGP, we modeled full unit outages and partial outages or derates were modeled as equivalent full unit outages. Explicitly modeling partial outages better represents unit outages and their effect on the system. Historical outage event data shows that, often, the total capacity on outage is composed of multiple derates and few full unit outages.
    - The probabilistic resource adequacy analysis process was revised to explicitly model these partial outages. For this analysis, separate outage rates were calculated for partial and full outages based on outage events in 2022-2023.

The grid needs assessment also examines the impact of contingency events on the system reliability; for example, if a variable or firm project is withdrawn, delayed, or on extended outage, we evaluated the amount of variable or firm resource that is needed as replacement to meet a 0.1 days/year LOLE. While a 0.1 LOLE is used as the reference benchmark for reliability, the cases also provide metrics for Loss of Load Events ("LOLEv"), Loss of Load Hours ("LOLH"), and Expected Unserved Energy ("EUE").

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[15] *See* Order No. 38253 Approving, With Modifications, Hawaiian Electric's Revised Inputs and Assumptions

[16] *See* Order No. 40651 Accepting the 2023 Final IGP Report and Providing Guidance, 3.

[17] Ibid, 78.

2.2.1 Primer on Probabilistic Resource Adequacy and Reliability Metrics

The methodology used to assess the reliability of the generating system is called probabilistic resource adequacy. We developed this methodology through extensive discussion with the Technical Advisory Panel in the Integrated Grid Planning process. Probabilistic resource adequacy is a method to quantify the risk of capacity shortfalls given the uncertainty in future system operating conditions. This method utilizes a random sampling approach to define distributions of generating resource availability using an outage rate for thermal generators and historical weather years for variable renewable resources. Fifty (50) outage draws for thermal generators and five (5) weather years for variable renewable resources are modeled for a total of 250 samples. Onshore wind data is based on historical hourly production data from existing facilities for 2015-2019. Solar and offshore wind data was provided by the National Renewable Energy Laboratory ("NREL") as part of their technical potential studies.[18]

Several metrics can be calculated to characterize the reliability of the resource plan:

- LOLE or Loss of Load Expectation is the average number of event-periods per year with unserved load across all simulated random samples. In our analyses, this is defined as days per year.
- LOLEv or Loss of Load Frequency is the average count of events per year with unserved load across all simulated random samples. An event is defined as consecutive hours of unserved load.
- LOLH or Loss of Load Hours is the average number of hours with unserved load across all simulated random samples.
- EUE or Expected Unserved Energy is the average load not served per year across all simulated random samples.

For LOLE, a target range of 0.1 represents a commonly used standard on the US Mainland. The analyses contained herein use a 0.1 LOLE as a reference to assess the relative reliability of the evaluated scenarios. The Commission intends to address reliability standards as part of its next order in the IGP docket which may provide further guidance on an appropriate standard to use when assessing the reliability of a resource plan.

Examples of LOLEv, LOLH, and EUE are provided below to illustrate how each of these metrics are calculated.

[18] See https://www.hawaiianelectric.com/a/9390 and https://energy.hawaii.gov/wp-content/uploads/2021/11/OffshoreWindOahu_NREL_Oct2021.pdf

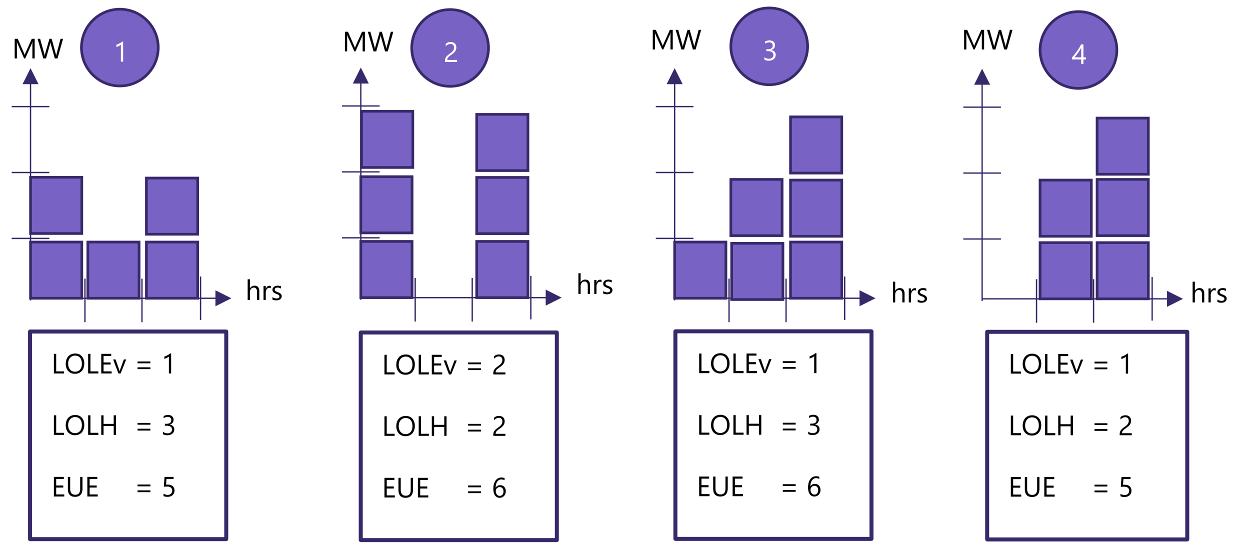

Figure 2-4: Illustration of Reliability Metrics

For a system that experiences unserved energy as defined by the blocks in Figure 2-4,

- Examples 1 and 3 have the same LOLEv and LOLH but different EUE
- Examples 1 and 4 have the same LOLEv and EUE but different LOLH
- Examples 2 and 3 have the same EUE but different LOLEv and LOLH
- In all examples, the LOLE is the same because the unserved demand occurs within the same day

2.2.2 O'ahu

Near-term reliability on O'ahu is expected to improve with the resources awarded in the Stage 3 RFP. The awarded capacity and energy from those projects, however, did not meet the entire RFP targets for O'ahu. As a result, the first round IGP RFP will target the remaining capacity and energy from the Stage 3 RFP, plus replacement energy for Barbers Point Solar, a Stage 2 project that withdrew. The first round IGP RFP will have an energy target of 589 GWh of variable renewable energy with a commercial operations date no later than December 1, 2029, as well as a firm capacity target of 50 MW with a commercial operations date no later than December 1, 2032. The firm capacity target is being sought with a later commercial operations date target due to the longer lead time needed for firm generation.

The second round IGP RFP will target 232 GWh variable renewable energy with a commercial operations date no later than December 1, 2032 to replace expiring IPP resources. The second round IGP RFP energy target may increase if any projects from prior RFPs fail to reach commercial operation and to account for any shortfall from the first round IGP RFP.

Updates to Outage Assumptions

To understand how reliability is impacted by the resources procured through the two rounds of IGP RFPs, an extensive probabilistic analysis was performed. The methodology that was established during the IGP process and presented in the IGP Final Report was improved upon in this analysis by incorporating generator derates. This analysis looked at the availability of our existing generators in 2022 and 2023, including any derated performance.

Shown below in Figure 2-5 is the number of hours that the utility-owned generators experienced a forced outage or forced derate between 2022 and 2023. Figure 2-6 is the number of hours that the utility-owned generators experienced a maintenance outage or maintenance derate between 2022 and 2023. In both figures, the outages were categorized based on the type of generator and the size of the outage. These figures compared actual performance in 2022 and 2023 to the outage rates assumed in the IGP.

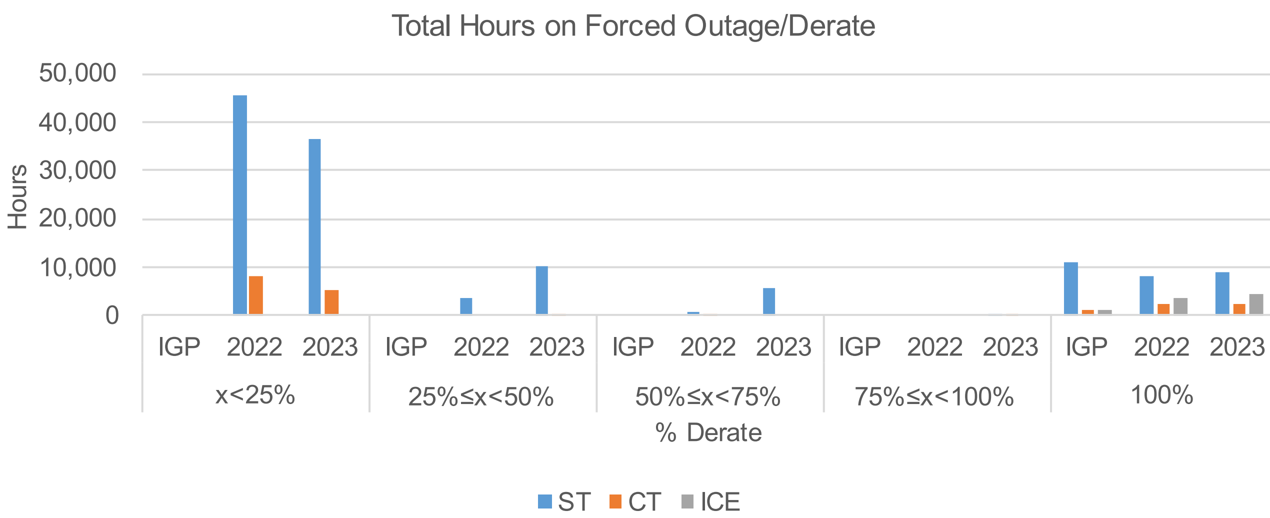

Figure 2-5: Total hours on forced outage/forced derates in 2022-2023 for utility-owned generators on O'ahu.

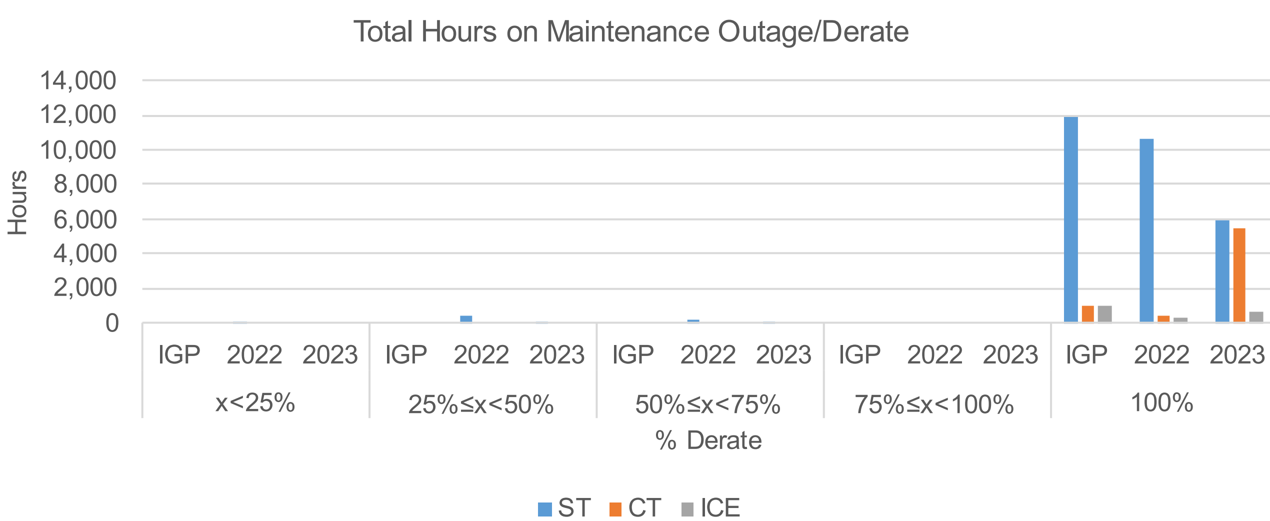

Figure 2-6: Total hours on maintenance outage/maintenance derates in 2022-2023 for utility-owned generators on O'ahu.

As shown in Figure 2-5 and Figure 2-6, the outage rate assumptions used in IGP, which modeled full unit outages and derates as equivalent full unit outages, captured the full unit outages but may have understated the derates that occurred in recent years. While a significant portion of the forced derates were less than

25% of the installed capacity, they covered a significant fraction of the year, and when added together, can represent a significant amount of firm capacity. This is evident in Figure 2-7 shown below.

Figure 2-7 takes the forced outages, from each utility-owned generator and categorize the outages based on the size of the derate. Similar to Figure 2-5, this figure highlights the impact that the derates can have on the availability of a generator. For example, as shown below, Kahe 1-3 were derated up to 25% of their installed capacity for roughly 75% of the year.

Similarly, Figure 2-8 takes the maintenance outage from each utility-owned generator and categorizes the outages based on the size of the derate. While most of the maintenance outages were full generator outages, this figure shows that several generators experienced full maintenance outages for more than 10% of the year. The 2022 and 2023 outage data were used to update assumptions regarding the duration of the outage, the size of the outage/derate, and the frequency.

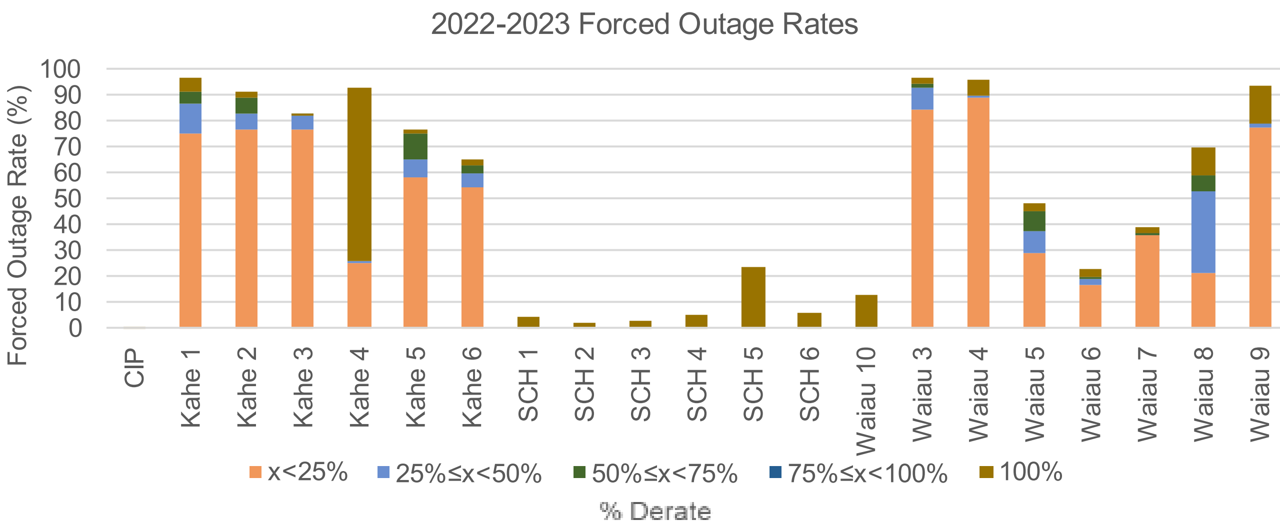

Figure 2-7: Modeled forced outage rates for utility-owned generators on O'ahu using 2022-2023 data.

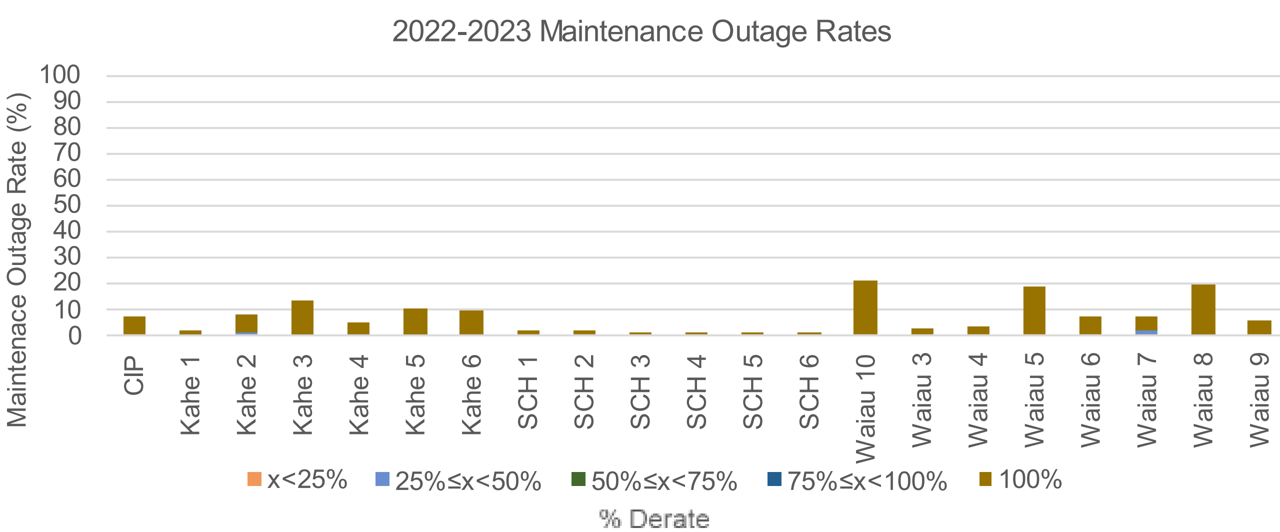

Figure 2-8: Modeled maintenance outage rates for utility-owned generators on O'ahu using 2022-2023 data.

Given the impact that derated generators are having on the reliability of our system, the probabilistic analysis was updated to directly model derates instead of approximating their impact through equivalent full unit outages. Shown below in Figure 2-9 is the total capacity on outage in year 2029 that was simulated in the probabilistic analysis. This figure shows that while the average outage across all the modeled samples may be between 300 – 600 MW, on a bad day, an individual sample may experience an outage over 900 MW, which is similar to what was experienced on January 8, 2024.

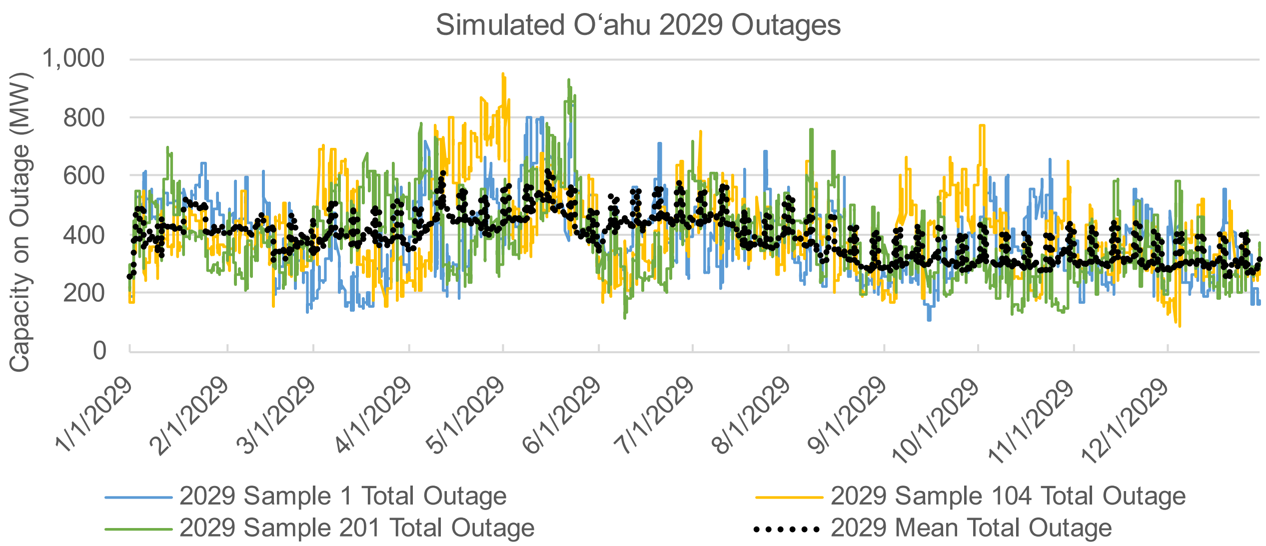

Figure 2-9: Simulated outages incorporating latest derate trends on O'ahu.[19]

On January 8, 2024, the O'ahu system experienced a severe outage event. Shown below in Figure 2-10 is the capacity that was not available. The column on the left shows the capacity that was not available the morning of January 8, 2024. While there were several large generators out of service, the "Derates @ Start of Day" was almost 200 MW and already larger than any single generator. As the day progressed, the capacity on outage reached about 1,000 MW. The January 8 outage event provides validation that the updated outage assumptions are reasonable.

[19] When comparing to actual 2024 outage events, note that there is approximately 12 MW more firm capacity on O'ahu in 2029. Waiau 3-4 (93.5 MW) are retired in 2024, Par Hawai'i (30 MW) is installed in 2027, Pu'uloa Energy (99 MW) is installed in 2028, Waiau 5-6 (108.1 MW) are retired in 2029, and Waiau 11-12 (84.2 MW) are installed in 2029.

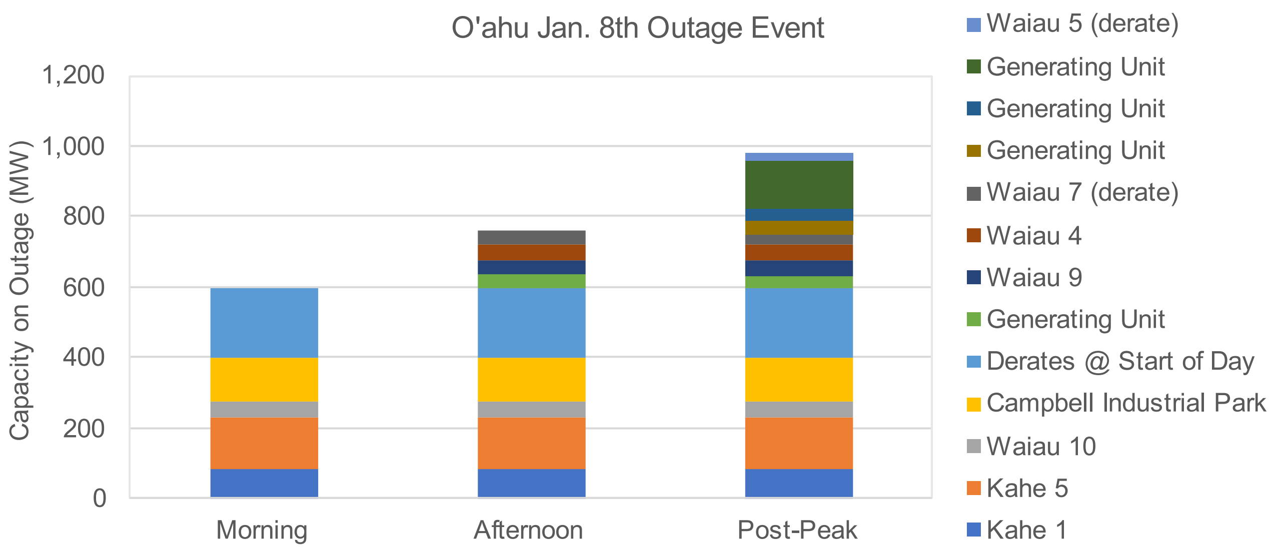

Figure 2-10: Generator capacity on outage related to January 8, 2024 event on Oʻahu.[20]

Unless otherwise noted, the scenarios examined in this analysis include partial derates and are based on 2022-2023 outage data.

For repowered facilities such as KPLP, partial derates based on its 2022-2023 outage data were removed due to its repowered status (full unit derates still modeled). The expectation is that a repowered generator would still incur full unit forced outages, like any other firm generator, but the repowering with new equipment would significantly reduce partial derates.

Updates to Planned Removal from Service Assumptions

The following units were assumed to be deactivated. Removal from service dates for Waiau 5-8 were made consistent with the Waiau Repower project schedule.

- 2024: Waiau 3-4
- 2029: Waiau 5-6
- 2031: Waiau 7-8
- 2033: Kahe 1-2

Analyses Performed

Using the updated outage rates with the derates and starting with the Oʻahu 2024 IGP Plan provided in Section 3.1 Oʻahu without future resources after Stage 3, the following probabilistic cases were performed:

[20] Specific independent power producers are not identified due to confidentiality purposes.

- Derate Sensitivity: The cases compare the 2029 and 2033 reliability metrics when the IGP outage rates are used versus recent outage rates with derates, both with and without proxy variable resources for the energy target in the first round (285 MW hybrid solar) and second round IGP RFPs (11 MW standalone solar, 99 MW onshore wind).
- Variable Sensitivity: The cases increase the amount of future hybrid solar installed in 2029, which is being used as the proxy variable resource for the energy targets in the first round IGP RFP, to determine the impact it has on the 2029 reliability metrics.
- Firm Sensitivity: The cases add in the proxy variable resources for the energy targets in the first round IGP RFP (285 MW hybrid solar) and second round IGP RFP (11 MW standalone solar, 99 MW onshore wind) then increase the amount of future firm generation installed at the start of 2033 to determine the impact it has on the 2033 reliability metrics.
- Long-Duration Energy Storage Sensitivity: The cases add in the proxy variable resources for the energy targets in the first round IGP RFP (285 MW hybrid solar) and second round IGP RFP (11 MW standalone solar, 99 MW onshore wind) then look at the feasibility of substituting any firm generation need with long-duration storage.
- Stage 3 RFP Sensitivity: The cases test how the reliability of the system may change if one of the awarded Stage 3 RFP projects does not achieve commercial operations, and what is needed to bring the LOLE below 0.1 days/year.
- Deactivation Schedule Sensitivity: The cases test whether deactivations can be accelerated or delayed while keeping the LOLE below 0.1 days/year.
- Load Sensitivity: The cases test how the reliability metrics may change based on the load forecast and how much firm generation may be needed to achieve a 2033 LOLE below 0.1 days/year.

Conclusions

Below were some of the conclusions determined from the above analysis.

- Derate Sensitivity: Incorporation of derates into the analysis can drastically impact the results of the reliability analysis.
- Variable Sensitivity: In 2029, we may not need any future hybrid solar from the first round IGP RFP to achieve a 2029 LOLE below 0.1 days/year based on the modeled capacity, assuming the base load forecast and all resources expected from past programs and procurements are in service.
- Firm Generation Sensitivity: In 2033, the variable renewable resources expected from the first round IGP RFP and second round IGP RFP are not enough to achieve a 2033 LOLE below 0.1 days/year. Approximately 50 MW of future firm generation will be needed to reach a 2033 LOLE below 0.1 days/year based on the modeled capacity.
- Long-Duration Energy Storage Sensitivity: Long-duration energy storage could not be utilized in place of firm generation. While 12-hour long-duration energy storage did improve reliability, it did not achieve a 2033 LOLE below 0.1 days/year based on the modeled capacity.

- Stage 3 RFP Sensitivity:[21]
  - If the 99 MW Pu'uloa Energy firm generation project from Stage 3 is not operational by 2029, we will need 285 MW of future hybrid solar from the first round IGP RFP to achieve a 2029 LOLE below 0.1 days/year based on the modeled capacity.
  - If the 120 MW Mahi Solar and Storage project from Stage 3 is not operational by 2029, we may not be able to achieve a 2029 LOLE below 0.1 days/year without some future hybrid solar based on the modeled capacity.
  - If Waiau Repower does not occur and the existing Waiau generators are not deactivated, we may not be able to deactivate Kahe 1-2 in 2033, and we will need some firm generation along with 285 MW of future hybrid solar from the first round IGP RFP to achieve a 2033 LOLE below 0.1 days/year based on the modeled capacity.
- Deactivation Schedule Sensitivity:
  - If we do not obtain 50 MW of future firm generation by 2033 but obtain the variable renewable resources expected from the first round IGP RFP and second round IGP RFP, the deactivation of Kahe 1-2 may need to be delayed to achieve a 2033 LOLE below 0.1 days/year. It is important to note, however, that by 2033, Kahe 1-2 will be approximately 70 years old. Their availability and maintenance requirements will likely be worse than they are currently.
  - If we obtain 50 MW of future firm generation by 2029, earlier than targeted in the IGP RFP, along with 285 MW of future hybrid solar, we may be able to accelerate the deactivation of Kahe 1-2 and have a 2029 LOLE close to 0.1 days/year based on the modeled capacity.
- Load Sensitivity: If the load exceeds the base load forecast, we may have a 2033 LOLE significantly above 0.1 days/year even if we meet the targets from the first round and second round IGP RFPs.
  - In a faster technology adoption scenario, approximately 98 MW of future firm generation would be needed to bring the 2033 LOLE below 0.1 days/year based on the modeled capacity.
  - In a high load scenario, approximately 260 MW of future firm generation would be needed to bring the 2033 LOLE below 0.1 days/year based on the modeled capacity.

RFP Targets

The recommended O'ahu RFP targets based on the extensive analysis detailed in this report are summarized below.

First Round IGP RFP Targets

- Energy Target: 589 GWh in service by December 1, 2029.

[21] These scenarios are for illustrative purposes only to demonstrate the reliability impacts of certain projects and project capacity not reaching commercial operations.

- Stability Target: 270 MW of grid-forming resources in service by December 1, 2029.
- Firm Capacity Target: 50 MW in service by December 1, 2032.

Second Round IGP RFP Targets

- Energy Target: 232 GWh in service by December 1, 2032.
    - Target may increase because of remaining needs from the first round IGP RFP or withdrawn projects from previous procurements.

While the variable sensitivity analysis indicates that we may be able to achieve a 2029 LOLE below 0.1 days/year without any resources from the first round IGP RFP, the Stage 3 RFP sensitivity has shown that if one firm Stage 3 RFP project is not in service by their proposed commercial operations date, we may need up to 285 MW of hybrid solar to bring the 2029 LOLE below 0.1 days/year. Furthermore, the firm sensitivity shows that even after maximizing all of the variable renewable potential in the Land Constrained scenario, we still need around 50 MW of firm generation in service to achieve a 2033 LOLE below 0.1 days/year, and even more in higher load scenarios. While we may be able to achieve a 2033 LOLE below 0.1 days/year by delaying the deactivation of Kahe 1-2 instead, it is important to note that, by 2033, Kahe 1-2 will be approximately 70 years old. Given the long lead time needed to procure firm generation, earlier procurement of new firm generation is prudent before existing firm generators are inoperable.

Additional details on the probabilistic analysis performed to support the conclusions above can be found in the following sections.

2.2.2.1 Derate Sensitivity

Incorporating recent derates into the analysis, the following scenarios were tested.

2029 Scenarios:

- O_Y29LC_OutIGP
  - O'ahu 2024 IGP Plan, without future resources after Stage 3.
  - Outage rates match the IGP outage rates.
- O_Y29LC_Out24
  - O'ahu 2024 IGP Plan, without future resources after Stage 3.
- O_Y29LC_OutIGP_w285HS
  - O_Y29LC_OutIGP with an additional 285 MW of hybrid solar.
  - 285 MW of hybrid solar is based on the estimated amount of hybrid solar needed to achieve the 589 GWh energy target of the First Round IGP RFP.
- O_Y29LC_Out24_w285HS
  - O_Y29LC_Out24 with an additional 285 MW of hybrid solar.

2033 Scenarios:

- O_Y33LC_OutIGP
  - O'ahu 2024 IGP Plan, without future resources after Stage 3.
  - Outage rates match the IGP outage rates.
- O_Y33LC_Out24
  - O'ahu 2024 IGP Plan, without future resources after Stage 3.
- O_Y33LC_OutIGP_w(285HS_RFP2)
  - O_Y33LC_OutIGP with an additional 285 MW of hybrid solar, 99 MW of onshore wind, and 11 MW of standalone solar.
  - The additional 99 MW of onshore wind and 11 MW of standalone solar are replacement capacity for existing IPPs that are expiring from 2029 through 2033 and represent the 232 GWh energy target of the Second Round IGP RFP.
- O_Y33LC_Out24_w(285HS_RFP2)
  - O_Y33LC_Out24 with an additional 285 MW of hybrid solar, 99 MW of onshore wind, and 11 MW of standalone solar.

Shown below in Figure 2-11 and Figure 2-12 is the relationship between future hybrid solar and LOLE when the IGP outage rates were used versus when the updated outage rates with derates were used, for years 2029 and 2033, respectively. As expected, when the derates were included, the LOLE increased. Subsequent analysis assumed the updated outage rates with derates.

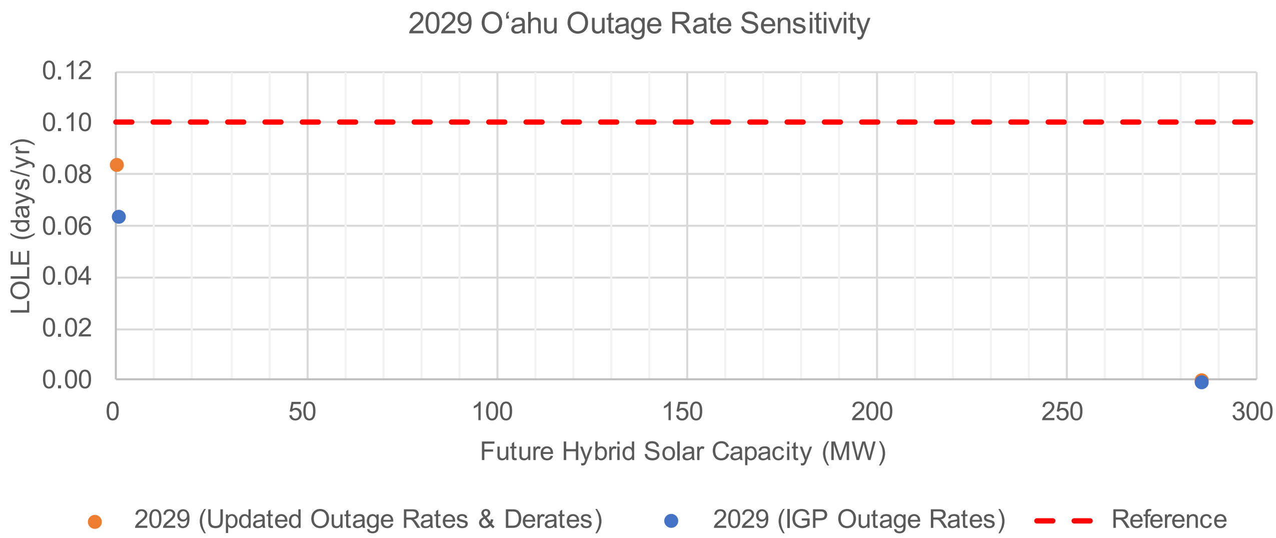

Figure 2-11: O‘ahu LOLE vs. future hybrid solar in 2029. Derate sensitivity.

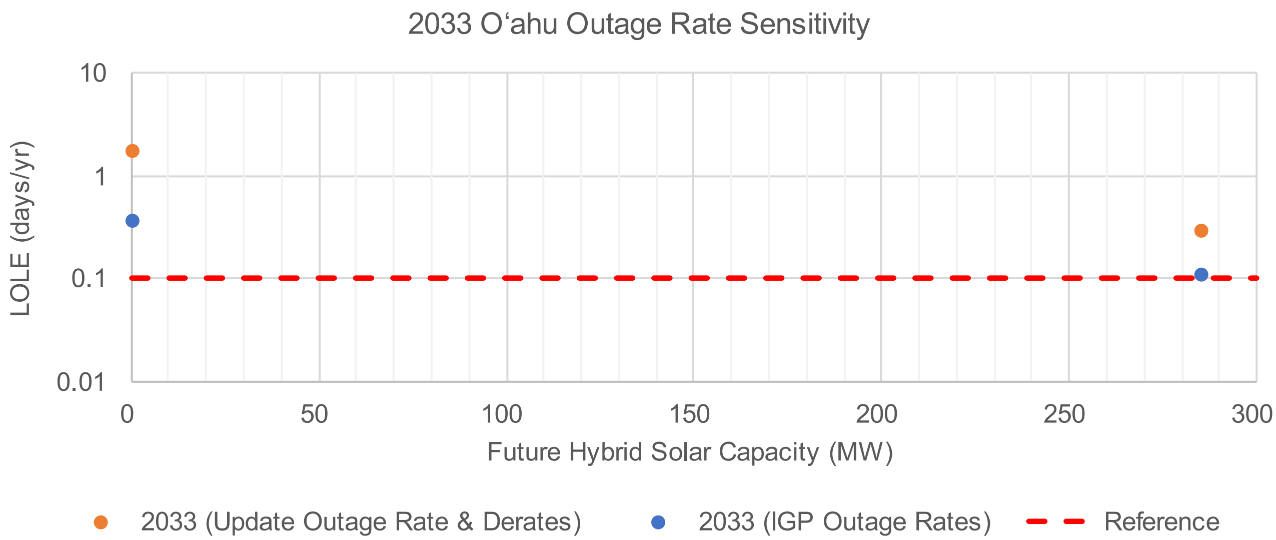

Figure 2-12: O‘ahu LOLE vs. future hybrid solar in 2033. Derate sensitivity.

The probabilistic analysis looked at 250 combinations of outage schedules and weather years. The unserved energy shown in the heat maps below is derived from the average of those 250 samples to account for all the outage/weather combinations and to correlate with LOLE. The maximum unserved energy of the average sample is shown for each time period in the heat maps.

Shown below in Figure 2-13 and Figure 2-14 are heat maps for 2029 and 2033, respectively. These heat maps show when we expect to experience unserved energy when using the IGP outage rates (left) versus when using the updated outage rates including derates (right). Evident in the figures below, the magnitude and frequency of the outages increased when derates were incorporated.

2029 O‘ahu Max. EUE of Mean Sample: L - IGP Outage Rates; R - Updated Outage Rates

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	1.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.2	0.4	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.4	0.6	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	1.3	1.6	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.5	3.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.0	3.2	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.1	2.4	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.5	2.7	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.4	3.2	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.1	3.6	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	5.7	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.2	6.5	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	2.4	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	2.8	0.0	0.0	0.0	0.0	0.0

MAX
9 MW
0 MW
MIN

Figure 2-13: O‘ahu EUE heat map, year 2029. Left - IGP outage rates (O_Y29LC_OutIGP); Right – updated outage rates with firm derates (O_Y29LC_Out24).

2033 O‘ahu Max. EUE of Mean Sample (with IGP RFP 1-2 Variable):
L - IGP Outage Rates; R - Updated Outage Rates

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.6	0.6	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.6	1.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.3	0.5	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.5	0.2	0.0	0.0	0.0	0.0	0.0
5	0.0	0.2	0.0	0.0	0.0	1.2	0.3	0.0	0.0	0.0	0.0	0.0
6	0.0	0.3	0.0	0.0	0.0	2.1	1.3	0.0	0.0	0.0	0.0	0.0
7	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
8	0.0	0.1	0.0	0.0	0.0	0.1	0.2	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.1	0.4	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	1.1	0.2	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	1.7	3.6	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	1.2	2.7	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.4	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.3	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.4	1.5	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.2	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.7	2.7	0.2	0.0	0.3	0.0	0.0
6	0.0	0.0	0.0	0.1	0.0	2.7	1.9	0.2	0.0	1.3	0.0	0.0
7	0.3	0.0	0.0	0.0	0.0	0.6	1.1	0.0	0.0	0.3	0.0	0.9
8	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.1
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	3.5	0.1	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	3.9	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	3.2	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0	0.0	0.0	0.0

MAX
9 MW
0 MW
MIN

Figure 2-14: O‘ahu EUE heat map, year 2033. Left – IGP outage rates (O_Y33LC_OutIGP_w(285HS_RFP2)); Right – updated outage rates with firm derates (O_Y33LC_Out24_w(285HS_RFP2)).

Shown below in Table 2-4 and Table 2-5 are the capacity of the resources on the system in 2029 and 2033, respectively. Any changes that were made between the cases are highlighted. At the bottom of the table are the resulting changes in the reliability metrics. As shown, by incorporating recent outage rates and derates into the analysis, the LOLE can increase significantly. This is evident, especially in 2033, when we expect to have less firm generation on the system than in 2029 due to the deactivation of Kahe 1-2 and some of the Stage 3 firm resources not being in-service at the start of the year. It is important to note that while Table 2-5 shows 590 MW of Stage 3 firm resource in 2033, this is the capacity in service at the end of the year. Of that 590 MW, approximately 85 MW is part of the Waiau Repower project and approximately 200 MW is part of the Kalaeloa Partners Base project, both of which are expected to be in service for only a fraction of the year.

Table 2-4: O'ahu probabilistic analysis results summary, year 2029. Derate sensitivity.

Year 2029	O_Y29LC_OutIGP	O_Y29LC_Out24	O_Y29LC_OutIGP_w285HS	O_Y29LC_Out24_w285HS
Outage Rate	IGP	Updated Rates with Derate	IGP	Updated Rates with Derate
Existing Firm	1,450 MW	1,450 MW	1,450 MW	1,450 MW
Existing PV	188 MW	188 MW	188 MW	188 MW
Existing Wind	123 MW	123 MW	123 MW	123 MW
CBRE	92 MW	92 MW	92 MW	92 MW
Stage 1 Ho'ohana / Mililani / Waiawa / West O'ahu	140 MW	140 MW	140 MW	140 MW
Stage 2 Kūpono / Mountain View / Waiawa2	79 MW	79 MW	79 MW	79 MW
Stage 3 Mahi / Makana Lā / Pu'uloa	206 MW	206 MW	206 MW	206 MW
Stage 3 Firm Pu'uloa / Kalaeloa / Waiau / Par	130 MW	130 MW	130 MW	130 MW
Future Hybrid Solar	0 MW	0 MW	285 MW	285 MW
Future Standalone Solar	0 MW	0 MW	0 MW	0 MW
Future Onshore Wind	0 MW	0 MW	0 MW	0 MW
Future Firm Units	0 MW	0 MW	0 MW	0 MW
Total	**2,408 MW**	**2,408 MW**	**2,693 MW**	**2,693 MW**
Stage 1 BESS	140 MW / 558 MWh	140 MW / 558 MWh	140 MW / 558 MWh	140 MW / 558 MWh
Stage 2 BESS (incl. Kapolei BESS)	214 MW / 983 MWh	214 MW / 983 MWh	214 MW / 983 MWh	214 MW / 983 MWh
Stage 3 BESS	206 MW / 990 MWh	206 MW / 990 MWh	206 MW / 990 MWh	206 MW / 990 MWh
Future BESS	0 MW / 0 MWh	0 MW / 0 MWh	285 MW / 1,140 MWh	285 MW / 1,140 MWh
Total	**560 MW / 2,531 MWh**	**560 MW / 2,531 MWh**	**845 MW / 3,671 MWh**	**845 MW / 3,671 MWh**
LOLE (days/year)	**0.06**	**0.08**	**0.00**	**0.00**
LOLEv (events/year)	**0.09**	**0.11**	**0.00**	**0.00**
LOLH (hours/year)	**0.21**	**0.47**	**0.00**	**0.00**
EUE (GWh/year)	**0.02**	**0.06**	**0.00**	**0.00**

Table 2-5: O'ahu probabilistic analysis results summary, year 2033. Derate sensitivity.

Year 2033	O_Y33LC_OutIGP	O_Y33LC_Out24	O_Y33LC_OutIGP_w(285HS_RFP2)	O_Y33LC_Out24_w(285HS_RFP2)
Outage Rate	IGP	Updated Rates with Derate	IGP	Updated Rates with Derate
Existing Firm	800 MW	800 MW	800 MW	800 MW
Existing PV	177 MW	177 MW	177 MW	177 MW
Existing Wind	24 MW	24 MW	24 MW	24 MW
CBRE	92 MW	92 MW	92 MW	92 MW
Stage 1 Ho'ohana / Mililani / Waiawa / West O'ahu	140 MW	140 MW	140 MW	140 MW
Stage 2 Kūpono / Mountain View / Waiawa2	79 MW	79 MW	79 MW	79 MW
Stage 3 Mahi / Makana Lā / Pu'uloa	206 MW	206 MW	206 MW	206 MW
Stage 3 Firm Pu'uloa / Kalaeloa / Waiau / Par	590 MW	590 MW	590 MW	590 MW
Future Hybrid Solar	0 MW	0 MW	285 MW	285 MW
Future Standalone Solar	0 MW	0 MW	11 MW	11 MW
Future Onshore Wind	0 MW	0 MW	99 MW	99 MW
Future Firm Units	0 MW	0 MW	0 MW	0 MW
Total	**2,108 MW**	**2,108 MW**	**2,503 MW**	**2,503 MW**
Stage 1 BESS	140 MW / 558 MWh	140 MW / 558 MWh	140 MW / 558 MWh	140 MW / 558 MWh
Stage 2 BESS (incl. Kapolei BESS)	214 MW / 983 MWh	214 MW / 983 MWh	214 MW / 983 MWh	214 MW / 983 MWh
Stage 3 BESS	206 MW / 990 MWh	206 MW / 990 MWh	206 MW / 990 MWh	206 MW / 990 MWh
Future BESS	0 MW / 0 MWh	0 MW / 0 MWh	285 MW / 1,140 MWh	285 MW / 1,140 MWh
Total	**560 MW / 2,531 MWh**	**560 MW / 2,531 MWh**	**845 MW / 3,671 MWh**	**845 MW / 3,671 MWh**
LOLE (days/year)	**0.38**	**1.78**	**0.11**	**0.30**
LOLEv (events/year)	**0.52**	**3.12**	**0.19**	**0.41**
LOLH (hours/year)	**1.24**	**8.69**	**0.29**	**0.74**
EUE (GWh/year)	**0.11**	**0.91**	**0.03**	**0.06**

2.2.2.2 Variable Sensitivity

The first round IGP RFP targets approximately 285 MW of hybrid solar. This capacity represents the approximate size of a proxy hybrid solar resource needed to make up the difference between what was targeted in the Stage 3 RFP and what was awarded in the Stage 3 RFP. The 285 MW of hybrid solar also includes energy that was lost by the withdrawal of Barber's Point Solar from the Stage 2 RFP.

Incorporating recent firm capacity derates into the analysis, the following scenarios were tested to determine how much of the 285 MW of hybrid solar is needed to achieve a 2029 LOLE below 0.1 days/year.

Hybrid Solar Scenarios:

- O_Y29LC_Out24
    - O'ahu 2024 IGP Plan, without future resources after Stage 3.
- O_Y29LC_Out24_w50HS
    - O_Y29LC_Out24 with an additional 50 MW of hybrid solar.
- O_Y29LC_Out24_w100HS
    - O_Y29LC_Out24 with an additional 100 MW of hybrid solar.
- O_Y29LC_Out24_w200HS
    - O_Y29LC_Out24 with an additional 200 MW of hybrid solar.
- O_Y29LC_Out24_w285HS
    - O_Y29LC_Out24 with an additional 285 MW of hybrid solar.

Shown below in Figure 2-15 is the relationship between future hybrid solar and 2029 LOLE. As expected, the results show that lower amounts of future hybrid solar have higher LOLE. The results also show that with all the expected resources through the Stage 3 RFP, we may be able to achieve a 2029 LOLE below 0.1 days/year without any future hybrid solar.

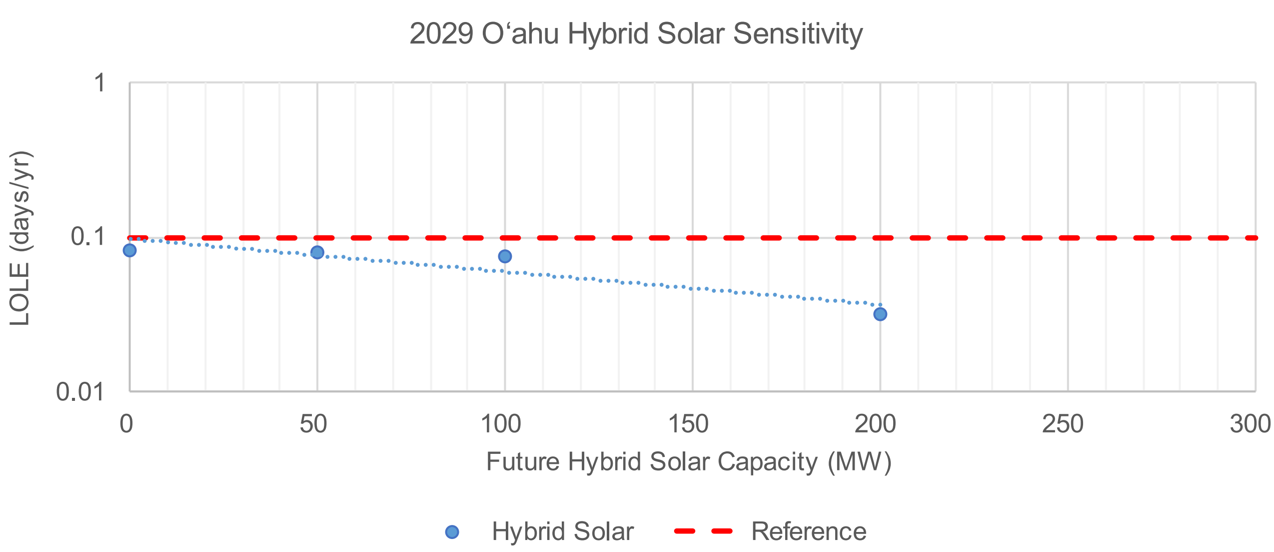

Figure 2-15: O'ahu LOLE vs. future hybrid solar in 2029. Variable sensitivity.

Figure 2-16 are heat maps showing when we expect to experience unserved energy without any future hybrid solar (left) and with an additional 200 MW of future hybrid solar (right). Figure 2-15 and Figure 2-16 indicate that while the 2029 LOLE is below 0.1 days/year with or without additional future hybrid solar, there is still some unserved energy due to forced and maintenance outages of thermal generating units that occur in July.

2029 O‘ahu Max. EUE of Mean Sample: L – 0 MW Future HS; R – 200 MW Future HS

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.0	3.2	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.1	2.4	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.5	2.7	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.4	3.2	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.1	3.6	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	5.7	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.2	6.5	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	2.4	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	2.8	0.0	0.0	0.0	0.0	0.0

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0

MAX
9 MW
0 MW
MIN

Figure 2-16: O‘ahu EUE heat map, year 2029. Left – no future hybrid solar (O_Y29LC_Out24); Right – 200 MW of future hybrid solar (O_Y29LC_Out24_w200HS).

Shown below in Table 2-6 are the capacity of the resources on the system. Any changes that were made between the cases are highlighted. At the bottom of the table are the resulting changes in the reliability metrics. The results indicate that with all the expected resources through the Stage 3 RFP, we may be able to achieve a 2029 LOLE less than 0.1 days/year without any future hybrid solar.

Table 2-6: O'ahu probabilistic analysis results summary, year 2029. Variable sensitivity.

Year 2029	O_Y29LC_Out24	O_Y29LC_Out24_w50 HS	O_Y29LC_Out24_w100 HS	O_Y29LC_Out24_w200 HS	O_Y29LC_Out24_w285 HS
Existing Firm	1,450 MW	1,450 MW	1,450 MW	1,450 MW	1,450 MW
Existing PV	188 MW	188 MW	188 MW	188 MW	188 MW
Existing Wind	123 MW	123 MW	123 MW	123 MW	123 MW
CBRE	92 MW	92 MW	92 MW	92 MW	92 MW
Stage 1 Ho'ohana / Mililani / Waiawa / West O'ahu	140 MW	140 MW	140 MW	140 MW	140 MW
Stage 2 Kūpono / Mountain View / Waiawa2	79 MW	79 MW	79 MW	79 MW	79 MW
Stage 3 Mahi / Makana Lā / Pu'uloa	206 MW	206 MW	206 MW	206 MW	206 MW
Stage 3 Firm Pu'uloa / Kalaeloa / Waiau / Par	130 MW	130 MW	130 MW	130 MW	130 MW
Future Hybrid Solar	0 MW	50 MW	100 MW	200 MW	285 MW
Future Standalone Solar	0 MW	0 MW	0 MW	0 MW	0 MW
Future Onshore Wind	0 MW	0 MW	0 MW	0 MW	0 MW
Future Firm Units	0 MW	0 MW	0 MW	0 MW	0 MW
Total	**2,408 MW**	**2,458 MW**	**2,508 MW**	**2,608 MW**	**2,693 MW**
Stage 1 BESS	140 MW / 558 MWh	140 MW / 558 MWh	140 MW / 558 MWh	140 MW / 558 MWh	140 MW / 558 MWh
Stage 2 BESS (incl. Kapolei BESS)	214 MW / 983 MWh	214 MW / 983 MWh	214 MW / 983 MWh	214 MW / 983 MWh	214 MW / 983 MWh
Stage 3 BESS	206 MW / 990 MWh	206 MW / 990 MWh	206 MW / 990 MWh	206 MW / 990 MWh	206 MW / 990 MWh
Future BESS	0 MW / 0 MWh	50 MW / 200 MWh	100 MW / 400 MWh	200 MW / 800 MWh	285 MW / 1,140 MWh
Total	**560 MW / 2,531 MWh**	**610 MW / 2,731 MWh**	**660 MW / 2,931 MWh**	**760 MW / 3,331 MWh**	**845 MW / 3,671 MWh**
LOLE (days/year)	**0.08**	**0.08**	**0.08**	**0.03**	**0.00**
LOLEv (events/year)	**0.11**	**0.12**	**0.13**	**0.05**	**0.00**
LOLH (hours/year)	**0.47**	**0.50**	**0.45**	**0.10**	**0.00**
EUE (GWh/year)	**0.06**	**0.06**	**0.05**	**0.01**	**0.00**

2.2.2.3 Firm Sensitivity

Assuming we obtain 285 MW of hybrid solar from the first round IGP RFP, there may be limitations on any further variable renewable resources due to land constraints as described in the Land Constrained scenario in the IGP Final Report. Therefore, the second round IGP RFP is comprised of replacing the energy produced by existing IPP resources that will expire between 2029 through 2033. This is approximately 99 MW of onshore wind and 11 MW of standalone solar.

As shown previously in Table 2-5, after Stage 3, with an additional 285 MW of hybrid solar, 99 MW of onshore wind, and 11 MW of standalone solar, the 2033 LOLE is expected to be around 0.30 days/year. Incorporating recent firm capacity derates into the analysis, the following scenarios were tested to determine how much future firm capacity may be needed achieve a 2033 LOLE below 0.1 days/year.

Combustion Turbine Scenarios:

- O_Y33LC_Out24_w(285HS_RFP2)
    - O'ahu 2024 IGP Plan, without future resources after Stage 3.
    - Add 285 MW of hybrid solar, 99 MW onshore wind, and 11 MW standalone solar.
- O_Y33LC_Out24_w(285HS_RFP2_50CT)
    - O_Y33LC_Out24_w(285HS_RFP2) with 1x50 MW combustion turbine.
- O_Y33LC_Out24_w(285HS_RFP2_100CT)
    - O_Y33LC_Out24_w(285HS_RFP2) with 2x50 MW combustion turbine.

Internal Combustion Engine Scenarios:

- O_Y33LC_Out24_w(285HS_RFP2_24ICE)
    - O_Y33LC_Out24_w(285HS_RFP2) with 3x8.14 MW internal combustion engines.
- O_Y33LC_Out24_w(285HS_RFP2_49ICE)
    - O_Y33LC_Out24_w(285HS_RFP2) with 6x8.14 MW internal combustion engines.
- O_Y33LC_Out24_w(285HS_RFP2_98ICE)
    - O_Y33LC_Out24_w(285HS_RFP2) with 12x8.14 MW internal combustion engines.

Shown below in Figure 2-17 is the relationship between future firm capacity and 2033 LOLE. As expected, the results show that as the amount of future firm increases, the LOLE decreases. Based on Figure 2-17 and modeled results, approximately 50 MW of future firm capacity should result in a 2033 LOLE below 0.1 days/year.

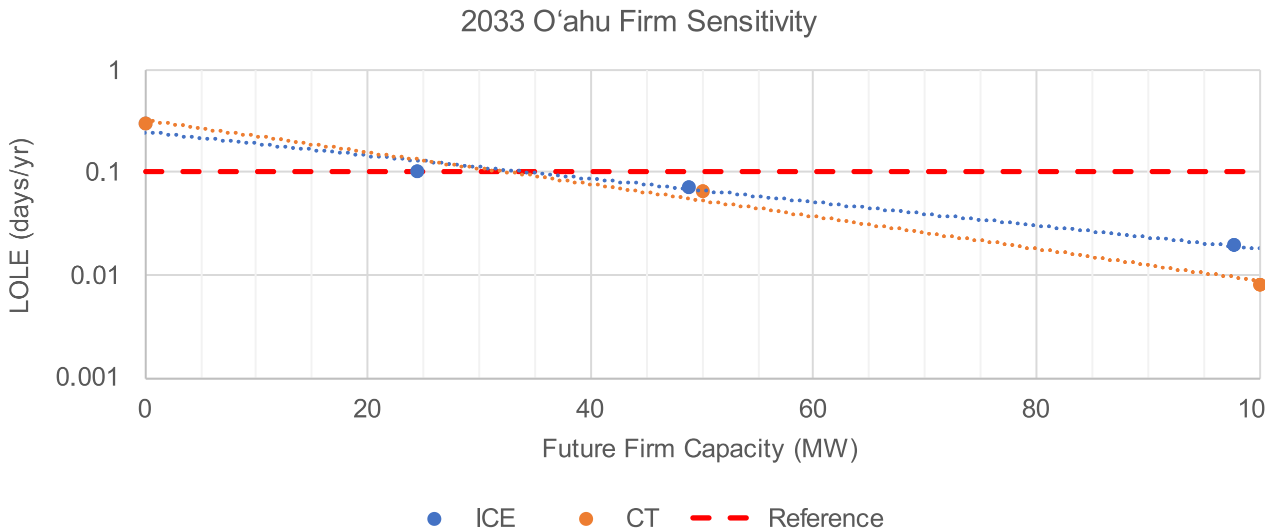

Figure 2-17: O‘ahu LOLE vs. future firm generation in 2033. Firm sensitivity.

Figure 2-18 are heat maps showing when we may expect to experience unserved energy without any future firm generation (left) and with 1x50 MW combustion turbine (right). Figure 2-19 are heat maps showing when we may expect to experience unserved energy without any future firm generation (left) and with 6x8.14 MW internal combustion engines (right). These figures show that while there may still be some unserved energy, adding firm generation should reduce the frequency and magnitude of the unserved energy.

2033 O‘ahu Max. EUE of Mean Sample (with IGP RFP 1-2 Variable):
L – 0 MW Future CT; R – 50 MW Future CT

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.4	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.3	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.4	1.5	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.2	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.7	2.7	0.2	0.0	0.3	0.0	0.0
6	0.0	0.0	0.0	0.1	0.0	2.7	1.9	0.2	0.0	1.3	0.0	0.0
7	0.3	0.0	0.0	0.0	0.0	0.6	1.1	0.0	0.0	0.3	0.0	0.9
8	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.1
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	3.5	0.1	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	3.9	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	3.2	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0	0.0	0.0	0.0

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.2	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0	0.1	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.0	0.1	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.5	1.4	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0

MAX
9 MW
0 MW
MIN

Figure 2-18: O‘ahu EUE heat map, year 2033. Left – no future firm (O_Y33LC_Out24_w(285HS_RFP2)); Right – One future CT unit (50 MW) (O_Y33LC_Out24_w(285HS_RFP2_50CT)).

2033 O‘ahu Max. EUE of Mean Sample (with IGP RFP 1-2 Variable Resources):
L – 0 MW Future ICE; R – 49 MW Future ICE

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.4	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.3	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.4	1.5	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.2	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.7	2.7	0.2	0.0	0.3	0.0	0.0
6	0.0	0.0	0.0	0.1	0.0	2.7	1.9	0.2	0.0	1.3	0.0	0.0
7	0.3	0.0	0.0	0.0	0.0	0.6	1.1	0.0	0.0	0.3	0.0	0.9
8	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.1
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	3.5	0.1	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	3.9	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	3.2	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0	0.0	0.0	0.0

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.7	2.2	0.0	0.0	0.2	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	3.7	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0

MAX
9 MW
0 MW
MIN

Figure 2-19: O‘ahu EUE heat map, year 2033. Left – no future firm (O_Y33LC_Out24_w(285HS_RFP2)); Right – Six future ICE units (49 MW) (O_Y33LC_Out24_w(285HS_RFP2_49ICE)).

Shown below in Table 2-7 and Table 2-8 are the capacity of the resources on the system. Any changes that were made between the cases are highlighted. At the bottom of the table are the resulting changes in the reliability metrics. Based on these tables, approximately 50 MW of future firm capacity is needed to achieve a 2033 LOLE below 0.1 days/year, assuming the acquired resources through the Stage 3 RFP go into service.

Table 2-7: Oʻahu probabilistic analysis results summary, year 2033. Firm sensitivity with combustion turbines.

Year 2033	O_Y33LC_Out24_w(285HS_RFP2)	O_Y33LC_Out24_w(285HS_RFP2_50CT)	O_Y33LC_Out24_w(285HS_RFP2_100CT)
Existing Firm	800 MW	800 MW	800 MW
Existing PV	177 MW	177 MW	177 MW
Existing Wind	24 MW	24 MW	24 MW
CBRE	92 MW	92 MW	92 MW
Stage 1 Hoʻohana / Mililani / Waiawa / West Oʻahu	140 MW	140 MW	140 MW
Stage 2 Kūpono / Mountain View / Waiawa2	79 MW	79 MW	79 MW
Stage 3 Mahi / Makana Lā / Puʻuloa	206 MW	206 MW	206 MW
Stage 3 Firm Puʻuloa / Kalaeloa / Waiau / Par	590 MW	590 MW	590 MW
Future Hybrid Solar	285 MW	285 MW	285 MW
Future Standalone Solar	11 MW	11 MW	11 MW
Future Onshore Wind	99 MW	99 MW	99 MW
Future Firm Units	0 MW	50 MW	100 MW
Total	**2,503 MW**	**2,553 MW**	**2,603 MW**
Stage 1 BESS	140 MW / 558 MWh	140 MW / 558 MWh	140 MW / 558 MWh
Stage 2 BESS (incl. Kapolei BESS)	214 MW / 983 MWh	214 MW / 983 MWh	214 MW / 983 MWh
Stage 3 BESS	206 MW / 990 MWh	206 MW / 990 MWh	206 MW / 990 MWh
Future BESS	285 MW / 1,140 MWh	285 MW / 1,140 MWh	285 MW / 1,140 MWh
Total	**845 MW / 3,671 MWh**	**845 MW / 3,671 MWh**	**845 MW / 3,671 MWh**
LOLE (days/year)	**0.30**	**0.06**	**0.01**
LOLEv (events/year)	**0.41**	**0.10**	**0.01**
LOLH (hours/year)	**0.74**	**0.16**	**0.01**
EUE (GWh/year)	**0.06**	**0.01**	**0.00**

Table 2-8: Oʻahu probabilistic analysis results summary, year 2033. Firm sensitivity with internal combustion engines.

Year 2033	O_Y33LC_Out24_w(285HS_RFP2)	O_Y33LC_Out24_w(285HS_RFP2_24ICE)	O_Y33LC_Out24_w(285HS_RFP2_49ICE)	O_Y33LC_Out24_w(285HS_RFP2_98ICE)
Existing Firm	800 MW	800 MW	800 MW	800 MW
Existing PV	177 MW	177 MW	177 MW	177 MW
Existing Wind	24 MW	24 MW	24 MW	24 MW
CBRE	92 MW	92 MW	92 MW	92 MW
Stage 1 Hoʻohana / Mililani / Waiawa / West Oʻahu	140 MW	140 MW	140 MW	140 MW
Stage 2 Kūpono / Mountain View / Waiawa2	79 MW	79 MW	79 MW	79 MW
Stage 3 Mahi / Makana Lā / Puʻuloa	206 MW	206 MW	206 MW	206 MW
Stage 3 Firm Puʻuloa / Kalaeloa / Waiau / Par	590 MW	590 MW	590 MW	590 MW
Future Hybrid Solar	285 MW	285 MW	285 MW	285 MW
Future Standalone Solar	11 MW	11 MW	11 MW	11 MW
Future Onshore Wind	99 MW	99 MW	99 MW	99 MW
Future Firm Units	0 MW	24 MW	49 MW	98 MW
Total	**2,503 MW**	**2,528 MW**	**2,552 MW**	**2,601 MW**
Stage 1 BESS	140 MW / 558 MWh	140 MW / 558 MWh	140 MW / 558 MWh	140 MW / 558 MWh
Stage 2 BESS (incl. Kapolei BESS)	214 MW / 983 MWh	214 MW / 983 MWh	214 MW / 983 MWh	214 MW / 983 MWh
Stage 3 BESS	206 MW / 990 MWh	206 MW / 990 MWh	206 MW / 990 MWh	206 MW / 990 MWh
Future BESS	285 MW / 1,140 MWh	285 MW / 1,140 MWh	285 MW / 1,140 MWh	285 MW / 1,140 MWh
Total	**845 MW / 3,671 MWh**	**845 MW / 3,671 MWh**	**845 MW / 3,671 MWh**	**845 MW / 3,671 MWh**
LOLE (days/year)	**0.30**	**0.10**	**0.07**	**0.02**
LOLEv (events/year)	**0.41**	**0.15**	**0.08**	**0.02**
LOLH (hours/year)	**0.74**	**0.26**	**0.16**	**0.05**
EUE (GWh/year)	**0.06**	**0.03**	**0.02**	**0.00**

2.2.2.4 Long-Duration Energy Storage Sensitivity

Incorporating recent firm capacity derates into the analysis, the following scenarios were tested to determine whether long-duration energy storage could be utilized in place of firm generation to reduce the 2033 LOLE below 0.1 days/year. Scenarios adjusting either the power output (MW) or the capacity (MWh) were tested.

Battery Power Output Scenarios:

- O_Y33LC_Out24_w(285HS_RFP2)
  - O'ahu 2024 IGP Plan, without future resources after Stage 3.
  - Add 285 MW of hybrid solar, 99 MW onshore wind, and 11 MW standalone solar.
- O_Y33LC_Out24_w(285HS_RFP2_25LDS[12])
  - O_Y33LC_Out24_w(285HS_RFP2) with a 25 MW 12-hour long-duration energy storage.
- O_Y33LC_Out24_w(285HS_RFP2_50LDS[12])
  - O_Y33LC_Out24_w(285HS_RFP2) with a 50 MW 12-hour long-duration energy storage.
- O_Y33LC_Out24_w(285HS_RFP2_100LDS[12])
  - O_Y33LC_Out24_w(285HS_RFP2) with a 100 MW 12-hour long-duration energy storage.

Battery Capacity Scenarios:

- O_Y33LC_Out24_w(285HS_RFP2)
  - O'ahu 2024 IGP Plan, without future resources after Stage 3.
  - Add 285 MW of hybrid solar, 99 MW onshore wind, and 11 MW standalone solar.
- O_Y33LC_Out24_w(285HS_RFP2_100LDS[6])
  - O_Y33LC_Out24_w(285HS_RFP2) with a 100 MW 6-hour long-duration energy storage.
- O_Y33LC_Out24_w(285HS_RFP2_100LDS[8])
  - O_Y33LC_Out24_w(285HS_RFP2) with a 100 MW 8-hour long-duration energy storage.
- O_Y33LC_Out24_w(285HS_RFP2_100LDS[12])
  - O_Y33LC_Out24_w(285HS_RFP2) with a 100 MW 12-hour long-duration energy storage.

Shown below in Figure 2-20 is the relationship between the 2033 LOLE and the power output of a 12-hr long-duration storage. Figure 2-21 shows the relationship between the 2033 LOLE and the storage capacity of a 100 MW long-duration storage. As shown in both figures, while long-duration storage may help reduce the LOLE, there are diminishing returns on LOLE reductions. Greater amounts of additional long-duration storage require more non-storage generating resources on the system to charge it (i.e., solar, wind, firm renewables).

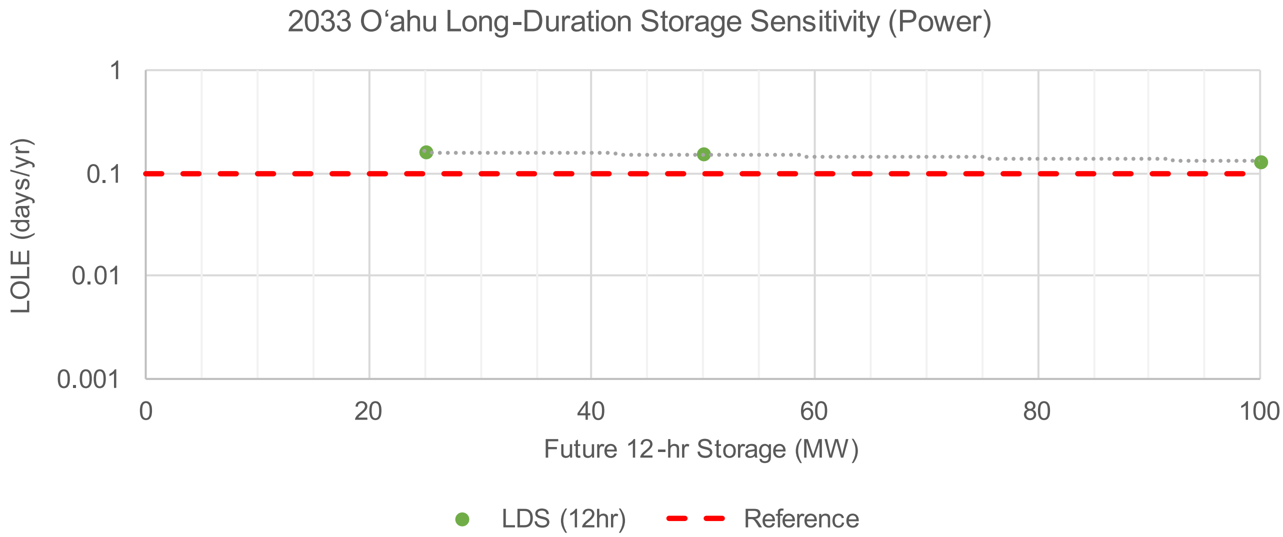

Figure 2-20: O‘ahu LOLE vs. power output of 12-hr long-duration storage in 2033. Long-duration storage sensitivity.

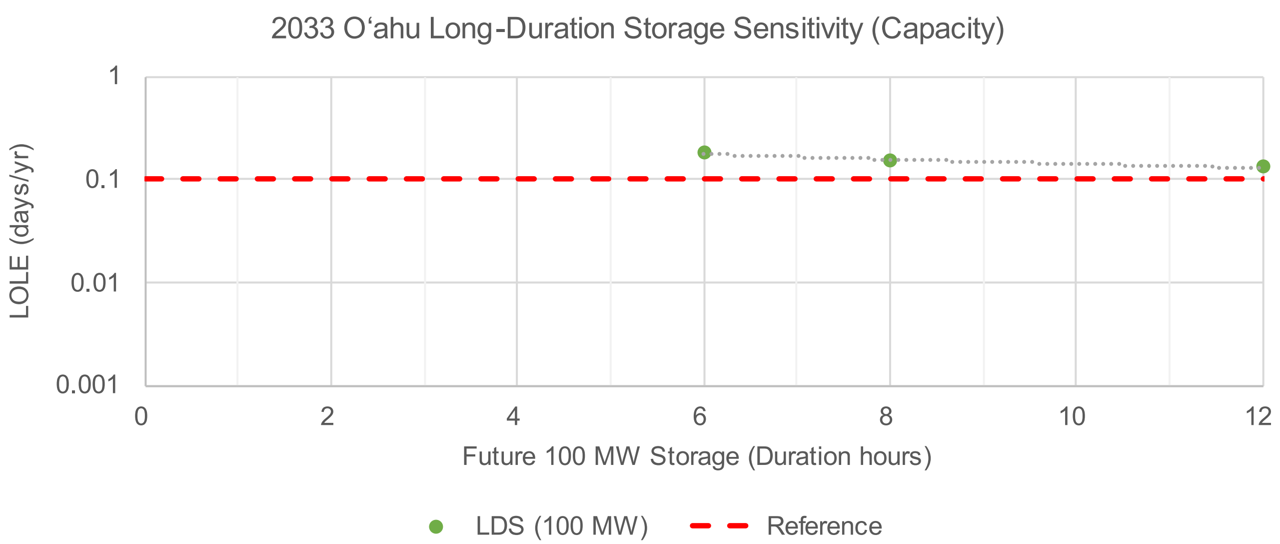

Figure 2-21: O‘ahu LOLE vs. capacity of 100 MW of long-duration storage in 2033. Long-duration storage sensitivity.

Figure 2-22 are heat maps showing when we may expect to experience unserved energy without any long-duration storage (left) and with a 100 MW 12-hr long-duration storage (right). While long-duration storage addresses some of the unserved energy, the impact is not as drastic when compared to installing firm generation, as was shown earlier.

2033 O‘ahu Max. EUE of Mean Sample (with IGP RFP 1-2 Variable):
L – 0 MW Future LDS(12h); R – 100 MW Future LDS(12h)

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.4	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.3	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.4	1.5	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.2	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.7	2.7	0.2	0.0	0.3	0.0	0.0
6	0.0	0.0	0.0	0.1	0.0	2.7	1.9	0.2	0.0	1.3	0.0	0.0
7	0.3	0.0	0.0	0.0	0.0	0.6	1.1	0.0	0.0	0.3	0.0	0.9
8	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.1
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	3.5	0.1	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	3.9	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	3.2	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0	0.0	0.0	0.0

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.1	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.8	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	1.7	1.2	0.0	0.1	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.4	2.0	3.1	0.0	0.6	0.0	0.2
7	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.0	0.0	0.2	0.0	0.4
8	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	2.4	1.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0

MAX
9 MW
0 MW
MIN

Figure 2-22: O‘ahu EUE heat map, year 2033. Left – no future long-duration storage (O_Y33LC_Out24_w(285HS_RFP2)); Right – 100 MW 12-hr future long-duration storage (O_Y33LC_Out24_w(285HS_RFP2_100LDS[12])).

Shown below in Table 2-9 and Table 2-10 are the capacity of the resources on the system. Any changes that were made between the cases are highlighted. At the bottom of the table are the resulting changes in the reliability metrics. The tables show that while increasing the power (MW) or capacity (MWh) of long-duration storage may help reduce the LOLE, unlike the addition of future firm resources, the impact of additional long-duration storage on reducing LOLE becomes minimal. The 2033 LOLE is still above 0.1 days/year, even with 385 MW / 2,340 MWh of future storage added.

Table 2-9: O'ahu probabilistic analysis results summary, year 2033. Long-duration energy storage sensitivity. Power output scenarios.

Year 2033	O_Y33LC_Out24_w(285HS_RFP2)	O_Y33LC_Out24_w(285HS_RFP2_25LDS[12])	O_Y33LC_Out24_w(285HS_RFP2_50LDS[12])	O_Y33LC_Out24_w(285HS_RFP2_100LDS[12])
Existing Firm	800 MW	800 MW	800 MW	800 MW
Existing PV	177 MW	177 MW	177 MW	177 MW
Existing Wind	24 MW	24 MW	24 MW	24 MW
CBRE	92 MW	92 MW	92 MW	92 MW
Stage 1 Ho'ohana / Mililani / Waiawa / West O'ahu	140 MW	140 MW	140 MW	140 MW
Stage 2 Kūpono / Mountain View / Waiawa2	79 MW	79 MW	79 MW	79 MW
Stage 3 Mahi / Makana Lā / Pu'uloa	206 MW	206 MW	206 MW	206 MW
Stage 3 Firm Pu'uloa / Kalaeloa / Waiau / Par	590 MW	590 MW	590 MW	590 MW
Future Hybrid Solar	285 MW	285 MW	285 MW	285 MW
Future Standalone Solar	11 MW	11 MW	11 MW	11 MW
Future Onshore Wind	99 MW	99 MW	99 MW	99 MW
Future Firm Units	0 MW	0 MW	0 MW	0 MW
Total	**2,503 MW**	**2,503 MW**	**2,503 MW**	**2,503 MW**
Stage 1 BESS	140 MW / 558 MWh	140 MW / 558 MWh	140 MW / 558 MWh	140 MW / 558 MWh
Stage 2 BESS (incl. Kapolei BESS)	214 MW / 983 MWh	214 MW / 983 MWh	214 MW / 983 MWh	214 MW / 983 MWh
Stage 3 BESS	206 MW / 990 MWh	206 MW / 990 MWh	206 MW / 990 MWh	206 MW / 990 MWh
Future BESS	285 MW / 1,140 MWh	310 MW / 1,440 MWh	335 MW / 1,740 MWh	385 MW / 2,340 MWh
Total	**845 MW / 3,671 MWh**	**870 MW / 3,971 MWh**	**895 MW / 4,271 MWh**	**945 MW / 4,871 MWh**
LOLE (days/year)	**0.30**	**0.16**	**0.16**	**0.13**
LOLEv (events/year)	**0.41**	**0.26**	**0.27**	**0.21**
LOLH (hours/year)	**0.74**	**0.46**	**0.45**	**0.42**
EUE (GWh/year)	**0.06**	**0.04**	**0.04**	**0.03**

Table 2-10: O'ahu probabilistic analysis results summary, year 2033. Long-duration energy storage sensitivity. Capacity scenarios.

Year 2033	O_Y33LC_Out24_w(285HS_RFP2)	O_Y33LC_Out24_w(285HS_RFP2_100LDS[6])	O_Y33LC_Out24_w(285HS_RFP2_100LDS[8])	O_Y33LC_Out24_w(285HS_RFP2_100LDS[12])
Existing Firm	800 MW	800 MW	800 MW	800 MW
Existing PV	177 MW	177 MW	177 MW	177 MW
Existing Wind	24 MW	24 MW	24 MW	24 MW
CBRE	92 MW	92 MW	92 MW	92 MW
Stage 1 Ho'ohana / Mililani / Waiawa / West O'ahu	140 MW	140 MW	140 MW	140 MW
Stage 2 Kūpono / Mountain View / Waiawa2	79 MW	79 MW	79 MW	79 MW
Stage 3 Mahi / Makana Lā / Pu'uloa	206 MW	206 MW	206 MW	206 MW
Stage 3 Firm Pu'uloa / Kalaeloa / Waiau / Par	590 MW	590 MW	590 MW	590 MW
Future Hybrid Solar	285 MW	285 MW	285 MW	285 MW
Future Standalone Solar	11 MW	11 MW	11 MW	11 MW
Future Onshore Wind	99 MW	99 MW	99 MW	99 MW
Future Firm Units	0 MW	0 MW	0 MW	0 MW
Total	**2,503 MW**	**2,503 MW**	**2,503 MW**	**2,503 MW**
Stage 1 BESS	140 MW / 558 MWh	140 MW / 558 MWh	140 MW / 558 MWh	140 MW / 558 MWh
Stage 2 BESS (incl. Kapolei BESS)	214 MW / 983 MWh	214 MW / 983 MWh	214 MW / 983 MWh	214 MW / 983 MWh
Stage 3 BESS	206 MW / 990 MWh	206 MW / 990 MWh	206 MW / 990 MWh	206 MW / 990 MWh
Future BESS	285 MW / 1,140 MWh	385 MW / 1,740 MWh	385 MW / 1,940 MWh	385 MW / 2,340 MWh
Total	**845 MW / 3,671 MWh**	**945 MW / 4,271 MWh**	**945 MW / 4,471 MWh**	**945 MW / 4,871 MWh**
LOLE (days/year)	**0.30**	**0.18**	**0.15**	**0.13**
LOLEv (events/year)	**0.41**	**0.28**	**0.26**	**0.21**
LOLH (hours/year)	**0.74**	**0.46**	**0.44**	**0.42**
EUE (GWh/year)	**0.06**	**0.04**	**0.04**	**0.03**

Figure 2-23 is a sample dispatch of the day with the highest amount of unserved energy as well as the two days before and after. In general, unserved energy occurs over consecutive days, where there are not enough resources on the system to charge the long-duration storage.

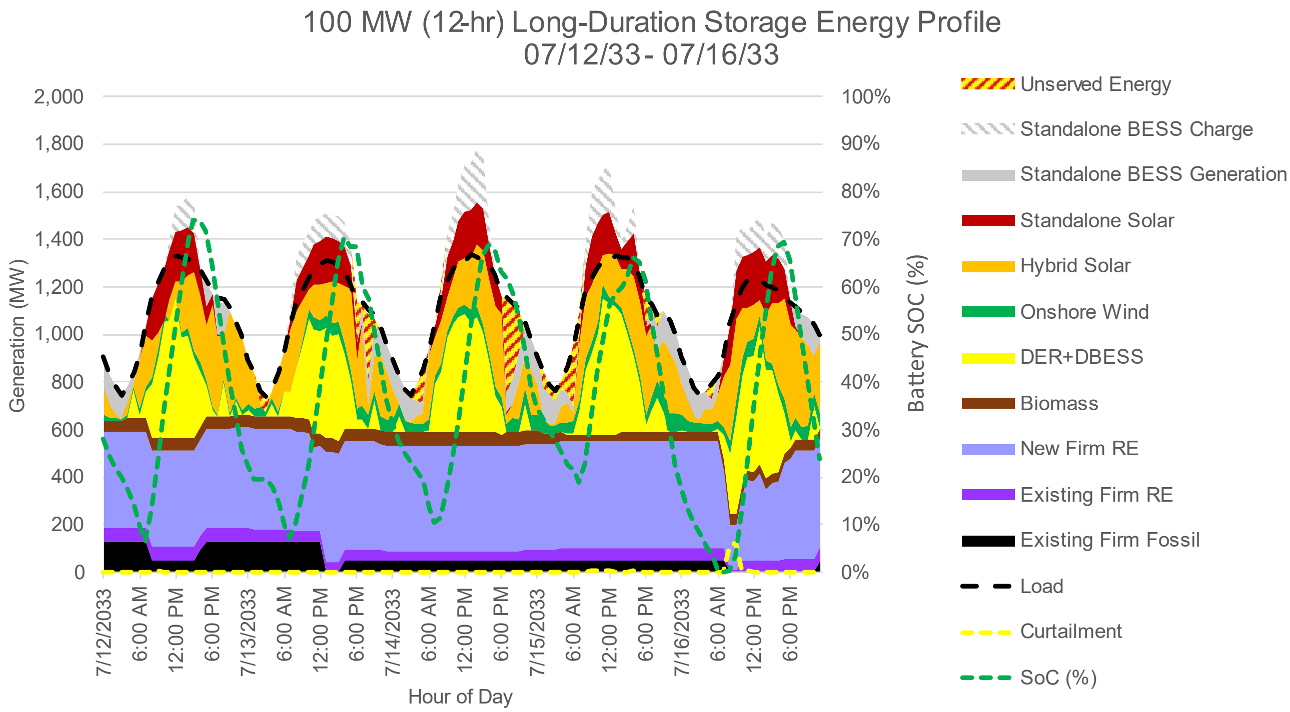

Figure 2-23: Oʻahu five-day sample dispatch containing the day with the highest amount of unserved energy.

2.2.2.5 Stage 3 RFP Sensitivity

We recently awarded several new projects through the Stage 3 RFP. Based on experience from past RFPs, there is a possibility that some of the selected proposals from the Stage 3 RFP may experience delays or withdraw completely. Based on this experience, a few sensitivities were performed to examine how the LOLE is affected if a Stage 3 awardee does not come into service. The following sensitivities are for illustrative purposes only to test the impact to reliability if certain projects or MW capacity does not achieve commercial operations.

Puʻuloa Energy

In 2029, the largest Stage 3 firm resource that is expected to be operational is Puʻuloa Energy, which are internal combustion engines with a combined output of 99 MW. Incorporating recent derates into the analysis, the following scenarios were tested to determine how the withdrawal of Puʻuloa Energy impacts the needs of the first round IGP RFP.

Scenarios w/o Puʻuloa Energy:

- O_Y29LC_Out24_woPuuFm_w100HS
    - Oʻahu 2024 IGP Plan, without future resources after Stage 3.
    - Remove Puʻuloa Energy.

    - Add 100 MW of hybrid solar.
- O_Y29LC_Out24_woPuuFm_w200HS
    - Oʻahu 2024 IGP Plan, without future resources after Stage 3.
    - Remove Puʻuloa Energy.
    - Add 200 MW of hybrid solar.
- O_Y29LC_Out24_woPuuFm_w285HS
    - Oʻahu 2024 IGP Plan, without future resources after Stage 3.
    - Remove Puʻuloa Energy.
    - Add 285 MW of hybrid solar.

Shown below in Figure 2-24, if Puʻuloa Energy does not come into service, we will need 285 MW of hybrid solar from the First Round IGP RFP to have a 2029 LOLE below 0.1 days/year based on the modeled capacity. If, however, only 200 MW of hybrid solar is obtained in the First Round IGP RFP, which is approximately the same amount awarded during the Stage 3 RFP, the 2029 LOLE would be greater than 0.1 days/year based on the modeled capacity.

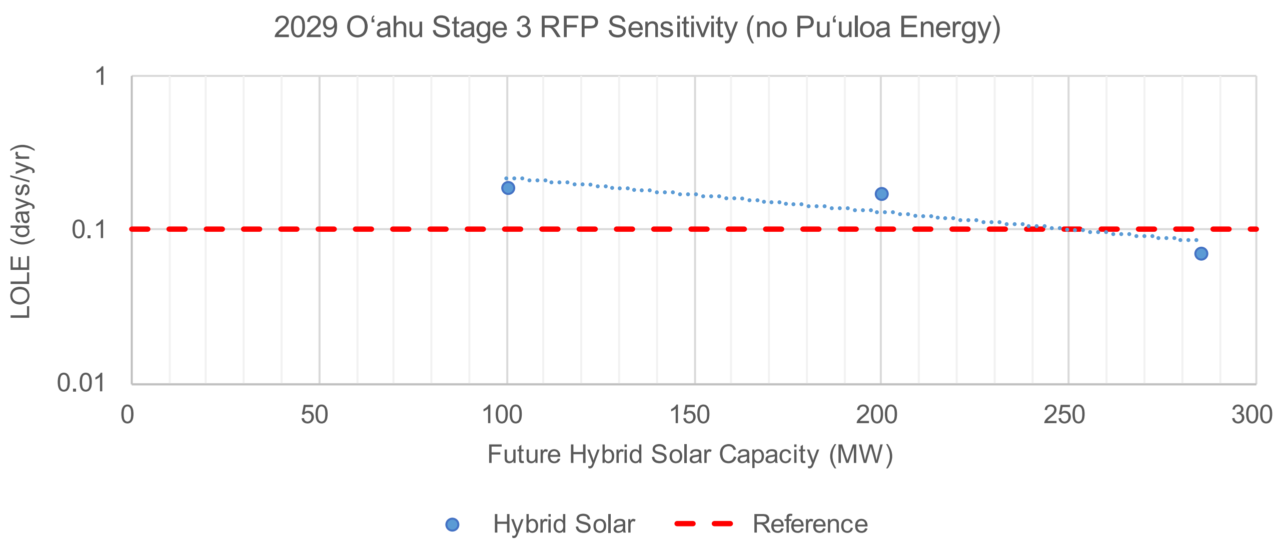

Figure 2-24: Oʻahu LOLE vs. future hybrid solar in 2029 without Puʻuloa Energy. Stage 3 sensitivity.

Figure 2-25 are heat maps showing when we may expect to experience unserved energy without Puʻuloa Energy and with only 100 MW of future hybrid solar (left) and without Puʻuloa Energy and with 285 MW of future hybrid solar (right). Both the magnitude and frequency of unserved energy is greatly reduced when future hybrid solar is increased from 100 MW to 285 MW.

2029 O‘ahu Max. EUE of Mean Sample (No Pu‘uloa Energy):
L – 100 MW Future HS; R – 285 MW Future HS

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.8	0.0	2.2	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.3	0.0	3.3	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.7	0.0	2.2	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	2.4	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	1.2	0.0	3.4	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	2.7	0.0	5.1	0.2	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	4.3	0.3	6.7	0.2	0.0	0.1	0.0	0.0
7	0.0	0.0	0.0	0.0	1.2	0.0	2.9	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.2	0.0	0.1	0.0	0.0	0.0	0.2	0.0
19	0.0	0.0	0.0	0.0	0.8	0.0	0.9	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.8	0.0	3.3	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.4	0.0	2.4	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	1.0	0.0	2.1	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.2	0.0	2.7	0.0	0.0	0.0	0.0	0.0

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.1	0.0	0.3	0.0	0.1	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.3	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.2	0.0	0.3	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.1	0.6	0.0	1.1	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.6	0.0	0.3	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.2	0.0	0.6	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

MAX
9 MW
0 MW
MIN

Figure 2-25: O‘ahu EUE heat map, year 2029. Left – 100 MW future hybrid solar (O_Y29LC_Out24_woPuuFm_w100HS); Right – 285 MW future hybrid solar (O_Y29LC_Out24_woPuuFm_w285HS).

Shown below in Table 2-11 are the capacity of the resources on the system. Any changes that were made between the cases are highlighted. At the bottom of the table are the resulting changes in the reliability metrics. Results show that with the removal of Pu‘uloa Energy, the 2029 LOLE increases from 0.00 days/year to 0.07 days/year. This assumes that we get 285 MW of future hybrid solar operational in 2029. If we get less hybrid solar, the 2029 LOLE will likely be higher than 0.1 days/year based on the modeled capacity.

Table 2-11: O'ahu probabilistic analysis results summary, year 2029, without Pu'uloa Energy. Stage 3 RFP sensitivity.

Year 2029	O_Y29LC_Out24_w285HS	O_Y29LC_Out24_woPuuFm_ w285HS	O_Y29LC_Out24_woPuuFm_ w200HS	O_Y29LC_Out24_woPuuFm_ w100HS
Existing Firm	1,450 MW	1,450 MW	1,450 MW	1,450 MW
Existing PV	188 MW	188 MW	188 MW	188 MW
Existing Wind	123 MW	123 MW	123 MW	123 MW
CBRE	92 MW	92 MW	92 MW	92 MW
Stage 1 Ho'ohana / Mililani / Waiawa / West O'ahu	140 MW	140 MW	140 MW	140 MW
Stage 2 Kūpono / Mountain View / Waiawa2	79 MW	79 MW	79 MW	79 MW
Stage 3 Mahi / Makana Lā / Pu'uloa	206 MW	206 MW	206 MW	206 MW
Stage 3 Firm Pu'uloa / Kalaeloa / Waiau / Par	130 MW	31 MW	31 MW	31 MW
Future Hybrid Solar	285 MW	285 MW	200 MW	100 MW
Future Standalone Solar	0 MW	0 MW	0 MW	0 MW
Future Onshore Wind	0 MW	0 MW	0 MW	0 MW
Future Firm Units	0 MW	0 MW	0 MW	0 MW
Total	**2,693 MW**	**2,594 MW**	**2,509 MW**	**2,409 MW**
Stage 1 BESS	140 MW / 558 MWh	140 MW / 558 MWh	140 MW / 558 MWh	140 MW / 558 MWh
Stage 2 BESS (incl. Kapolei BESS)	214 MW / 983 MWh	214 MW / 983 MWh	214 MW / 983 MWh	214 MW / 983 MWh
Stage 3 BESS	206 MW / 990 MWh	206 MW / 990 MWh	206 MW / 990 MWh	206 MW / 990 MWh
Future BESS	285 MW / 1,140 MWh	285 MW / 1,140 MWh	200 MW / 800 MWh	100 MW / 400 MWh
Total	**845 MW / 3,671 MWh**	**845 MW / 3,671 MWh**	**760 MW / 3,331 MWh**	**660 MW / 2,931 MWh**
LOLE (days/year)	**0.00**	**0.07**	**0.18**	**0.19**
LOLEv (events/year)	**0.00**	**0.08**	**0.26**	**0.24**
LOLH (hours/year)	**0.00**	**0.12**	**0.52**	**0.82**
EUE (GWh/year)	**0.00**	**0.01**	**0.05**	**0.09**

Mahi Solar and Storage

In 2029, the largest Stage 3 variable resource that is expected to be operational is Mahi Solar and Storage, which is a 120 MW/480 MWh hybrid solar system. Incorporating recent derates into the analysis, the following scenarios were tested to determine how the withdrawal of Mahi Solar and Storage may impact the needs of the First Round IGP RFP.

Scenarios w/o Mahi Solar and Storage:

- O_Y29LC_Out24_woMahi_w0HS
  - O'ahu 2024 IGP Plan, without future resources after Stage 3.
  - Remove Mahi Solar and Storage.
- O_Y29LC_Out24_woMahi_w100HS
  - O_Y29LC_Out24_woMahi_w0HS with an additional 100 MW of hybrid solar.
- O_Y29LC_Out24_woMahi_w200HS
  - O_Y29LC_Out24_woMahi_w0HS with an additional 200 MW of hybrid solar.
- O_Y29LC_Out24_woMahi_w285HS
  - O_Y29LC_Out24_woMahi_w0HS with an additional 285 MW of hybrid solar.

Shown below in Figure 2-26, if Mahi Solar and Storage does not come into service, 2029 LOLE may be close to 0.1 days/year without any future hybrid solar. By comparing Figure 2-24 and Figure 2-26, we can compare the value of firm generation to hybrid solar toward reducing the likelihood of unserved energy. Without Mahi Solar and Storage, which is 120 MW of hybrid solar, we may need some future hybrid solar to achieve a 2029 LOLE below 0.1 days/year; but without Pu'uloa Energy, which is 100 MW of firm generation, we may need 285 MW of future hybrid solar to achieve a 2029 LOLE below 0.1 days/year based on the modeled capacity.

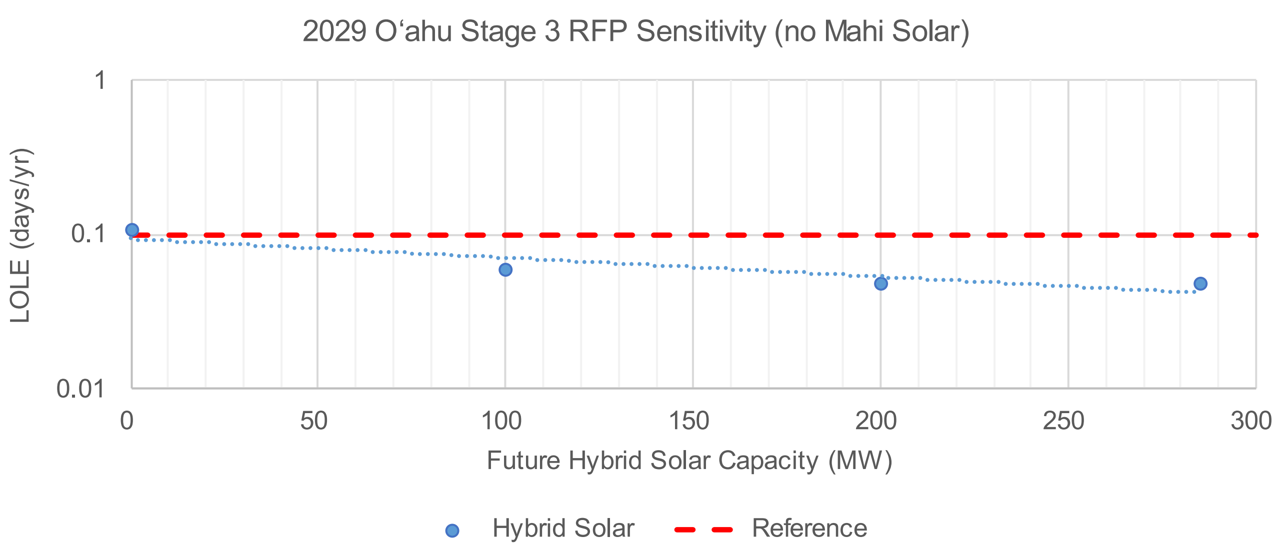

Figure 2-26: O'ahu LOLE vs. future hybrid solar in 2029 without Mahi Solar and Storage. Stage 3 sensitivity.

Figure 2-27 are heat maps showing when we may expect to experience unserved energy without Mahi Solar and Storage and without future hybrid solar (left) and without Mahi Solar and Storage but with 285 MW of future hybrid solar (right). The results show that we may still experience unserved energy even with 285 MW of hybrid solar from the First Round IGP RFP if Mahi Solar and Storage does not come into service.

2029 Oʻahu Max. EUE of Mean Sample (No Mahi Solar):
L – 0 MW Future HS; R – 285 MW Future HS

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.1	4.6	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.2	3.3	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.2	3.1	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.6	3.6	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	4.6	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.1	0.8	6.4	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.2	1.2	8.2	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.1	0.0	4.2	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.1	4.1	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	4.2	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.4	4.6	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.2	4.4	0.0	0.0	0.0	0.0	0.0

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.3	0.0	0.4	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	1.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	2.4	0.0	0.5	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0

MAX
9 MW
0 MW
MIN

Figure 2-27: Oʻahu EUE heat map, year 2029. Left – 0 MW future hybrid solar (O_Y29LC_Out24_woMahi_w0HS); Right – 285 MW future hybrid solar (O_Y29LC_Out24_woMahi_w285HS).

Shown below in Table 2-12 are the capacity of the resources on the system. Any changes that were made between the cases are highlighted. At the bottom of the table are the resulting changes in the reliability metrics. With the removal of Mahi Solar and Storage, the 2029 LOLE increases from 0.00 days/year to 0.05 days/year. This assumes that we get 285 MW of hybrid solar in service at the beginning of 2029. If we get less future hybrid solar, the 2029 LOLE will likely be higher and may be above 0.1 days/year if no future hybrid solar is acquired based on the modeled capacity. Comparing the results shown in Table 2-11 and Table 2-12 highlights the value that reliable firm generation provides in reducing the likelihood of days of unserved energy. Removing a firm project from the Stage 3 RFP resulted in a higher 2029 LOLE than removing a similar sized variable project from the Stage 3 RFP.

Table 2-12: O'ahu probabilistic analysis results summary, year 2029, without Mahi Solar and Storage. Stage 3 RFP sensitivity.

Year 2029	O_Y29LC_Out24_w285 HS	O_Y29LC_Out24_woMa hi_w285HS	O_Y29LC_Out24_woMa hi_w200HS	O_Y29LC_Out24_woMa hi_w100HS	O_Y29LC_Out24_woMa hi_w0HS
Existing Firm	1,450 MW	1,450 MW	1,450 MW	1,450 MW	1,450 MW
Existing PV	188 MW	188 MW	188 MW	188 MW	188 MW
Existing Wind	123 MW	123 MW	123 MW	123 MW	123 MW
CBRE	92 MW	92 MW	92 MW	92 MW	92 MW
Stage 1 Ho'ohana / Mililani / Waiawa / West O'ahu	140 MW	140 MW	140 MW	140 MW	140 MW
Stage 2 Kūpono / Mountain View / Waiawa2	79 MW	79 MW	79 MW	79 MW	79 MW
Stage 3 Mahi / Makana Lā / Pu'uloa	206 MW	86 MW	86 MW	86 MW	86 MW
Stage 3 Firm Pu'uloa / Kalaeloa / Waiau / Par	130 MW	130 MW	130 MW	130 MW	130 MW
Future Hybrid Solar	285 MW	285 MW	200 MW	100 MW	0 MW
Future Standalone Solar	0 MW	0 MW	0 MW	0 MW	0 MW
Future Onshore Wind	0 MW	0 MW	0 MW	0 MW	0 MW
Future Firm Units	0 MW	0 MW	0 MW	0 MW	0 MW
Total	**2,693 MW**	**2,573 MW**	**2,488 MW**	**2,388 MW**	**2,288 MW**
Stage 1 BESS	140 MW / 558 MWh	140 MW / 558 MWh	140 MW / 558 MWh	140 MW / 558 MWh	140 MW / 558 MWh
Stage 2 BESS (incl. Kapolei BESS)	214 MW / 983 MWh	214 MW / 983 MWh	214 MW / 983 MWh	214 MW / 983 MWh	214 MW / 983 MWh
Stage 3 BESS	206 MW / 990 MWh	86 MW / 510 MWh	206 MW / 990 MWh	206 MW / 990 MWh	206 MW / 990 MWh
Future BESS	285 MW / 1,140 MWh	285 MW / 1,140 MWh	200 MW / 800 MWh	100 MW / 400 MWh	0 MW / 0 MWh
Total	**845 MW / 3,671 MWh**	**725 MW / 3,191 MWh**	**640 MW / 2,851 MWh**	**540 MW / 2,451 MWh**	**440 MW / 2,051 MWh**
LOLE (days/year)	**0.00**	**0.05**	**0.05**	**0.06**	**0.11**
LOLEv (events/year)	**0.00**	**0.06**	**0.06**	**0.08**	**0.15**
LOLH (hours/year)	**0.00**	**0.12**	**0.17**	**0.46**	**0.63**
EUE (GWh/year)	**0.00**	**0.01**	**0.02**	**0.06**	**0.09**

Waiau Repower

In 2033, when the second round IGP RFP resources are expected to come into service, the largest Stage 3 firm resource that is expected to be operational are the new generators at Waiau Power Plant. By the end of 2033, the new units at Waiau are expected to have a combined output of 252.6 MW. If the Waiau Repower project does not achieve commercial operations, we will likely have to delay the deactivation of Waiau 5-8, as well as, delay the deactivation of Kahe 1-2. Incorporating recent firm capacity derates into the analysis, the following scenarios were tested to determine how the reliability may change if the Waiau Repower project is not successful, and we must rely on our existing Waiau generators.

Scenarios with Waiau 5-8 instead of Waiau Repower:

- O_Y33LC_Out24_w(W5-8_K1-2)
  - O'ahu 2024 IGP Plan, without future resources after Stage 3.
  - Remove Waiau Repower.
  - Waiau 5-8 remain in service. Kahe 1-2 remain in service.
- O_Y33LC_Out24_w(W5-8_K1-2_285HS)
  - O_Y33LC_Out24_w(W5-8_K1-2) with an additional 285 MW hybrid solar.
- O_Y33LC_Out24_w(W5-8_K1-2_RFP1)
  - O_Y33LC_Out24_w(W5-8_K1-2) with an additional 285 MW hybrid solar and 6x8.14 MW internal combustion engines.
- O_Y33LC_Out24_w(W5-8_K1-2_RFP1-2)
  - O_Y33LC_Out24_w(W5-8_K1-2) with an additional 285 MW hybrid solar, 99 MW of onshore wind, 11 MW of standalone solar and 6x8.14 MW internal combustion engines,.

Shown below in Figure 2-28, if Waiau Repower does not occur and we are required to rely on our existing Waiau generators and delay the deactivation of Kahe 1-2, we will not achieve a 2033 LOLE below 0.1 days/year with just the 285 MW of hybrid solar from the first round IGP RFP. We will need some firm generation along with the hybrid solar to achieve a 2033 LOLE below 0.1 days/year based on the modeled capacity assuming we keep Waiau 5-8 and Kahe 1-2 in service. It is important to note that by 2033, Waiau 5-8 will be 65-75 years old and Kahe 1-2 will be about 70 years old and may have lower availability due to increased maintenance and forced outages associated with their age. Therefore, while the analysis suggests we may be able to achieve a 2033 LOLE below 0.1 days/year without the Stage 3 Waiau Repower, this assumes that we get resources from the first round IGP RFP, and that the availability of Waiau 5-8 and Kahe 1-2 will not be worse than their 2022-2023 data for the next ten years. If, however, we do not get firm resources from the first round IGP RFP, the 2033 LOLE will likely be higher than 0.1 days/year, as shown in Figure 2-28.

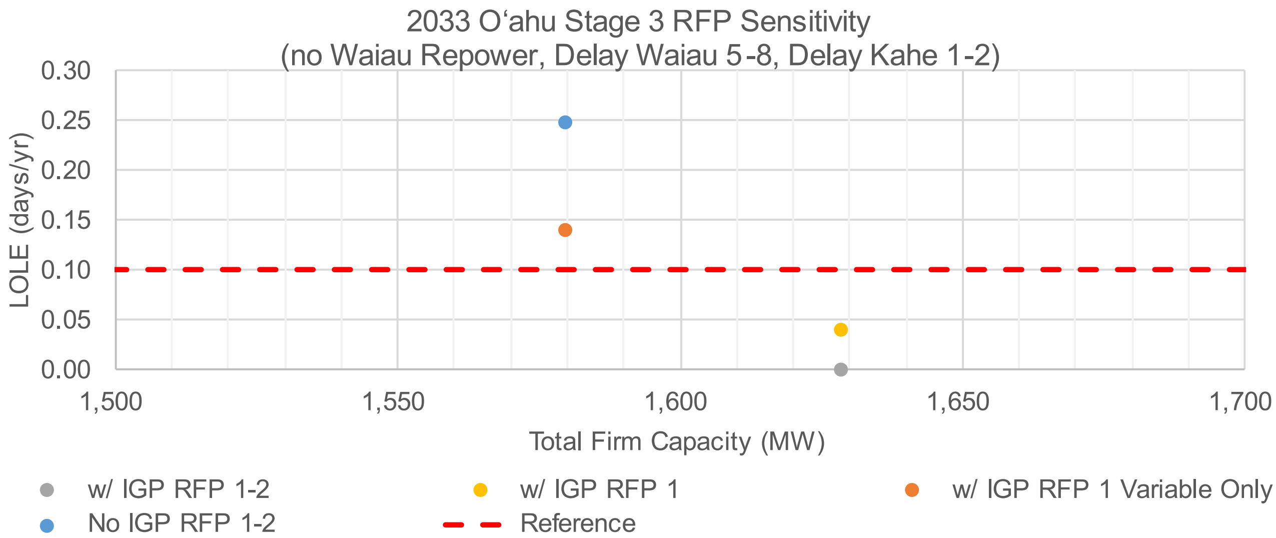

Figure 2-28: O‘ahu LOLE vs. total firm capacity in 2033 without Waiau Repower. Stage 3 sensitivity.

Figure 2-29 are heat maps showing when we may expect to experience unserved energy without Waiau Repower and no future IGP RFPs (left) and without Waiau Repower and all the resources from the first round and second round IGP RFPs (right). The results show that we may not experience unserved energy, assuming the base load forecast and all resources expected from past programs and procurements and the first Round and second Round IGP RFPs, are in service. This also assumes that the availability of Waiau 5-8 and Kahe 1-2 will not deteriorate further. As stated earlier, however, by 2033, Waiau 5-8 will be 65-75 years old and Kahe 1-2 will be about 70 years old and may have lower availability due to increased maintenance and forced outages associated with their age. Even though the system may appear reliable, these older generators must be replaced with adequate levels of new firm capacity as soon as possible.

2033 O‘ahu Max. EUE of Mean Sample (no Waiau Repower, Delay Waiau 5-8, Delay Kahe 1-2):
L – without IGP RFPs; R – with IGP RFPs

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.5	3.6	0.2	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.5	2.1	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.4	2.1	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.6	2.1	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	1.3	3.3	0.1	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.9	4.2	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	2.7	5.3	0.5	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.3	1.3	0.1	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.1	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.1	2.2	0.5	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.2	4.5	0.4	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.5	8.1	1.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.3	6.8	0.1	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	7.2	0.3	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	4.9	0.6	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	4.9	0.2	0.0	0.0	0.0	0.0

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

MAX	
9 MW	
0 MW	
MIN	

Figure 2-29: O‘ahu EUE heat map, year 2033. Left – without IGP RFPs (O_Y33LC_Out24_w(W5-8_K1-2)); Right – with IGP RFPs (O_Y33LC_Out24_w(W5-8_K1-2_RFP1-2)).

Shown below in Table 2-13 are the capacity of the resources on the system. Any changes that were made between the cases are highlighted. At the bottom of the table are the resulting changes in the reliability metrics. With the removal of Waiau Repower, the 2033 LOLE is around 0.25 days/year. This assumes that we continue our existing generation at Waiau and Kahe, some of which we planned to deactivate by 2033 and account for approximately 440 MW of firm generation. By 2033, Waiau 5-8 will have ages ranging from 65-75 years old, Kahe 1-2 will be around 70 years old, and both will likely be less reliable than they are currently. With the addition of 285 MW of hybrid solar and 50 MW of firm generation from the First Round IGP RFP, we may be able to deactivate some firm generation and achieve a 2033 LOLE below 0.1 days/year based on the modeled capacity.

Table 2-13: O‘ahu probabilistic analysis results summary, year 2033, without Waiau Repower. Stage 3 RFP sensitivity.

Year 2033	O_Y33LC_Out24_w(W5-8_K1-2)	O_Y33LC_Out24_w(W5-8_K1-2_285HS)	O_Y33LC_Out24_w(W5-8_K1-2_RFP1)	O_Y33LC_Out24_w(W5-8_K1-2_RFP1-2)
Existing Firm	1,242 MW	1,242 MW	1,242 MW	1,242 MW
Existing PV	177 MW	177 MW	177 MW	177 MW
Existing Wind	24 MW	24 MW	24 MW	24 MW
CBRE	92 MW	92 MW	92 MW	92 MW
Stage 1 Ho‘ohana / Mililani / Waiawa / West O‘ahu	140 MW	140 MW	140 MW	140 MW
Stage 2 Kūpono / Mountain View / Waiawa2	79 MW	79 MW	79 MW	79 MW
Stage 3 Mahi / Makana Lā / Pu‘uloa	206 MW	206 MW	206 MW	206 MW
Stage 3 Firm Pu‘uloa / Kalaeloa / Waiau / Par	338 MW	338 MW	338 MW	338 MW
Future Hybrid Solar	0 MW	285 MW	285 MW	285 MW
Future Standalone Solar	0 MW	0 MW	0 MW	11 MW
Future Onshore Wind	0 MW	0 MW	0 MW	99 MW
Future Firm Units	0 MW	0 MW	49 MW	49 MW
Total	**2,298 MW**	**2,583 MW**	**2,631 MW**	**2,741 MW**
Stage 1 BESS	140 MW / 558 MWh	140 MW / 558 MWh	140 MW / 558 MWh	140 MW / 558 MWh
Stage 2 BESS (incl. Kapolei BESS)	214 MW / 983 MWh	214 MW / 983 MWh	214 MW / 983 MWh	214 MW / 983 MWh
Stage 3 BESS	206 MW / 990 MWh	206 MW / 990 MWh	206 MW / 990 MWh	206 MW / 990 MWh
Future BESS	0 MW / 0 MWh	285 MW / 1,140 MWh	285 MW / 1,140 MWh	285 MW / 1,140 MWh
Total	**560 MW / 2,531 MWh**	**845 MW / 3,671 MWh**	**845 MW / 3,671 MWh**	**845 MW / 3,671 MWh**
LOLE (days/year)	**0.25**	**0.14**	**0.04**	**0.00**
LOLEv (events/year)	**0.40**	**0.21**	**0.08**	**0.00**
LOLH (hours/year)	**1.10**	**0.55**	**0.21**	**0.00**
EUE (GWh/year)	**0.14**	**0.07**	**0.02**	**0.00**

2.2.2.6 Deactivation Schedule Sensitivity

Delayed Generator Deactivations

Incorporating recent firm capacity derates into the analysis, the following scenarios were tested to determine whether deactivations can be delayed, depending on the resources added, to achieve a 2033 LOLE below 0.1 days/year.

Delayed Generator Deactivation Scenarios:

- O_Y33LC_Out24_w(285HS_RFP2_49ICE)
  - O'ahu 2024 IGP Plan, without future resources after Stage 3.
  - Add 285 MW of hybrid solar, 99 MW onshore wind, 11 MW standalone solar and 6x8.14 MW internal combustion engines.
- O_Y33LC_Out24_w49ICE
  - O'ahu 2024 IGP Plan, without future resources after Stage 3.
  - Add 6x8.14 MW internal combustion engines.
- O_Y33LC_Out24_w(K1-2_285HS_RFP2)
  - O'ahu 2024 IGP Plan, without future resources after Stage 3.
  - Add 285 MW of hybrid solar, 99 MW onshore wind, and 11 MW standalone solar.
  - Kahe 1-2 remain in service.
- O_Y33LC_Out24_wK1-2
  - O'ahu 2024 IGP Plan, without future resources after Stage 3.
  - Kahe 1-2 remain in service.

Shown below in Figure 2-30 is the relationship between the 2033 LOLE and the total firm capacity that is on the system. The results indicate that we may achieve a LOLE below 0.1 days/year if we get the variable resources from the IGP RFPs and either delay the deactivation of Kahe 1-2 or install 49 MW of future firm generation. If, however, we do not get any variable resources from the IGP RFPs, we may not achieve a LOLE below 0.1 days/year, regardless if we delay the deactivation of Kahe 1-2 or install 49 MW of future firm generation. It is important to note that by 2033, Kahe 1-2 will be close to 70 years old and their availability may be worse than their 2022-2023 data.

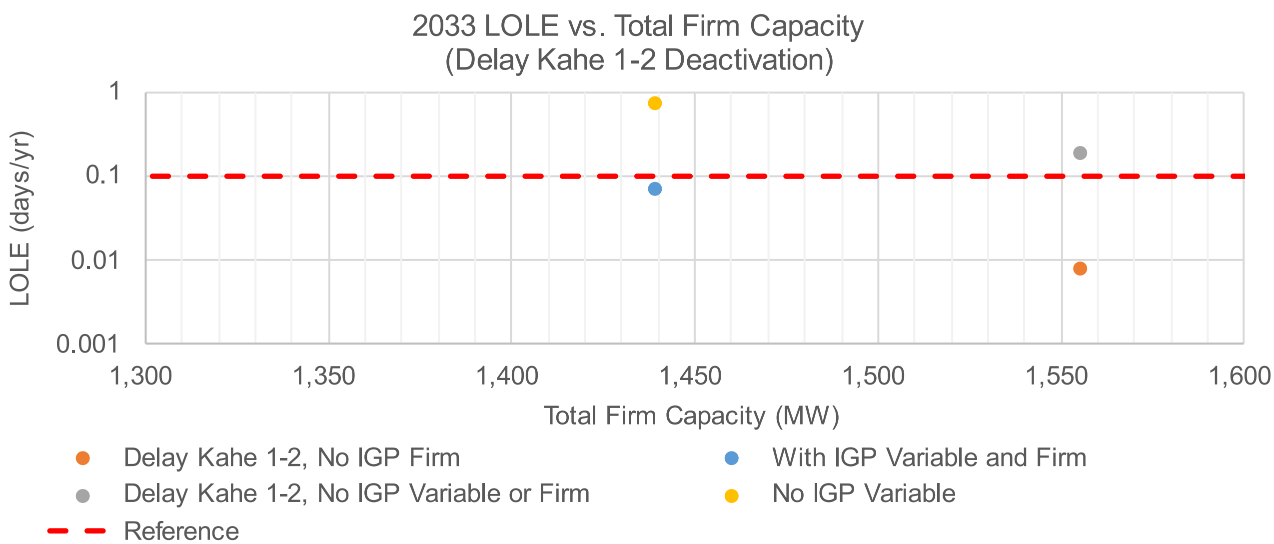

Figure 2-30: O‘ahu LOLE vs. Total firm capacity in 2033 with delayed Kahe 1-2 deactivation. Deactivation schedule sensitivity.

Figure 2-31 are heat maps showing when we may experience unserved energy with 6x8.14 MW future firm generation (left) and with the delayed deactivation of Kahe 1-2 (right). While there may be less unserved energy with the delayed deactivation of Kahe 1-2, this system has more firm generation on the system, which was evident in Figure 2-30.

2033 O‘ahu Max. EUE of Mean Sample (with IGP RFP 1-2 Variable):
L – 49 MW Future ICE; R – Delayed Kahe 1-2 Deactivation

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.7	2.2	0.0	0.0	0.2	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	3.7	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

MAX
9 MW
0 MW
MIN

Figure 2-31: O‘ahu EUE heat map, year 2033. Left – Six future ICE units (49 MW) (O_Y33LC_Out24_w(285HS_RFP2_49ICE)); Right – with delayed deactivation of Kahe 1-2 (O_Y33LC_Out24_w(K1-2_285HS_RFP2)).

Shown below in Table 2-14 are the resources on the system. Any changes that were made between the cases are highlighted. At the bottom of the table are the resulting changes in the reliability metrics. The results suggest that we may be able to obtain a 2033 LOLE below 0.1 days/year by delaying the deactivation of Kahe 1-2. This, however, assumes that we get some hybrid solar in the first round IGP RFP. If we do not get any new resources in the first or second Round IGP RFP, then our 2033 LOLE will be much higher than 0.1 days/year based on the modeled capacity, regardless of if we delay the deactivation of Kahe 1-2 or install 49 MW of future firm generation. While reliability appears to be better by delaying the deactivation of Kahe 1-2 instead of installing 49 MW of future firm generation, it is important to note that Kahe 1-2 have a combined firm capacity of 165 MW at lower availability versus 49 MW of future firm generation at higher availability, and therefore, the total firm generation that is on the system is significantly higher in the scenario where we delay the removal of Kahe 1-2. It is also important to note that, as stated earlier, by 2033, Kahe 1-2 will be approximately 70 years old and their availability will likely be worse than their 2022-2023 data. As a result, given the amount of time needed to procure new firm generation, we need to start the process of obtaining new firm generation in the First Round IGP RFP rather than delaying the deactivation of Kahe 1-2.

Table 2-14: Oʻahu probabilistic analysis results summary, year 2033. Deactivation schedule sensitivity.

Year 2033	O_Y33LC_Out24_w(285HS_RFP2_49ICE)	O_Y33LC_Out24_w(K1-2_285HS_RFP2)	O_Y33LC_Out24_w49ICE	O_Y33LC_Out24_wK1-2
Existing Firm	800 MW	965 MW	800 MW	965 MW
Existing PV	177 MW	177 MW	177 MW	177 MW
Existing Wind	24 MW	24 MW	24 MW	24 MW
CBRE	92 MW	92 MW	92 MW	92 MW
Stage 1 Hoʻohana / Mililani / Waiawa / West Oʻahu	140 MW	140 MW	140 MW	140 MW
Stage 2 Kūpono / Mountain View / Waiawa2	79 MW	79 MW	79 MW	79 MW
Stage 3 Mahi / Makana Lā / Puʻuloa	206 MW	206 MW	206 MW	206 MW
Stage 3 Firm Puʻuloa / Kalaeloa / Waiau / Par	590 MW	590 MW	590 MW	590 MW
Future Hybrid Solar	285 MW	285 MW	0 MW	0 MW
Future Standalone Solar	11 MW	11 MW	0 MW	0 MW
Future Onshore Wind	99 MW	99 MW	0 MW	0 MW
Future Firm Units	49 MW	0 MW	49 MW	0 MW
Total	**2,552 MW**	**2,668 MW**	**2,157 MW**	**2,273 MW**
Stage 1 BESS	140 MW / 558 MWh	140 MW / 558 MWh	140 MW / 558 MWh	140 MW / 558 MWh
Stage 2 BESS (incl. Kapolei BESS)	214 MW / 983 MWh	214 MW / 983 MWh	214 MW / 983 MWh	214 MW / 983 MWh
Stage 3 BESS	206 MW / 990 MWh	206 MW / 990 MWh	206 MW / 990 MWh	206 MW / 990 MWh
Future BESS	285 MW / 1,140 MWh	285 MW / 1,140 MWh	0 MW / 0 MWh	0 MW / 0 MWh
Total	**845 MW / 3,671 MWh**	**845 MW / 3,671 MWh**	**560 MW / 2,531 MWh**	**560 MW / 2,531 MWh**
LOLE (days/year)	**0.07**	**0.01**	**0.75**	**0.19**
LOLEv (events/year)	**0.08**	**0.02**	**1.35**	**0.25**
LOLH (hours/year)	**0.16**	**0.03**	**3.42**	**0.61**
EUE (GWh/year)	**0.02**	**0.00**	**0.31**	**0.04**

Accelerated Generator Deactivations

Given the old age of our existing fleet and recent outage events, plus the long lead time needed to procure replacement firm generation, it is important that we begin the process of procuring new firm generation as soon as possible. Rather than delay the deactivation of our existing generators, the prudent action is to procure additional firm generation that meet the needs of the system and accelerate the deactivation of existing firm generation. Therefore, incorporating recent derates into the analysis, the following scenarios were tested to determine whether a 2029 LOLE below 0.1 days/year can be achieved while accelerating deactivations, if we were to obtain the new firm generation sought in the first round IGP RFP at an earlier date.

Accelerated Generator Deactivation Scenarios:

- O_Y29LC_Out24_w285HS
  - O'ahu 2024 IGP Plan, without future resources after Stage 3.
  - Add 285 MW of hybrid solar.
- O_Y29LC_Out24_woK1-2_w285HS
  - O'ahu 2024 IGP Plan, without future resources after Stage 3.
  - Add 285 MW of hybrid solar.
  - Deactivate Kahe 1-2.
- O_Y29LC_Out24_woK1-2_w(285HS_49ICE)
  - O'ahu 2024 IGP Plan, without future resources after Stage 3.
  - Add 285 MW of hybrid solar and 6x8.14 MW internal combustion engines.
  - Deactivate Kahe 1-2.

Shown below in Figure 2-32 is the relationship between the 2029 LOLE and the total firm capacity that is on the system. The modeled results indicate that if we are able to get 285 MW of future hybrid solar and 49 MW of firm generation, we may be able to accelerate the deactivation of Kahe 1-2 and still have a 2029 LOLE around 0.1 days/year.

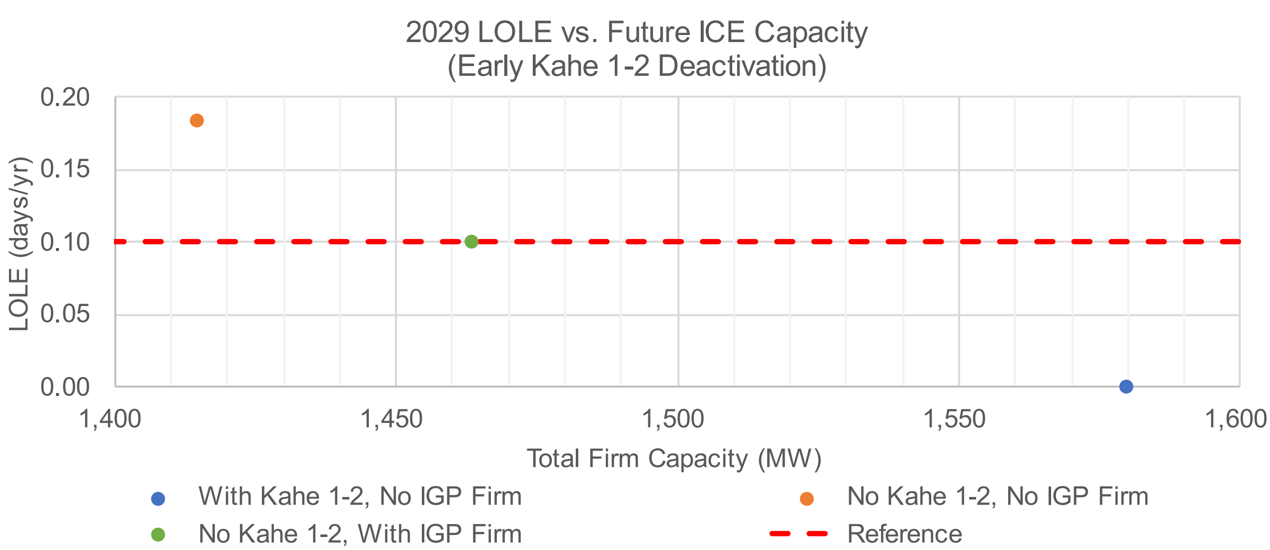

Figure 2-32: O'ahu LOLE vs. future firm in 2029 with early Kahe 1-2 deactivation. Deactivation schedule sensitivity.

Figure 2-33 are heat maps showing when we may expect to experience unserved energy if we accelerated the deactivation of Kahe 1-2 (left) and if we accelerated the deactivation of Kahe 1-2 but added 6x8.14 MW internal combustion engines (right). With the addition of the internal combustion engines, the magnitude of the unserved energy decreases.

2029 Oʻahu Max. EUE of Mean Sample (Early Kahe 1-2 Deactivation, with IGP RFP 1 Variable):
L – 0 MW Future ICE; R – 49 MW Future ICE

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.0	4.6	1.1	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	1.3	1.3	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.1	0.0	3.4	2.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.2	0.0	1.4	1.6	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.5	0.7	5.7	3.3	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.8	0.8	4.7	3.7	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	2.1	1.5	7.4	6.8	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.6	0.1	1.5	1.6	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.2	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	2.6	0.2	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.9	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.4	0.0	2.0	1.9	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	4.3	0.9	0.0	0.0	0.0	0.0

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.0	2.9	2.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	1.9	1.5	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.4	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	3.4	1.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	3.4	1.3	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	2.6	1.9	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.3	0.3	5.0	3.3	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.3	0.0	0.7	1.1	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.7	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	1.8	1.6	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.6	0.0	0.0	0.0	0.0

MAX
9 MW
0 MW
MIN

Figure 2-33: Oʻahu EUE heat map, year 2029. Left – no future firm (O_Y29LC_Out24_woK1-2_w285HS); Right – Six future ICE units (49 MW) (O_Y29LC_Out24_woK1-2_w(285HS_49ICE)).

Shown below in Table 2-15 are the capacity of the resources on the system. Any changes that were made between the cases are highlighted. At the bottom of the table are the resulting changes in the reliability metrics. The modeled results shown below suggest that we may be able to accelerate the deactivation of Kahe 1-2 if we obtain 49 MW of future firm generation along with the 285 MW of future hybrid solar from the first round IGP RFP. If, however, we do not obtain the 49 MW of future firm generation during the first round IGP RFP, we will not be able to accelerate the deactivation of Kahe 1-2 even though we get 285 MW of future hybrid solar in the first round IGP RFP.

Table 2-15: O'ahu probabilistic analysis results summary, year 2029. Deactivation Schedule Sensitivity.

Year 2029	O_Y29LC_Out24_w285HS	O_Y29LC_Out24_woK1-2_w285HS	O_Y29LC_Out24_woK1-2_w(285HS_49ICE)
Existing Firm	1,450 MW	1,285 MW	1,285 MW
Existing PV	188 MW	188 MW	188 MW
Existing Wind	123 MW	123 MW	123 MW
CBRE	92 MW	92 MW	92 MW
Stage 1 Ho'ohana / Mililani / Waiawa / West O'ahu	140 MW	140 MW	140 MW
Stage 2 Kūpono / Mountain View / Waiawa2	79 MW	79 MW	79 MW
Stage 3 Mahi / Makana Lā / Pu'uloa	206 MW	206 MW	206 MW
Stage 3 Firm Pu'uloa / Kalaeloa / Waiau / Par	130 MW	130 MW	130 MW
Future Hybrid Solar	285 MW	285 MW	285 MW
Future Standalone Solar	0 MW	0 MW	0 MW
Future Onshore Wind	0 MW	0 MW	0 MW
Future Firm Units	0 MW	0 MW	49 MW
Total	**2,693 MW**	**2,528 MW**	**2,576 MW**
Stage 1 BESS	140 MW / 558 MWh	140 MW / 558 MWh	140 MW / 558 MWh
Stage 2 BESS (incl. Kapolei BESS)	214 MW / 983 MWh	214 MW / 983 MWh	214 MW / 983 MWh
Stage 3 BESS	206 MW / 990 MWh	206 MW / 990 MWh	206 MW / 990 MWh
Future BESS	285 MW / 1,140 MWh	285 MW / 1,140 MWh	285 MW / 1,140 MWh
Total	**845 MW / 3,671 MWh**	**845 MW / 3,671 MWh**	**845 MW / 3,671 MWh**
LOLE (days/year)	**0.00**	**0.18**	**0.10**
LOLEv (events/year)	**0.00**	**0.29**	**0.15**
LOLH (hours/year)	**0.00**	**0.72**	**0.37**
EUE (GWh/year)	**0.00**	**0.10**	**0.05**

2.2.2.7 Load Sensitivity

The analysis performed thus far assumed a base load forecast. Given the amount of time that elapses between the issuance of an RFP and commercial operation, a sensitivity was performed to see how reliability may be impacted under higher load forecasts: the faster technology adoption scenario and the high electricity demand scenario. Faster technology adoption assumes faster customer adoption of managed electric vehicle ("EV") charging, energy efficiency ("EE"), and distributed energy resources ("DER"). High electricity demand assumes faster customer adoption of unmanaged EV charging and slower customer adoption of EE and DER.

Incorporating recent firm capacity derates into the analysis, the following scenarios were tested to determine how the 2033 LOLE may be impacted under a faster technology adoption scenario and a high electricity demand scenario.

Base Electricity Demand Scenarios:

- O_Y33LC_Out24_w(285HS_RFP2_49ICE)
    - O'ahu 2024 IGP Plan, without future resources after Stage 3.
    - Add 285 MW of hybrid solar, 99 MW onshore wind, and 11 MW standalone solar.
    - Add 6x8.14 MW internal combustion engines.
- O_Y33LC_Out24_w(285HS_RFP2_98ICE)
    - O'ahu 2024 IGP Plan, without future resources after Stage 3.
    - Add 285 MW of hybrid solar, 99 MW onshore wind, and 11 MW standalone solar.
    - Add 12x8.14 MW internal combustion engines.

Faster Technology Adoption Scenarios:

- O_Y33HiTechLC_Out24_w(285HS_RFP2_49ICE)
    - O_Y33LC_Out24_w(285HS_RFP2_49ICE) with a faster technology adoption load forecast.
- O_Y33HiTechLC_Out24_w(285HS_RFP2_98ICE)
    - O_Y33LC_Out24_w(285HS_RFP2_98ICE) with a faster technology adoption load forecast.

High Electricity Demand Scenarios:

- O_Y33HiLC_Out24_w(285HS_RFP2_49ICE)
    - O_Y33LC_Out24_w(285HS_RFP2_49ICE) with a high electricity load forecast.
- O_Y33HiLC_Out24_w(285HS_RFP2_98ICE)
    - O_Y33LC_Out24_w(285HS_RFP2_98ICE) with a high electricity load forecast.
- O_Y33HiLC_Out24_w(285HS_RFP2_260ICE)
    - O_Y33LC_Out24_w(285HS_RFP2_98ICE) with a high electricity demand load forecast.
    - Add 32x8.14 MW internal combustion engines instead of 12x8.14 MW internal combustion engines.

Shown below in Figure 2-34 is the relationship between future firm capacity and 2033 LOLE under the base load forecast, the high electricity demand forecast, and the faster technology adoption forecast. The results show the change in 2033 LOLE as the load forecast exceeds the base forecast and indicate that we may have a 2033 LOLE significantly above 0.1 days/year, even with all of the new resources acquired to meet the capacity and energy targets from both rounds of the IGP RFP. Section 2.2.2.3 shows that approximately 50 MW of future firm capacity is needed to achieve a 2033 LOLE below 0.1 days/year based on the modeled capacity. Based on the results in Figure 2-34, this increases to around 98 MW of future firm capacity under a faster technology adoption forecast and around 260 MW of future firm capacity under a high electricity demand forecast based on the modeled capacity.

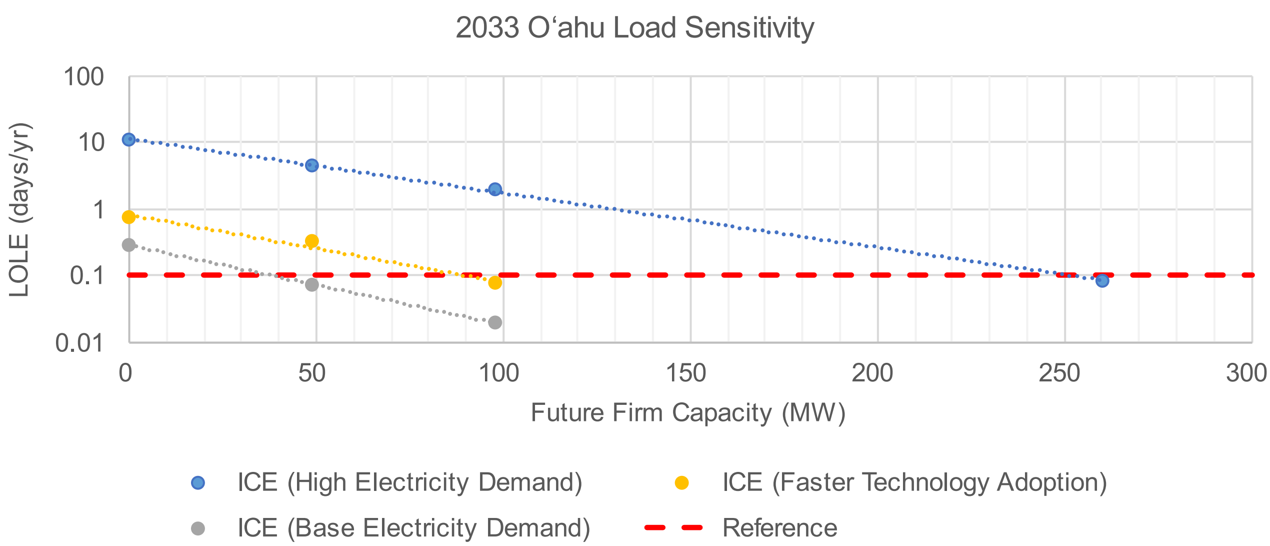

Figure 2-34: O‘ahu LOLE vs. future firm in 2033. Load sensitivity.

Figure 2-35 are heat maps showing when we may expect to experience unserved energy with the resources shown in Section 3.1 O‘ahu using the base load forecast (left) and the high electricity demand forecast (right). The results show that unserved energy may drastically increase if the load drastically exceeds the base forecast.

2033 O‘ahu Max. EUE of Mean Sample (with IGP RFP 1-2 Resources):
L – Base Load; R –High Load

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.7	2.2	0.0	0.0	0.2	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	3.7	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	3.6	1.3	1.1	4.4	0.2	2.3	2.8	0.5	1.7	3.2	5.4	5.0
1	2.0	0.6	0.2	1.2	0.1	2.8	3.6	0.3	0.7	1.2	2.7	2.7
2	1.1	0.1	0.1	0.3	0.0	1.4	2.5	0.0	0.7	0.4	1.4	1.6
3	0.7	0.0	0.1	0.2	0.0	1.7	2.1	0.0	0.7	0.1	0.1	0.8
4	1.6	0.1	0.3	0.5	0.2	2.1	2.8	0.0	0.1	0.4	0.8	1.4
5	3.8	0.6	1.6	1.8	0.0	2.6	3.3	0.3	1.1	1.0	2.0	2.6
6	8.2	2.1	3.4	5.2	0.3	4.4	4.2	1.5	1.4	2.5	6.0	5.0
7	12.5	5.0	2.7	2.0	0.0	1.2	2.5	0.2	0.9	0.8	7.1	5.8
8	3.8	0.8	0.7	0.2	0.0	1.1	1.0	0.0	0.0	0.5	1.4	2.3
9	0.1	0.6	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.2
10	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7
11	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.1
12	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6
13	0.0	0.2	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	1.1
14	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.2	0.0	1.9
15	0.2	0.5	0.0	0.4	0.0	0.1	0.1	0.5	0.3	0.6	1.7	5.2
16	1.3	1.4	0.3	2.9	0.0	0.4	2.2	1.0	1.8	0.7	7.1	5.4
17	5.7	3.7	1.3	4.1	0.2	1.8	5.1	2.1	4.3	1.7	13.2	8.5
18	13.8	4.2	4.0	8.9	1.3	4.4	14.4	2.9	4.2	5.9	25.8	15.8
19	19.6	6.9	12.1	7.8	1.5	10.4	28.6	4.2	11.1	5.5	23.9	12.1
20	9.7	4.5	11.7	10.6	0.9	14.2	37.0	6.8	10.4	6.3	16.9	13.0
21	10.9	3.6	8.6	7.2	1.5	8.1	27.4	2.6	5.7	6.1	21.1	10.7
22	11.2	3.6	5.8	9.6	1.3	6.3	17.8	3.6	5.5	4.8	15.3	11.4
23	11.6	2.5	7.2	6.5	0.8	4.3	11.2	1.9	4.1	5.7	13.1	8.6

MAX	
40 MW	
0 MW	
MIN	

Figure 2-35: O‘ahu EUE heat map, year 2033. Left – Base load (O_Y33LC_Out24_w(285HS_RFP2_49ICE)); Right – High load (O_Y33HiLC_Out24_w(285HS_RFP2_49ICE)).

Shown below in Table 2-16 and Table 2-17 are the capacity of the resources on the system. Any changes that were made between the cases are highlighted. At the bottom of the table are the resulting changes in the reliability metrics. The results indicate that we may experience higher amounts of unserved energy if our load increases towards the high load forecast. The tables show that under the faster technology adoption scenario, we may need around 98 MW of future firm generation to achieve a 2033 LOLE below 0.1 days/year, and under the high electricity demand scenario, we may need around 260 MW of future firm generation to achieve a 2033 LOLE below 0.1 days/year based on the modeled capacity.

Table 2-16: O‘ahu probabilistic analysis results summary, year 2033. High electricity demand scenario. Load sensitivity.

Year 2033	O_Y33LC_Out24_w(285HS_RFP2_49ICE)	O_Y33HiLC_Out24_w(285HS_RFP2_49ICE)	O_Y33LC_Out24_w(285HS_RFP2_98ICE)	O_Y33HiLC_Out24_w(285HS_RFP2_98ICE)	O_Y33HiLC_Out24_w(285HS_RFP2_260ICE)
Load Forecast	Base	High Electricity	Base	High Electricity	High Electricity
Existing Firm	800 MW	800 MW	800 MW	800 MW	800 MW
Existing PV	177 MW	177 MW	177 MW	177 MW	177 MW
Existing Wind	24 MW	24 MW	24 MW	24 MW	24 MW
CBRE	92 MW	92 MW	92 MW	92 MW	92 MW
Stage 1 Ho‘ohana / Mililani / Waiawa / West O‘ahu	140 MW	140 MW	140 MW	140 MW	140 MW
Stage 2 Kūpono / Mountain View / Waiawa2	79 MW	79 MW	79 MW	79 MW	79 MW
Stage 3 Mahi / Makana Lā / Pu‘uloa	206 MW	206 MW	206 MW	206 MW	206 MW
Stage 3 Firm Pu‘uloa / Kalaeloa / Waiau / Par	590 MW	590 MW	590 MW	590 MW	590 MW
Future Hybrid Solar	285 MW	285 MW	285 MW	285 MW	285 MW
Future Standalone Solar	11 MW	11 MW	11 MW	11 MW	11 MW
Future Onshore Wind	99 MW	99 MW	99 MW	99 MW	99 MW
Future Firm Units	49 MW	49 MW	98 MW	98 MW	260 MW
Total	**2,552 MW**	**2,552 MW**	**2,601 MW**	**2,601 MW**	**2,764 MW**
Stage 1 BESS	140 MW / 558 MWh	140 MW / 558 MWh	140 MW / 558 MWh	140 MW / 558 MWh	140 MW / 558 MWh
Stage 2 BESS (incl. Kapolei BESS)	214 MW / 983 MWh	214 MW / 983 MWh	214 MW / 983 MWh	214 MW / 983 MWh	214 MW / 983 MWh
Stage 3 BESS	206 MW / 990 MWh	206 MW / 990 MWh	206 MW / 990 MWh	206 MW / 990 MWh	206 MW / 990 MWh
Future BESS	285 MW / 1,140 MWh	285 MW / 1,140 MWh	285 MW / 1,140 MWh	285 MW / 1,140 MWh	285 MW / 1,140 MWh
Total	**845 MW / 3,671 MWh**	**845 MW / 3,671 MWh**	**845 MW / 3,671 MWh**	**845 MW / 3,671 MWh**	**845 MW / 3,671 MWh**
LOLE (days/year)	**0.07**	**4.56**	**0.02**	**1.92**	**0.08**
LOLEv (events/year)	**0.08**	**7.53**	**0.02**	**3.08**	**0.10**
LOLH (hours/year)	**0.16**	**18.30**	**0.05**	**7.03**	**0.22**
EUE (GWh/year)	**0.02**	**2.74**	**0.00**	**0.98**	**0.02**

Table 2-17: O'ahu probabilistic analysis results summary, year 2033. Faster technology adoption scenario. Load sensitivity.

Year 2033	O_Y33LC_Out24_w(285HS_RFP2_49ICE)	O_Y33HiTechLC_Out24_w(285HS_RFP2_49ICE)	O_Y33LC_Out24_w(285HS_RFP2_98ICE)	O_Y33HiTechLC_Out24_w(285HS_RFP2_98ICE)
Load Forecast	Base	Faster Adoption	Base	Faster Adoption
Existing Firm	800 MW	800 MW	800 MW	800 MW
Existing PV	177 MW	177 MW	177 MW	177 MW
Existing Wind	24 MW	24 MW	24 MW	24 MW
CBRE	92 MW	92 MW	92 MW	92 MW
Stage 1 Ho'ohana / Mililani / Waiawa / West O'ahu	140 MW	140 MW	140 MW	140 MW
Stage 2 Kūpono / Mountain View / Waiawa2	79 MW	79 MW	79 MW	79 MW
Stage 3 Mahi / Makana Lā / Pu'uloa	206 MW	206 MW	206 MW	206 MW
Stage 3 Firm Pu'uloa / Kalaeloa / Waiau / Par	590 MW	590 MW	590 MW	590 MW
Future Hybrid Solar	285 MW	285 MW	285 MW	285 MW
Future Standalone Solar	11 MW	11 MW	11 MW	11 MW
Future Onshore Wind	99 MW	99 MW	99 MW	99 MW
Future Firm Units	49 MW	49 MW	98 MW	98 MW
Total	**2,552 MW**	**2,552 MW**	**2,601 MW**	**2,601 MW**
Stage 1 BESS	140 MW / 558 MWh	140 MW / 558 MWh	140 MW / 558 MWh	140 MW / 558 MWh
Stage 2 BESS (incl. Kapolei BESS)	214 MW / 983 MWh	214 MW / 983 MWh	214 MW / 983 MWh	214 MW / 983 MWh
Stage 3 BESS	206 MW / 990 MWh	206 MW / 990 MWh	206 MW / 990 MWh	206 MW / 990 MWh
Future BESS	285 MW / 1,140 MWh	285 MW / 1,140 MWh	285 MW / 1,140 MWh	285 MW / 1,140 MWh
Total	**845 MW / 3,671 MWh**	**845 MW / 3,671 MWh**	**845 MW / 3,671 MWh**	**845 MW / 3,671 MWh**
LOLE (days/year)	**0.07**	**0.32**	**0.02**	**0.08**
LOLEv (events/year)	**0.08**	**0.50**	**0.02**	**0.10**
LOLH (hours/year)	**0.16**	**0.82**	**0.05**	**0.14**
EUE (GWh/year)	**0.02**	**0.08**	**0.00**	**0.01**

2.2.3 Hawaiʻi Island

The capacity and energy from projects awarded in the Stage 3 RFP met the RFP's capacity target and exceeded the RFP's energy target for Hawaiʻi Island. As a result, the first round IGP RFP will target capacity and energy to replace expiring IPP resources and will have an energy target of 134 GWh of renewable energy in service by December 1, 2029. A firm capacity target of 60 MW in service by December 1, 2031 was also identified for the first round IGP RFP, informed by recent outages and additional planning considerations for the loss of large thermal generators. If needed, a second round IGP RFP would target energy from any projects awarded in prior RFPs that withdrew.

The Hawaiʻi Island analyses include scenarios where large thermal generators such as PGV and Hamakua Energy are unavailable to better understand the sensitivity of the Hawaiʻi Island system's reliability if an extended forced outage of these large units were to occur. These scenarios are based on past events like the Leilani Estates lava flow event in 2018 where PGV was offline for approximately 2.5 years and recent outages earlier this year of the Hamakua Energy plant.[22] These plants represent large generators relative to the size of the load of the Hawaiʻi Island system. These scenarios are not intended to specifically plan for the replacement of these generators; instead, they are plausible what-if scenarios to be examined in a broader analysis of near-term system reliability.

Updates to Outage Assumptions

Similar to the Oʻahu analysis, an extensive probabilistic analysis was performed to understand how reliability is impacted by the resources procured through the IGP RFP. The methodology that was established during the IGP process and presented in the IGP Final Report was improved upon in this analysis by incorporating generator derates. This analysis looked at the availability of the existing generators in 2022 and 2023, including any derated performance.

Shown below in Figure 2-36 is the number of hours that the utility-owned generators experienced a forced outage or forced derate between 2022 and 2023. Figure 2-37 is the number of hours that the utility-owned generators experienced a maintenance outage or maintenance derate between 2022 and 2023. In both figures, the outages were categorized based on the type of generator and the size of the outage. The figures compared the actual performance in 2022 and 2023 to the outage rates assumed in the IGP.

[22] See https://www.hawaiinewsnow.com/2024/02/14/hawaii-island-residents-businesses-asked-conserve-power-with-generators-offline/ and https://www.hawaiinewsnow.com/2024/01/30/helco-institutes-rolling-outages-hawaii-island-amid-power-generation-issues/

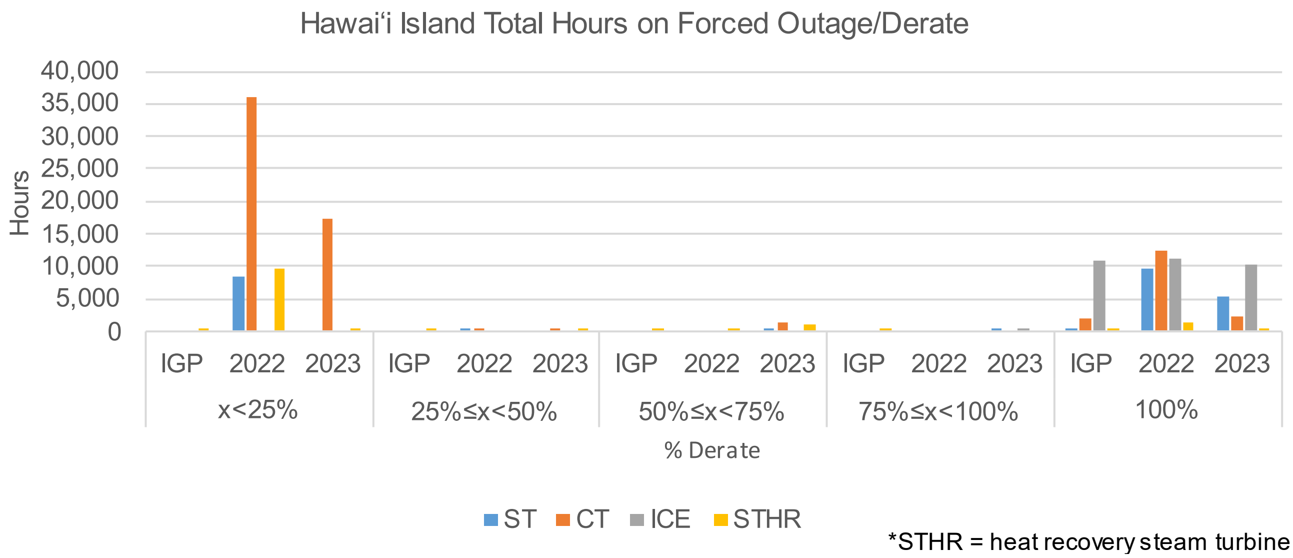

Figure 2-36: Total hours on forced outage/forced derates in 2022-2023 for utility-owned generators on Hawaiʻi Island.

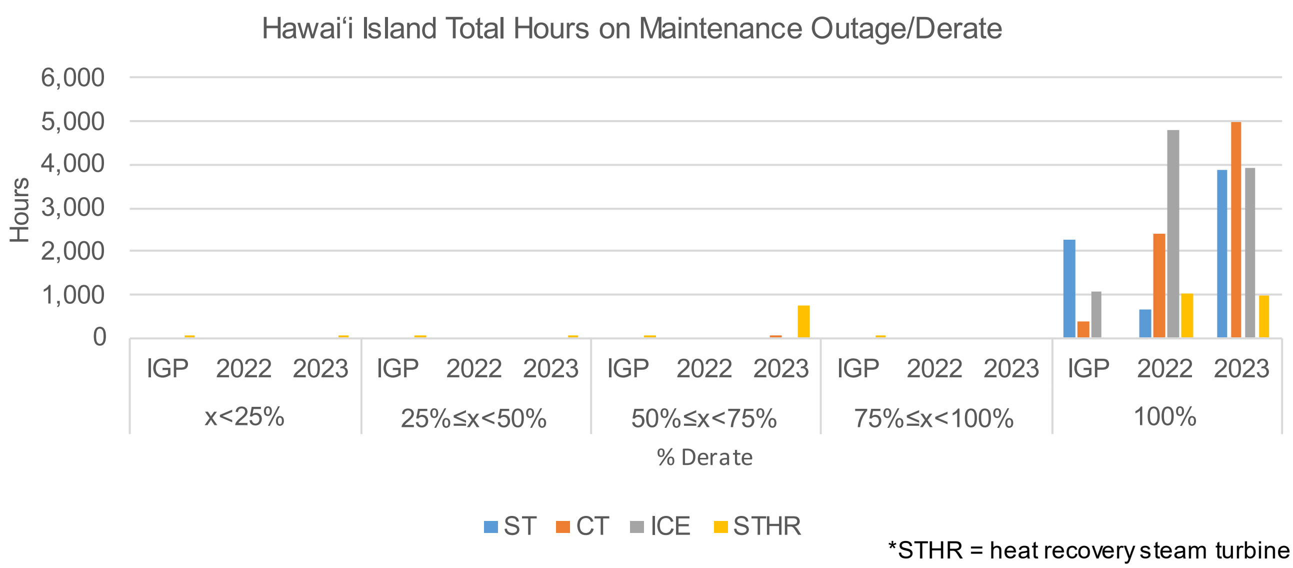

Figure 2-37 Total hours on maintenance outage/maintenance derates in 2022-2023 for utility-owned generators on Hawaiʻi Island.

As shown in Figure 2-36 and Figure 2-37, the outage rate assumptions used in IGP, which modeled full unit outages and derates as equivalent full unit outages, captured the full unit outages but may have understated the derates that occurred in recent years. The Hawaiʻi Island system showed a considerable amount of forced derates at less than 25% of the installed capacity while the maintenance derates were negligible since most maintenance was for the full unit. While the majority of the forced derates were less than 25% of the installed capacity, they covered a significant portion of the year and when added together, represent a considerable amount of firm capacity. For instance, Hill 5, Keāhole CT-2, and Keāhole Combined Cycle experienced partial outages up to 25% of their installed capacity that exceeded 40% of the year.

Figure 2-38 and Figure 2-39 take the forced outages and maintenance outages, respectively, from each utility-owned generator and categorize the outages based on the size of the derate. Similar to Figure 2-36, this figure highlights the impact that the derates can have on the availability of a generator. The 2022 and 2023 outage data were used to update assumptions regarding the duration of the outage, the size of the outage/derate, and the frequency.

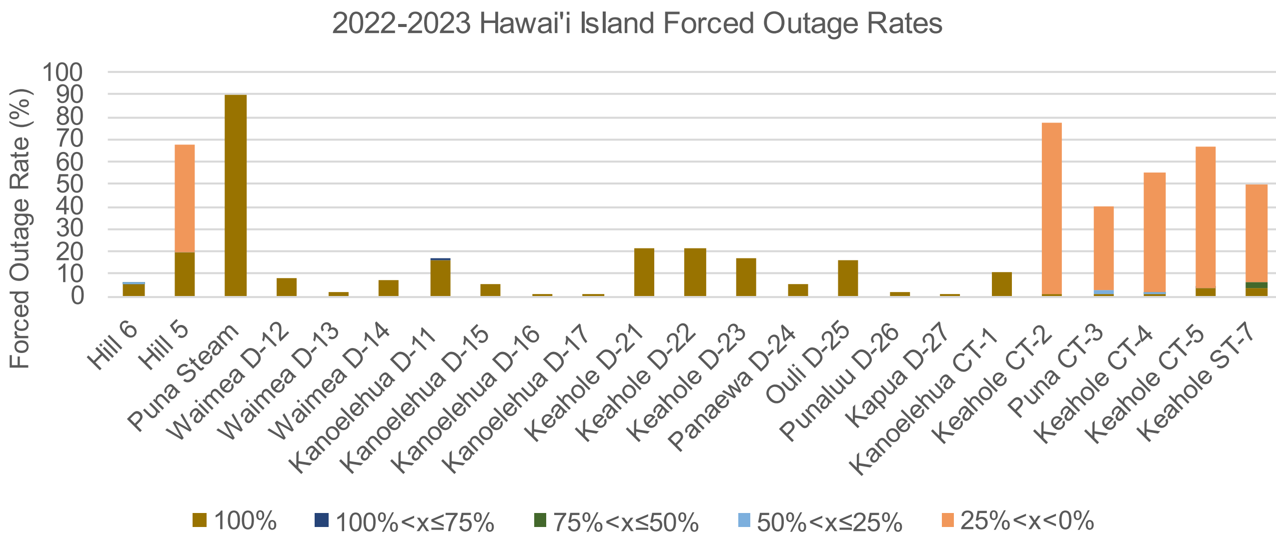

Figure 2-38: Modeled forced outage rates for utility-owned generators on Hawai'i Island using 2022-2023 data.

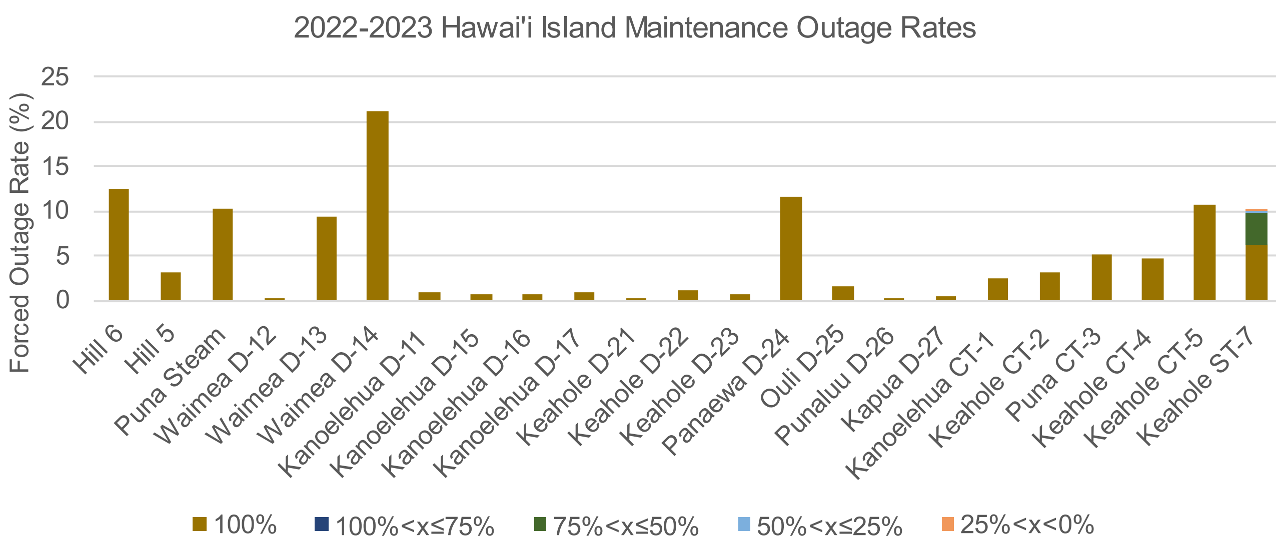

Figure 2-39: Modeled maintenance outage rates for utility-owned generators on Hawai'i Island using 2022-2023 data.

Given the impact that derated generators are having on system reliability, the probabilistic analysis was updated to directly model derates instead of approximating their impact through equivalent full unit outages. Shown below in Figure 2-40 is the total capacity on outage in year 2029 that was simulated in the probabilistic analysis. This figure shows that while the average outage across all of the modeled samples may be between 15 MW to 85 MW, on a bad day, the individual sample may experience an outage over 125 MW, which is similar to what the system experienced on January 30, 2024 and February 13, 2024.

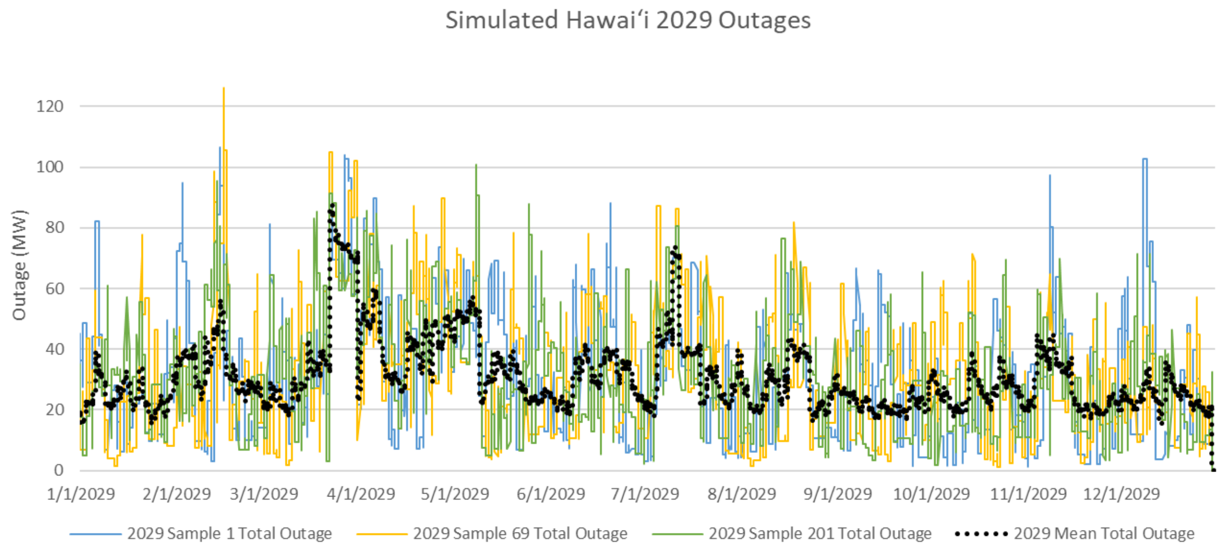

Figure 2-40: Simulated outages incorporating latest derate trends on Hawai'i Island.[23]

Generating unit outages affected our ability to serve load on Hawai'i Island on January 30th and February 13th when conservation measures were requested and subsequently rolling blackouts had to be implemented.[24] Shown below in Figure 2-41 and Figure 2-42 is the capacity that was not available. On both days, there was more than 125 MW of firm generation unavailable. The outage events provide validation that the updated outage assumptions are reasonable.

[23] When comparing to actual 2024 outage events, note that there is approximately 49 MW less firm capacity on Hawai'i Island in 2029. Puna Steam (15.5 MW) is placed on standby in 2025. Hill 5-6 (33.8 MW) are retired in 2029.

[24] See https://www.hawaiinewsnow.com/2024/02/14/hawaii-island-residents-businesses-asked-conserve-power-with-generators-offline/ and https://www.hawaiinewsnow.com/2024/01/30/helco-institutes-rolling-outages-hawaii-island-amid-power-generation-issues/

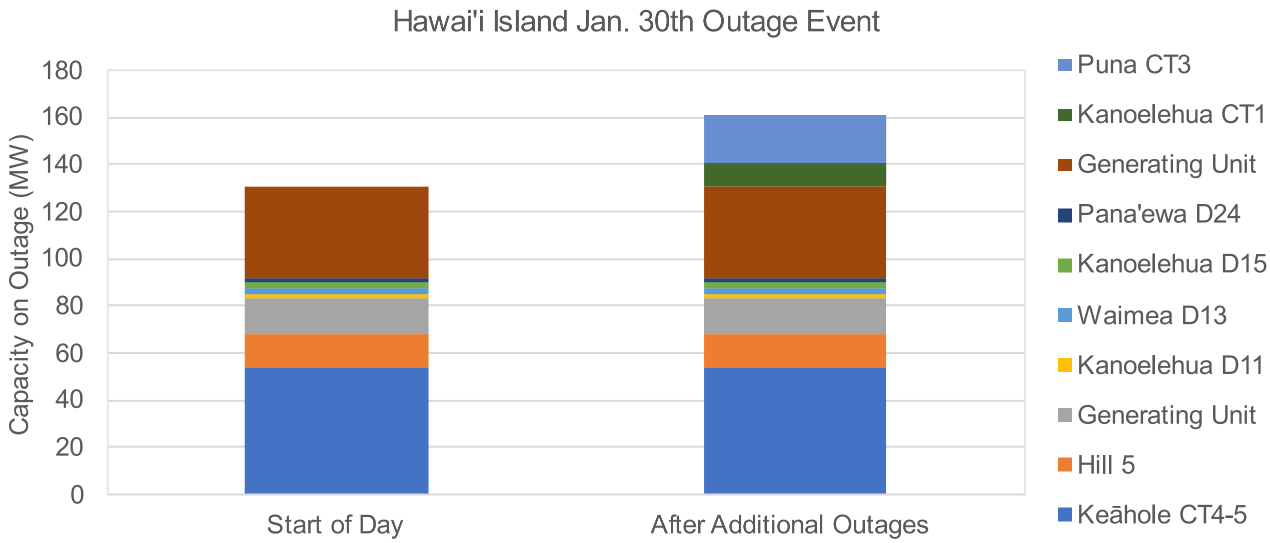

Figure 2-41: Generator capacity on outage related to January 30 event on Hawaiʻi Island.[25]

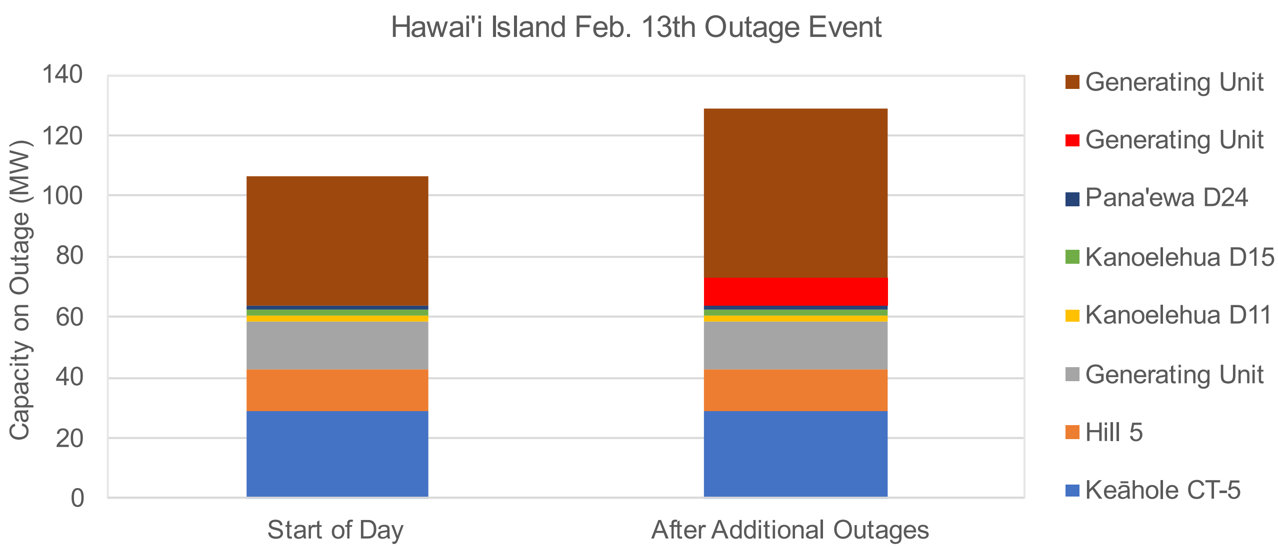

Figure 2-42: Generator capacity on outage related to February 13, 2024 event on Hawaiʻi Island.[26]

Unless otherwise noted, the scenarios examined in this analysis include partial derates and are based on 2022-2023 outage data.

For repowered facilities such as PGV and Hamakua Energy, partial derates based on their 2022-2023 outage data are removed due to their repowered status (full unit derates still modeled). The expectation is that a

[25] Specific independent power producers are not identified due to confidentiality purposes.

[26] Specific independent power producers are not identified due to confidentiality purposes.

repowered generator would still incur full unit forced outages, like any other firm generator, but the repowering with new equipment would significantly reduce partial derates.

Updates to Planned Removal from Service Assumptions

The following units were assumed to be deactivated. Additional units were added to this list due to a generator fire at Pana'ewa substation (D24) as well as concerns on future maintenance support and spare parts availability for older units (CT1 and CT2).

- 2024: Pana'ewa D24
- 2025: Puna Steam (standby)
- 2028: Hill 5 and Hill 6
- 2031: Kanoelehua CT1 and Keahole CT2

Analyses Performed

Using the updated outage rates with the derates and starting with the Hawai'i Island 2024 IGP Plan provided in Section 3.1 with planned resources expected through the Stage 3 RFP, the following probabilistic cases were performed:

- Derate Sensitivity: The cases compare the 2029 and 2033 reliability metrics when the IGP outage rates are used versus recent outage rates with derates.

PGV Sensitivities

- PGV Reduced Capacity Sensitivity: The cases evaluate system reliability with PGV's output derated to various levels, including 30 MW, 20 MW, and 0 MW.
- No PGV Firm Sensitivity: The cases add in the proxy variable resources for the energy target in the first round IGP RFP (30 MW onshore wind) and then increase the amount of future firm generation to determine the impact it has on the reliability metrics in a scenario with PGV unavailable. This sensitivity evaluated both 2029 and 2033.
- No PGV Variable Sensitivity: The cases add in the proxy variable resources for the energy target in the first round IGP RFP (30 MW onshore wind) and then increase the amount of future hybrid solar to determine the impact it has on the 2033 reliability metrics in a scenario with PGV unavailable.
- No PGV Long-Duration Storage Sensitivity: The cases add in the proxy variable resources for the energy target in the first round IGP RFP (30 MW onshore wind) and then look at the feasibility of substituting any firm generation need with long-duration energy storage.

Hamakua Energy Sensitivities

- No Hamakua Energy: The cases add in the proxy variable resources for the energy target in the first round IGP RFP (30 MW onshore wind). The existing Hamakua Energy facility as well as the repowered facility are not included in this analysis. PGV output is also assumed to be derated to 30 MW. The cases examine the impact of Hamakua Energy on the 2029 and 2033 reliability metrics.

- No Hamakua Energy Firm Sensitivity: The cases remove the proxy variable resources for the energy target in the first round IGP RFP (30 MW onshore wind). The existing Hamakua Energy facility as well as the repowered facility are not included in this analysis. PGV output is also assumed to be derated to 30 MW. The cases increase the amount of future firm generation to determine the impact it has on the 2029 and 2033 reliability metrics.
- No Hamakua Energy Variable Sensitivity: The cases remove the proxy variable resources for the energy target in the first round IGP RFP (30 MW onshore wind). The existing Hamakua Energy facility as well as the repowered facility are not included in this analysis. PGV output is also assumed to be derated to 30 MW. The cases increase the amount of future hybrid solar resources to determine the impact it has on the 2029 and 2033 reliability metrics.

Load Sensitivities

- Load Sensitivity with Firm Resources: The cases add in the proxy variable resources for the energy target in the first round IGP RFP (30 MW onshore wind). The existing Hamakua Energy facility as well as the repowered facility are not included in this analysis. PGV output is also assumed to be derated to 30 MW. The cases test how the reliability metrics may change based on the load forecast and how much firm generation may be needed to achieve an LOLE below 0.1 days/year.
- Load Sensitivity with Variable Resources: Similar to the load sensitivity with firm resources, the cases test how the reliability metrics may change based on the load forecast and how much variable generation may be needed to achieve an LOLE below 0.1 days/year.

Stage 3 RFP Sensitivities

- Stage 3 RFP Sensitivity: The cases compare the 2029 reliability metrics when Kaiwiki Solar is removed from the Stage 3 resource plan versus when it remains in the resource plan.

Conclusions

Below were some of the conclusions determined from the above analysis.

- Derate Sensitivity: Incorporation of derates into the analysis can drastically impact the results of the reliability analysis.

PGV Sensitivities

- PGV Reduced Capacity Sensitivity: If PGV output is derated to 30 MW or 20 MW, LOLE remains below 0.1 days/year. However, if PGV is derated to 20 MW and variable resources from the first round IGP RFP are not added, LOLE increases above 0.1 days/year in 2033. If PGV is completely unavailable and no replacement resources are added, LOLE is above 0.1 days/year in both 2029 and 2033.
- No PGV Firm Generation Sensitivity: If PGV is entirely unavailable, 16 MW of future firm generation will be needed by 2029, or 24 MW by 2033 to achieve an LOLE of 0.1 days/year. These firm generation amounts are based on the modeled capacities.
- No PGV Variable Sensitivity: If PGV is entirely unavailable, approximately 140 MW of future hybrid solar will be needed by 2033 to achieve an LOLE of 0.1 days/year, based on interpolation of the scenarios.

- **Long-Duration Energy Storage Sensitivity:** Long-duration energy storage could not be utilized in place of firm generation. While 12-hour long-duration energy storage did improve reliability, it did not achieve an LOLE below 0.1 days/year.

Hamakua Energy Sensitivities

- **No Hamakua Energy Sensitivity:** The system reliability will exceed 0.1 LOLE if Hamakua Energy is removed without additional replacement resources.
- **No Hamakua Energy Firm Generation Sensitivity:** A system without Hamakua Energy and without 30 MW of future wind needs approximately 19 MW of future firm generation in 2029 or 23 MW of future firm generation in 2033 to achieve an LOLE of 0.1 days/year, based on interpolation of scenarios.
- **No Hamakua Energy Variable Sensitivity:** Adding approximately 75 MW of future hybrid solar in 2029 or 270 MW of future hybrid solar in 2033 achieves an LOLE of 0.1 days/year, based on interpolation of scenarios.

Load Sensitivities

- **Load Sensitivity with Firm Resources:** If the load exceeds the base load forecast, we may have an LOLE significantly above 0.1 days/year.
    - In a faster technology adoption scenario, approximately 75 MW of future firm generation will be needed in 2033 to bring the LOLE below 0.1 days/year compared to approximately 24 MW of future firm generation needed with a base load forecast. The amount of firm generation is based on interpolation of scenarios.
    - In a high load scenario, approximately 107 MW of future firm generation will be needed in 2033 to bring the LOLE below 0.1 days/year compared to approximately 24 MW of future firm capacity needed with a base load forecast. The amount of firm generation is based on interpolation of scenarios.
- **Load Sensitivity with Variable Resources:** Variable resources may not be sufficient to achieve a 0.1 LOLE under increased loads in the faster customer technology adoption or high electricity demand scenarios. Up to 300 MW of future hybrid solar was tested but resulted in an LOLE that exceeded 0.1 days/year. Given the existing and planned hybrid solar through the Stage 3 RFP (261 MW), an additional 300 MW would more than double the amount of hybrid solar on the system.

Stage 3 RFP Sensitivities

- **Stage 3 RFP Sensitivity:**[27] Removing Kaiwiki Solar from the resource plan resulted in an LOLE greater than 0.1 days/year, indicating that the project is needed to achieve an LOLE below 0.1 days/year in 2029.

[27] These scenarios are for illustrative purposes only to demonstrate the reliability impacts of certain projects and project capacity not reaching commercial operations.

RFP Targets

The recommended Hawaiʻi Island RFP targets based on the extensive analysis detailed in this report are summarized below.

First Round IGP RFP Targets

- Energy Target: 134 GWh in service by December 1, 2029.
- Firm Capacity Target: 60 MW in service by December 1, 2031.

Second Round IGP RFP Targets

- To be determined and may include any remaining Round 1 needs plus consideration for other projects withdrawn in previous procurements.

The Hawaiʻi Island system will achieve an LOLE below 0.1 days/year if all planned resources in the near term achieve commercial operations. As a result, the energy target for the first round IGP RFP is 134 GWh to replace expiring IPPs. The first round IGP RFP will also include a procurement target for 60 MW of firm renewables.

The IGP RFP firm target was informed by the sensitivity analysis that examined the reliability impact of extended outage of large thermal generators in the resource plan. The future firm need may be higher under higher load scenarios developed in the IGP (i.e., Faster Technology Adoption and High Load). Future firm capacity also provides additional margin in the event that any planned RFP project fails to reach commercial operation. If all planned RFP projects successfully reach commercial operation, the proposed IGP RFP firm capacity could enable earlier retirement of our older thermal generating resources. We will consider a combination of proposals intended to address the firm generation and renewable dispatchable generation needs as part of a portfolio approach to satisfying the RFP targets.

Additional details on the probabilistic analysis performed to support the conclusions above can be found in the following sections.

2.2.3.1 Derate Sensitivities

After incorporating the recent outage updates and derates into the model, several scenarios were tested that examined year 2029 and 2033.

2029 Scenarios:

- H_Y29B_OutIGP
  - Hawaiʻi Island 2024 IGP Plan, without future resources after Stage 3. Outage rates match the IGP outage rates.
  - Add 30 MW of onshore wind.
  - 30 MW of onshore wind is based on the estimated amount of onshore wind needed to achieve the 134 GWh energy target of the first round IGP RFP.
- H_Y29B_Out24
  - Hawaiʻi Island 2024 IGP Plan, without future resources after Stage 3. Outage rates match 2022-2023 outage rates and includes derates.
  - Add 30 MW of onshore wind.

2033 Scenarios:

- 2033 H_Y33B_OutIGP
    - Hawai'i Island 2024 IGP Plan, without future resources after Stage 3. Outage rates match the IGP outage rates.
    - Add 30 MW of onshore wind.
- 2033 H_Y33B_Out24
    - Hawai'i Island 2024 IGP Plan, without future resources after Stage 3. Outage rates match 2022-2023 outage rates and includes derates.
    - Add 30 MW of onshore wind.

The probabilistic analysis looks at 250 combinations of outage schedules and weather years. The unserved energy shown in the heat maps below is derived from the average of those 250 samples to account for all the outage/weather combinations and to correlate with LOLE. The maximum unserved energy of the average sample is shown for each time period in the heat maps.

The following heat maps compare the resulting unserved energy when modeling the IGP outages against the updated modeling of derates. Figure 2-43 shows that in 2029 assuming PGV and Hamakua Energy are fully operational and the addition of 30 MW of wind in the first round IGP RFP, the system does not show unserved energy while Figure 2-44 shows in 2033 with the increase of load, and deactivation of Kanoelehua CT1 and Keāhole CT2 some unserved energy can be seen in the month of February.

2029 Hawaiʻi Max. EUE of Mean Sample: L – IGP Outage Rates; R – Updated Outage Rates

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

MAX	
6.6 MW	
0 MW	
MIN	

Figure 2-43: Hawai'i Island EUE heat map, year 2029. Left - IGP outage rates (H_Y29B_OutIGP); Right – Updated outage rates with firm derates (H_Y29B_Out24).

2033 Hawai'i Max. EUE of Mean Sample: L – IGP Outage Rates; R – Updated Outage Rates

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

MAX
6.6 MW
0 MW
MIN

Figure 2-44: Hawai'i Island EUE heat map, year 2033. Left - IGP outage rates (2033 H_Y33B_OutIGP); Right – Updated outage rates with firm derates (2033 H_Y33B_Out24).

Shown below in Table 2-18 and Table 2-19 are the resources on the system in 2029 and 2033, respectively, along with the reliability metrics. As shown, by incorporating recent outage rates and derates into the analysis, the LOLE increases. This is evident in 2033, when less firm generation is expected on the system than in 2029 due to the deactivation of Kanoelehua CT1 and Keāhole CT2, which was assumed to occur in 2031.

Table 2-18: Hawai'i Island probabilistic analysis results summary, year 2029. Derate sensitivity.

Year 2029	H_Y29B_OutIGP	H_Y29B_Out24
Outage Rate	IGP	Updated Rates with Derate
Existing Firm	124 MW	124 MW
PGV	46 MW	46 MW
Hamakua Energy	58 MW	58 MW
Existing PV	0 MW	0 MW
Existing Wind	11 MW	11 MW
Existing Hydro	3.35 MW	3.35 MW
CBRE	23 MW	23 MW
Stage 1 Waikoloa / Hale Kuawehi	60 MW	60 MW
Stage 3 Puako / Kaiwiki / Keamuku	115 MW	115 MW
Stage 3 Firm Hamakua Firm Renewable Energy	0 MW	0 MW
Future Hybrid Solar	0 MW	0 MW
Future Standalone Solar	0 MW	0 MW
Future Onshore Wind	30 MW	30 MW
Future Firm Units	0 MW	0 MW
Total	**470 MW**	**470 MW**
Stage 1 BESS	60 MW / 240 MWh	60 MW / 240 MWh
Stage 3 BESS	115 MW / 460 MWh	115 MW / 460 MWh
Future BESS	0 MW / 0 MWh	0 MW / 0 MWh
Total	**175 MW / 700 MWh**	**175 MW / 700 MWh**
LOLE (days/year)	**0.00**	**0.00**
LOLEv (events/year)	**0.00**	**0.00**
LOLH (hours/year)	**0.00**	**0.00**
EUE (GWh/year)	**0.00**	**0.00**

Table 2-19: Hawai'i Island probabilistic analysis results summary, year 2033. Derate sensitivity.

Year 2033	H_Y33B_OutIGP	H_Y33B_Out24
Outage Rate	IGP	Updated Rates with Derate
Existing Firm	100 MW	100 MW
PGV	46 MW	46 MW
Hamakua Energy	0 MW	0 MW
Existing PV	0 MW	0 MW
Existing Wind	11 MW	11 MW
Existing Hydro	3.35 MW	3.35 MW
CBRE	23 MW	23 MW
Stage 1 Waikoloa / Hale Kuawehi	60 MW	60 MW
Stage 3 Puako / Kaiwiki / Keamuku	201 MW	201 MW
Stage 3 Firm Hamakua Firm Renewable Energy	60 MW + 7.5 MW BESS	60 MW + 7.5 MW BESS
Future Hybrid Solar	0 MW	0 MW
Future Standalone Solar	0 MW	0 MW
Future Onshore Wind	30 MW	30 MW
Future Firm Units	0 MW	0 MW
Total	**534 MW**	**534 MW**
Stage 1 BESS	60 MW / 240 MWh	60 MW / 240 MWh
Stage 3 BESS	201 MW / 804 MWh	201 MW / 804 MWh
Future BESS	0 MW / 0 MWh	0 MW / 0 MWh
Total	**261 MW / 1044 MWh**	**261 MW / 1044 MWh**
LOLE (days/year)	**0.00**	**0.01**
LOLEv (events/year)	**0.00**	**0.02**
LOLH (hours/year)	**0.00**	**0.06**
EUE (GWh/year)	**0.00**	**0.00**

2.2.3.2 IGP Firm Sensitivities

Scenarios were tested to examine the impact of including and excluding the 60 MW IGP firm placeholder for 2033.

2033 Scenarios:

- H_Y33B_Out24
  - Hawai'i Island 2024 IGP Plan, without future resources after Stage 3. Outage rates match 2022-2023 outage rates and includes derates.
  - Add 30 MW of onshore wind.
- H_Y33B_Out24_w60CC

- H_Y33B_Out24 with 1x60 MW combined cycle unit.

Figure 2-45 are heat maps showing when we may expect to experience unserved energy without any future firm generation (left) and with the IGP firm placeholder (right). These figures show that while there may still be some unserved energy, after adding the IGP firm placeholder, the system does not show unserved energy.

2033 Hawai‘i Max. EUE of Mean Sample: L – Without IGP RFP Firm ; R – With IGP RFP Firm

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

MAX	
6.6 MW	
0 MW	
MIN	

Figure 2-45: Hawai‘i Island EUE heat map, year 2033. Left – Without IGP firm placeholder (2033 H_Y33B_Out24); Right – With IGP firm placeholder (2033 H_Y33B_Out24_w60CC).

As shown in Table 2-20, the 2024 IGP Plan with the 30 MW variable IGP placeholder already achieves an LOLE under 0.1 days/year. Adding the 60 MW firm IGP placeholder to this portfolio reduces LOLE to 0 days/year.

Table 2-20: Hawai'i Island probabilistic analysis results summary, year 2033. IGP firm sensitivity.

Year 2033	H_Y33B_Out24	H_Y33B_Out24_w60CC
Outage Rate	Updated Rates with Derate	Updated Rates with Derate
Existing Firm	100 MW	100 MW
PGV	46 MW	46 MW
Hamakua Energy	0 MW	0 MW
Existing PV	0 MW	0 MW
Existing Wind	11 MW	11 MW
Existing Hydro	3.35 MW	3.35 MW
CBRE	23 MW	23 MW
Stage 1 Waikoloa / Hale Kuawehi	60 MW	60 MW
Stage 3 Puako / Kaiwiki / Keamuku	201 MW	201 MW
Stage 3 Firm Hamakua Firm Renewable Energy	60 MW + 7.5 MW BESS	60 MW + 7.5 MW BESS
Future Hybrid Solar	0 MW	0 MW
Future Standalone Solar	0 MW	0 MW
Future Onshore Wind	30 MW	30 MW
Future Firm Units	0 MW	60 MW
Total	**534 MW**	**594 MW**
Stage 1 BESS	60 MW / 240 MWh	60 MW / 240 MWh
Stage 3 BESS	201 MW / 804 MWh	201 MW / 804 MWh
Future BESS	0 MW / 0 MWh	0 MW / 0 MWh
Total	**261 MW / 1044 MWh**	**261 MW / 1044 MWh**
LOLE (days/year)	**0.01**	**0.00**
LOLEv (events/year)	**0.02**	**0.00**
LOLH (hours/year)	**0.06**	**0.00**
EUE (GWh/year)	**0.00**	**0.00**

Although LOLE for both cases is low, this assumes all resources are placed into service and operate in accordance with their rated capacities. The subsequent sensitivities discussed here investigate impacts to reliability when this is not the case.

2.2.3.3 PGV Sensitivities

PGV represents a significant portion of Hawai'i Island's firm generating capacity. The geothermal plant continues to ramp its capacity to normal levels, prior to the 2018 Leilani Estates lava flow event. Given this relatively recent event that resulted in PGV's outage for approximately 2.5 years, we evaluated several sensitivities with PGV at different capacities to determine its impacts to system reliability.

PGV Reduced Capacity Sensitivity

Sensitivities were tested to analyze the effects of PGV being derated below 46 MW, at reduced capacities of 30 MW, 20 MW, and 0 MW (where PGV is completely unavailable) to understand the impacts on the system reliability.

2029 Scenarios:

- H_Y29B_Out24
    - Hawai'i Island 2024 IGP Plan, without future resources after Stage 3. Outage rates match 2022-2023 outage rates and includes derates.
    - Add 30 MW of onshore wind.
- H_Y29B_Out24_woPGV
    - H_Y29B_Out24 with PGV unavailable.

2033 Scenarios:

- H_Y33B_Out24
    - Hawai'i Island 2024 IGP Plan, without future resources after Stage 3. Outage rates match 2022-2023 outage rates and includes derates.
    - Add 30 MW of onshore wind.
- H_Y33B_Out24_wPGV30
    - H_Y33B_Out24 with PGV output reduced to 30 MW.
- H_Y33B_Out24_wPGV20
    - H_Y33B_Out24 with PGV output reduced to 20 MW.
- H_Y33B_Out24_woPGV
    - H_Y33B_Out24 with PGV unavailable.

- H_Y33B_Out24_woIGP_wPGV30
    - Hawai'i Island 2024 IGP Plan, without future resources after Stage 3. Outage rates match 2022-2023 outage rates and includes derates.
    - PGV output reduced to 30 MW.
- H_Y33B_Out24_woIGP_wPGV20
    - H_Y33B_Out24_woIGP_wPGV30 with PGV output reduced to 20 MW.

When PGV is unavailable, LOLE is above 0.1 days/year and results in unserved energy for both 2029 and 2033. The unserved energy heat maps for both years are shown in Figure 2-46 and Figure 2-47 below.

2029 Hawaiʻi Max. EUE of Mean Sample: L – PGV Available; R – PGV Unavailable

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.5	0.0	0.2	0.1	0.0	0.0	0.1	0.0	0.1	0.0	0.1
1	0.0	0.4	0.1	0.5	0.1	0.0	0.0	0.2	0.0	0.1	0.1	0.1
2	0.0	0.4	0.0	0.4	0.2	0.0	0.2	0.1	0.0	0.1	0.0	0.1
3	0.1	0.2	0.0	0.4	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.1
4	0.0	0.5	0.0	0.5	0.3	0.0	0.1	0.2	0.0	0.0	0.1	0.1
5	0.1	1.4	0.0	0.8	0.5	0.0	0.0	0.2	0.0	0.2	0.2	0.2
6	0.4	2.3	0.2	0.8	0.5	0.0	0.4	0.7	0.0	0.2	0.3	0.3
7	0.5	1.4	0.1	0.2	0.2	0.0	0.0	0.2	0.0	0.2	0.1	0.3
8	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.2	0.0	0.1
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
15	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.3
16	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
17	0.0	0.2	0.0	0.2	0.1	0.0	0.0	0.1	0.0	0.3	0.0	0.8
18	0.0	0.2	0.0	0.4	0.2	0.0	0.0	0.0	0.0	0.4	0.2	0.3
19	0.0	0.3	0.0	0.4	0.4	0.0	0.0	0.1	0.0	0.2	0.0	0.6
20	0.0	0.5	0.0	0.1	0.1	0.0	0.0	0.1	0.0	0.2	0.3	0.2
21	0.0	0.2	0.0	0.0	0.2	0.0	0.0	0.3	0.0	0.2	0.1	0.1
22	0.0	0.1	0.0	0.2	0.1	0.0	0.0	0.2	0.0	0.1	0.0	0.1
23	0.0	0.2	0.0	0.2	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.1

MAX
6.6 MW
0 MW
MIN

Figure 2-46: Hawaiʻi Island EUE heat map, year 2029. Left – PGV is available (H_Y29B_Out24); Right – PGV is unavailable (H_Y29B_Out24_woPGV).

2033 Hawaiʻi Max. EUE of Mean Sample: L – PGV Available; R – PGV Unavailable

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.9	0.0	0.2	0.1	0.0	0.1	0.2	0.0	0.5	0.0	0.3
1	0.0	0.7	0.0	0.2	0.1	0.0	0.0	0.3	0.0	0.6	0.0	0.1
2	0.0	1.0	0.1	0.1	0.2	0.0	0.1	0.2	0.0	0.7	0.1	0.2
3	0.0	0.8	0.0	0.2	0.1	0.0	0.2	0.2	0.0	0.5	0.0	0.3
4	0.0	1.1	0.0	0.2	0.2	0.1	0.4	0.4	0.0	0.8	0.0	0.5
5	0.0	2.3	0.1	0.3	0.2	0.4	0.5	0.5	0.0	1.1	0.1	0.5
6	0.1	3.0	0.1	0.5	0.2	0.5	0.4	0.7	0.1	1.2	0.1	0.6
7	0.3	2.7	0.1	0.2	0.0	0.0	0.0	0.1	0.0	0.2	0.0	0.6
8	0.1	0.4	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.5
9	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
10	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.3
16	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.3
17	0.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.1	0.3
18	0.1	0.9	0.0	0.1	0.0	0.0	0.0	0.1	0.0	1.2	0.0	0.4
19	0.1	0.7	0.0	0.0	0.2	0.0	0.0	0.0	0.0	1.2	0.0	0.4
20	0.1	0.4	0.1	0.0	0.3	0.0	0.1	0.1	0.0	1.0	0.0	0.2
21	0.0	1.0	0.0	0.2	0.1	0.0	0.0	0.2	0.0	0.8	0.1	0.2
22	0.0	0.9	0.0	0.3	0.4	0.0	0.0	0.3	0.0	0.6	0.0	0.2
23	0.0	0.8	0.1	0.2	0.3	0.0	0.1	0.2	0.0	0.5	0.0	0.2

MAX
6.6 MW
0 MW
MIN

Figure 2-47: Hawaiʻi Island EUE heat map, year 2033. Left – PGV is available (H_Y33B_Out24); Right – PGV is unavailable (H_Y33B_Out24_woPGV).

Table 2-21 and Table 2-22 show that the reliability decreases significantly when PGV is not on the system with LOLE of 0.62 and 0.88 days/year, in 2029 and 2033 respectively.

Table 2-21: Hawai'i Island probabilistic analysis results summary, year 2029. No PGV sensitivity.

Year 2029	H_Y29B_Out24	H_Y29B_Out24_woPGV
Existing Firm	124 MW	124 MW
PGV	46 MW	0 MW
Hamakua Energy	58 MW	58 MW
Existing PV	0 MW	0 MW
Existing Wind	11 MW	11 MW
Existing Hydro	3.35 MW	3.35 MW
CBRE	23 MW	23 MW
Stage 1 Waikoloa / Hale Kuawehi	60 MW	60 MW
Stage 3 Puako / Kaiwiki / Keamuku	115 MW	115 MW
Stage 3 Firm Hamakua Firm Renewable Energy	0 MW	0 MW
Future Hybrid Solar	0 MW	0 MW
Future Standalone Solar	0 MW	0 MW
Future Onshore Wind	30 MW	30 MW
Future Firm Units	0 MW	0 MW
Total	**470 MW**	**424 MW**
Stage 1 BESS	60 MW / 240 MWh	60 MW / 240 MWh
Stage 3 BESS	115 MW / 460 MWh	115 MW / 460 MWh
Future BESS	0 MW / 0 MWh	0 MW / 0 MWh
Total	**175 MW / 700 MWh**	**175 MW / 700 MWh**
LOLE (days/year)	**0.00**	**0.62**
LOLEv (events/year)	**0.00**	**0.95**
LOLH (hours/year)	**0.00**	**2.34**
EUE (GWh/year)	**0.00**	**0.06**

Table 2-22: Hawai'i Island probabilistic analysis results summary, year 2033. No PGV sensitivity

Year 2033	**H_Y33B_Out24**	**H_Y33B_Out24_woPGV**
Existing Firm	100 MW	100 MW
PGV	46 MW	0 MW
Hamakua Energy	0 MW	0 MW
Existing PV	0 MW	0 MW
Existing Wind	11 MW	11 MW
Existing Hydro	3.35 MW	3.35 MW
CBRE	23 MW	23 MW
Stage 1 Waikoloa / Hale Kuawehi	60 MW	60 MW
Stage 3 Puako / Kaiwiki / Keamuku	201 MW	201 MW
Stage 3 Firm Hamakua Firm Renewable Energy	60 MW + 7.5 MW BESS	60 MW + 7.5 MW BESS
Future Hybrid Solar	0 MW	0 MW
Future Standalone Solar	0 MW	0 MW
Future Onshore Wind	30 MW	30 MW
Future Firm Units	0 MW	0 MW
Total	**534 MW**	**488 MW**
Stage 1 BESS	60 MW / 240 MWh	60 MW / 240 MWh
Stage 3 BESS	201 MW / 804 MWh	201 MW / 804 MWh
Future BESS	0 MW / 0 MWh	0 MW / 0 MWh
Total	**261 MW / 1044 MWh**	**261 MW / 1044 MWh**
LOLE (days/year)	**0.01**	**0.89**
LOLEv (events/year)	**0.02**	**1.35**
LOLH (hours/year)	**0.06**	**3.68**
EUE (GWh/year)	**0.00**	**0.12**

Figure 2-48 shows that when PGV's maximum capacity is reduced, the resulting LOLE remains under 0.1. However, if the IGP first round variable placeholder of 30 MW Wind resource is removed, the LOLE is above 0.1 when PGV is assumed at 20 MW of capacity.

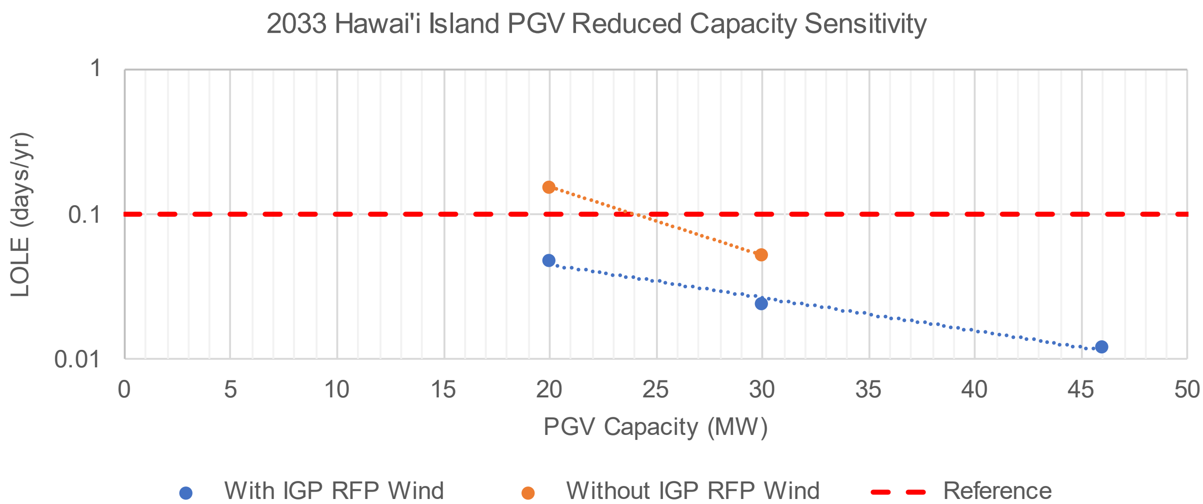

Figure 2-48: Hawai'i Island reliability of system with the 2024 IGP plan and PGV capacity at 46 MW, 30 MW and 20 MW compared against a resource plan with no future IGP RFP Wind and PGV capacity at 30 MW and 20 MW.

Figure 2-49 shows a comparison of the average unserved energy between PGV assumed at 30 MW and 20 MW. The higher firm capacity helps to decrease the unserved energy in the system. Likewise, in Figure 2-50 a similar comparison is done with PGV operating at 30 MW and 20 MW capacities with the 30 MW IGP RFP Wind resource removed in both scenarios.

2033 Hawai'i Max. EUE of Mean Sample: L – PGV at 30 MW; R – PGV at 20 MW

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
5	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
6	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0
7	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1
1	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0
3	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1
4	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
5	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.1
6	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.1	0.0	0.0
7	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
19	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

MAX	
6.6 MW	
0 MW	
MIN	

Figure 2-49: Hawai'i Island EUE heat map, year 2033. Left – PGV output reduced to 30 MW (H_Y33B_Out24_wPGV30); Right – PGV output reduced to 20 MW (H_Y33B_Out24_wPGV20).

2033 Hawai‘i Max. EUE of Mean Sample (no IGP RFP Wind): L – PGV at 30 MW; R – PGV at 20 MW

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
4	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
5	0.0	0.2	0.2	0.1	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0
6	0.0	0.2	0.3	0.1	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0
7	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
2	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
3	0.0	0.4	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
4	0.0	0.3	0.1	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0
5	0.1	0.6	0.2	0.2	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.1
6	0.4	0.6	0.2	0.1	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.1
7	0.6	0.5	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1
8	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
9	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

MAX
6.6 MW
0 MW
MIN

Figure 2-50: Hawai‘i Island EUE heat map, year 2033. Left – PGV output reduced to 30 MW (H_Y33B_Out24_woIGP_wPGV30); Right – PGV output reduced to 20 MW (H_Y33B_Out24_woIGP_wPGV20).

In Table 2-23, when PGV is derated, most scenarios show that the system can be reliable except for when PGV is at 20 MW and the 30 MW IGP RFP Wind resource is excluded. In this case, the LOLE is 0.15 days/year.

Table 2-23: Hawai'i Island probabilistic analysis results summary, year 2033. PGV Derate sensitivity.

Year 2033	H_Y33B_Out24	H_Y33B_Out24_wPGV 20	H_Y33B_Out24_wPGV 30	H_Y33B_Out24_woIGP _wPGV20	H_Y33B_Out24_woIG P_wPGV30
Existing Firm	100 MW	100 MW	100 MW	100 MW	100 MW
PGV	46 MW	20 MW	30 MW	20 MW	30 MW
Hamakua Energy	0 MW	0 MW	0 MW	0 MW	0 MW
Existing PV	0 MW	0 MW	0 MW	0 MW	0 MW
Existing Wind	11 MW	11 MW	11 MW	11 MW	11 MW
Existing Hydro	3.35 MW	3.35 MW	3.35 MW	3.35 MW	3.35 MW
CBRE	23 MW	23 MW	23 MW	23 MW	23 MW
Stage 1 Waikoloa / Hale Kuawehi	60 MW	60 MW	60 MW	60 MW	60 MW
Stage 3 Puako / Kaiwiki / Keamuku	201 MW	201 MW	201 MW	201 MW	201 MW
Stage 3 Firm Hamakua Firm Renewable Energy	60 MW + 7.5 MW BESS	60 MW + 7.5 MW BESS	60 MW + 7.5 MW BESS	60 MW + 7.5 MW BESS	60 MW + 7.5 MW BESS
Future Hybrid Solar	0 MW	0 MW	0 MW	0 MW	0 MW
Future Standalone Solar	0 MW	0 MW	0 MW	0 MW	0 MW
Future Onshore Wind	30 MW	30 MW	30 MW	0 MW	0 MW
Future Firm Units	0 MW	0 MW	0 MW	0 MW	0 MW
Total	**534 MW**	**508 MW**	**518 MW**	**478 MW**	**488 MW**
Stage 1 BESS	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh
Stage 3 BESS	201 MW / 804 MWh	201 MW / 804 MWh	201 MW / 804 MWh	201 MW / 804 MWh	201 MW / 804 MWh
Future BESS	0 MW / 0 MWh	0 MW / 0 MWh	0 MW / 0 MWh	0 MW / 0 MWh	0 MW / 0 MWh
Total	**261 MW / 1044 MWh**	**261 MW / 1044 MWh**	**261 MW / 1044 MWh**	**261 MW / 1044 MWh**	**261 MW / 1044 MWh**
LOLE (days/year)	**0.01**	**0.05**	**0.02**	**0.15**	**0.05**
LOLEv (events/year)	**0.02**	**0.08**	**0.03**	**0.24**	**0.08**
LOLH (hours/year)	**0.06**	**0.25**	**0.11**	**0.55**	**0.21**
EUE (GWh/year)	**0.00**	**0.01**	**0.00**	**0.01**	**0.00**

No PGV Firm Sensitivity

This section shows the amount of firm capacity needed in 2029 and 2033 to obtain an LOLE of 0.1 days/year without PGV.

2029 Scenarios:

- H_Y29B_Out24_woPGV
  - Hawai'i Island 2024 IGP Plan, without future resources after Stage 3. Outage rates match 2022-2023 outage rates and includes derates.
  - Add 30 MW of onshore wind.
  - PGV is unavailable.
- H_Y29B_Out24_woPGV_w8ICE
  - H_Y29B_Out24_woPGV with 1x8.14 MW internal combustion engine.
- H_Y29B_Out24_woPGV_w16ICE
  - H_Y29B_Out24_woPGV with 2x8.14 MW internal combustion engines.
- H_Y29B_Out24_woPGV_w24ICE
  - H_Y29B_Out24_woPGV with 3x8.14 MW internal combustion engines.
- H_Y29B_Out24_woPGV_w34CT
  - H_Y29B_Out24_woPGV with 1x34 MW combustion turbine.

2033 Scenarios:

- H_Y33B_OutI24_woPGV
  - Hawai'i Island 2024 IGP Plan, without future resources after Stage 3. Outage rates match 2022-2023 outage rates and includes derates.
  - Add 30 MW of onshore wind.
  - PGV is unavailable.
- H_Y33B_Out24_woPGV_w8ICE
  - H_Y33B_OutI24_woPGV with 1x8.14 MW internal combustion engine.
- H_Y33B_Out24_woPGV_w16ICE
  - H_Y33B_OutI24_woPGV with 2x8.14 MW internal combustion engines.
- H_Y33B_Out24_woPGV_w24ICE
  - H_Y33B_OutI24_woPGV with 3x8.14 MW internal combustion engines.
- H_Y33B_Out24_woPGV_w34CT
  - H_Y33B_OutI24_woPGV with 1x34 MW combustion turbine.

Figure 2-51 shows the resulting LOLE for the No PGV sensitivities in which 8 MW ICEs were added incrementally to the system to increase reliability in years 2029 and 2033. Based on modeled capacity, the system needs about 16 MW of firm resources in 2029 and about 24 MW of firm resources in 2033 to achieve an LOLE of 0.1 days/year. More resources are needed in 2033 due to its higher forecasted load compared to 2029 and planned removal of additional firm generation (CT1, CT2) in 2031.

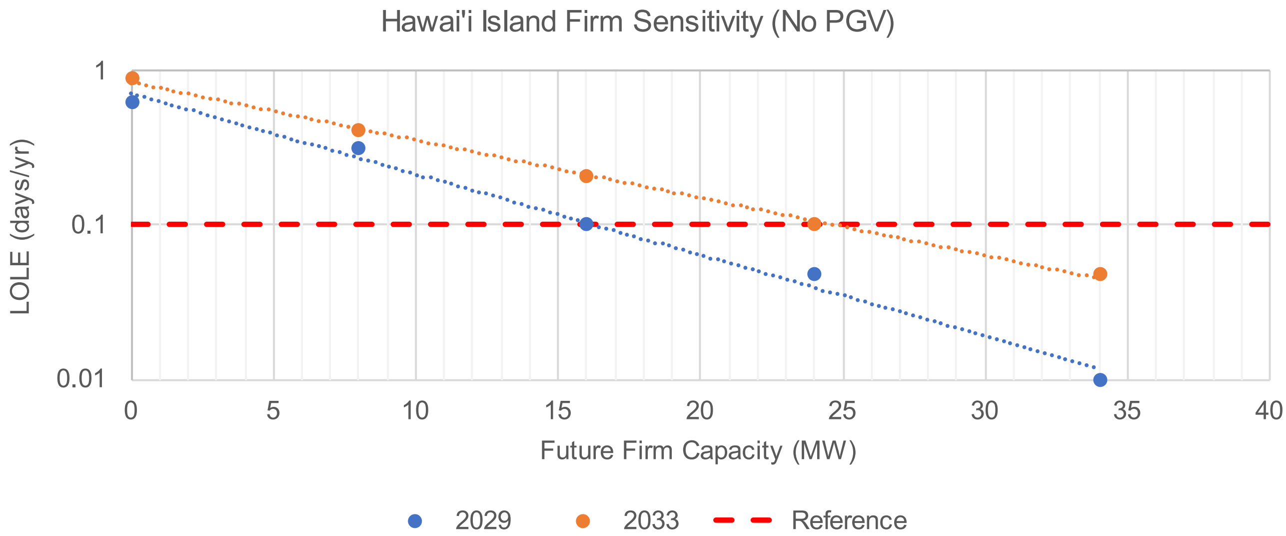

Figure 2-51: Hawaiʻi Island system reliability without PGV and resulting LOLE with incremental addition of firm capacity (ICE).

Figure 2-52 shows the amount of unserved energy that the system will experience without PGV and how adding 24 MW of ICEs to the system will decrease it.

2033 Hawaiʻi Max. EUE of Mean Sample (No PGV): L – 0 MW Future ICE; R – 24 MW Future ICE,

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.9	0.0	0.2	0.1	0.0	0.1	0.2	0.0	0.5	0.0	0.3
1	0.0	0.7	0.0	0.2	0.1	0.0	0.0	0.3	0.0	0.6	0.0	0.1
2	0.0	1.0	0.1	0.1	0.2	0.0	0.1	0.2	0.0	0.7	0.1	0.2
3	0.0	0.8	0.0	0.2	0.1	0.0	0.2	0.2	0.0	0.5	0.0	0.3
4	0.0	1.1	0.0	0.2	0.2	0.1	0.4	0.4	0.0	0.8	0.0	0.5
5	0.0	2.3	0.1	0.3	0.2	0.4	0.5	0.5	0.0	1.1	0.1	0.5
6	0.1	3.0	0.1	0.5	0.2	0.5	0.4	0.7	0.1	1.2	0.1	0.6
7	0.3	2.7	0.1	0.2	0.0	0.0	0.0	0.1	0.0	0.2	0.0	0.6
8	0.1	0.4	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.5
9	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
10	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.3
16	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.3
17	0.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.1	0.3
18	0.1	0.9	0.0	0.1	0.0	0.0	0.0	0.1	0.0	1.2	0.0	0.4
19	0.1	0.7	0.0	0.0	0.2	0.0	0.0	0.0	0.0	1.2	0.0	0.4
20	0.1	0.4	0.1	0.0	0.3	0.0	0.1	0.1	0.0	1.0	0.0	0.2
21	0.0	1.0	0.0	0.2	0.1	0.0	0.0	0.2	0.0	0.8	0.1	0.2
22	0.0	0.9	0.0	0.3	0.4	0.0	0.0	0.3	0.0	0.6	0.0	0.2
23	0.0	0.8	0.1	0.2	0.3	0.0	0.1	0.2	0.0	0.5	0.0	0.2

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
1	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
2	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
3	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1
4	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1
5	0.0	0.6	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.1	0.0	0.2
6	0.0	0.8	0.0	0.1	0.0	0.0	0.0	0.2	0.0	0.1	0.0	0.2
7	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
8	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
21	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
22	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
23	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

MAX
6.6 MW
0 MW
MIN

Figure 2-52: Hawaiʻi Island EUE heat map, year 2033. Left – no future firm (H_Y33B_Out24_woPGV); Right – three future ICE units (24 MW) (H_Y33B_Out24_woPGV_w24ICE).

Table 2-24 and Table 2-25 describe the amount of resources in the system without PGV and the effect on the system when adding incrementally firm resources to get an LOLE of 0.1 days/year.

Table 2-24: Hawai'i Island probabilistic analysis results summary, year 2029. Firm sensitivity

Year 2029	H_Y29B_Out24_woPGV	H_Y29B_Out24_woPGV_w8ICE	H_Y29B_Out24_woPGV_w16ICE	H_Y29B_Out24_woPGV_w24ICE	H_Y29B_Out24_woPGV_w34CT
Existing Firm	124 MW	124 MW	124 MW	124 MW	124 MW
PGV	0 MW	0 MW	0 MW	0 MW	0 MW
Hamakua Energy	58 MW	58 MW	58 MW	58 MW	58 MW
Existing PV	0 MW	0 MW	0 MW	0 MW	0 MW
Existing Wind	11 MW	11 MW	11 MW	11 MW	11 MW
Existing Hydro	3.35 MW	3.35 MW	3.35 MW	3.35 MW	3.35 MW
CBRE	23 MW	23 MW	23 MW	23 MW	23 MW
Stage 1 Waikoloa / Hale Kuawehi	60 MW	60 MW	60 MW	60 MW	60 MW
Stage 3 Puako / Kaiwiki / Keamuku	115 MW	115 MW	115 MW	115 MW	115 MW
Stage 3 Firm Hamakua Firm Renewable Energy	0 MW	0 MW	0 MW	0 MW	0 MW
Future Hybrid Solar	0 MW	0 MW	0 MW	0 MW	0 MW
Future Standalone Solar	0 MW	0 MW	0 MW	0 MW	0 MW
Future Onshore Wind	30 MW	30 MW	30 MW	30 MW	30 MW
Future Firm Units	0 MW	8 MW	16 MW	24 MW	34 MW
Total	**424 MW**	**432 MW**	**440 MW**	**448 MW**	**458 MW**
Stage 1 BESS	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh
Stage 3 BESS	115 MW / 460 MWh	115 MW / 460 MWh	115 MW / 460 MWh	115 MW / 460 MWh	115 MW / 460 MWh
Future BESS	0 MW / 0 MWh	0 MW / 0 MWh	0 MW / 0 MWh	0 MW / 0 MWh	0 MW / 0 MWh
Total	**175 MW / 700 MWh**	**175 MW / 700 MWh**	**175 MW / 700 MWh**	**175 MW / 700 MWh**	**175 MW / 700 MWh**
LOLE (days/year)	**0.62**	**0.31**	**0.10**	**0.05**	**0.01**
LOLEv (events/year)	**0.95**	**0.46**	**0.14**	**0.06**	**0.01**
LOLH (hours/year)	**2.34**	**0.97**	**0.29**	**0.14**	**0.01**
EUE (GWh/year)	**0.00**	**0.02**	**0.01**	**0.00**	**0.00**

Table 2-25: Hawai'i Island probabilistic analysis results summary, year 2033. Firm sensitivity.

Year 2033	H_Y33B_Out24_woPGV	H_Y33B_Out24_woPGV_w8ICE	H_Y33B_Out24_woPGV_w16ICE	H_Y33B_Out24_woPGV_w24ICE	H_Y33B_Out24_woPGV_w34CT
Existing Firm	100 MW	100 MW	100 MW	100 MW	100 MW
PGV	0 MW	0 MW	0 MW	0 MW	0 MW
Hamakua Energy	0 MW	0 MW	0 MW	0 MW	0 MW
Existing PV	0 MW	0 MW	0 MW	0 MW	0 MW
Existing Wind	11 MW	11 MW	11 MW	11 MW	11 MW
Existing Hydro	3.35 MW	3.35 MW	3.35 MW	3.35 MW	3.35 MW
CBRE	23 MW	23 MW	23 MW	23 MW	23 MW
Stage 1 Waikoloa / Hale Kuawehi	60 MW	60 MW	60 MW	60 MW	60 MW
Stage 3 Puako / Kaiwiki / Keamuku	201 MW	201 MW	201 MW	201 MW	201 MW
Stage 3 Firm Hamakua Firm Renewable Energy	60 MW + 7.5 MW BESS	60 MW + 7.5 MW BESS	60 MW + 7.5 MW BESS	60 MW + 7.5 MW BESS	60 MW + 7.5 MW BESS
Future Hybrid Solar	0 MW	0 MW	0 MW	0 MW	0 MW
Future Standalone Solar	0 MW	0 MW	0 MW	0 MW	0 MW
Future Onshore Wind	30 MW	30 MW	30 MW	30 MW	30 MW
Future Firm Units	0 MW	8 MW	16 MW	24 MW	34 MW
Total	**488 MW**	**496 MW**	**504 MW**	**512 MW**	**522 MW**
Stage 1 BESS	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh
Stage 3 BESS	201 MW / 804 MWh	201 MW / 804 MWh	201 MW / 804 MWh	201 MW / 804 MWh	201 MW / 804 MWh
Future BESS	0	0	0	0	0
Total	**261 MW / 1044 MWh**	**261 MW / 1044 MWh**	**261 MW / 1044 MWh**	**261 MW / 1044 MWh**	**261 MW / 1044 MWh**
LOLE (days/year)	**0.89**	**0.40**	**0.20**	**0.10**	**0.05**
LOLEv (events/year)	**1.35**	**0.58**	**0.33**	**0.14**	**0.06**
LOLH (hours/year)	**3.68**	**1.65**	**0.84**	**0.43**	**0.20**
EUE (GWh/year)	**0.12**	**0.05**	**0.02**	**0.01**	**0.00**

No PGV Variable Sensitivity

This section shows the amount of hybrid solar needed in 2033 to get to an LOLE of 0.1 days/year without PGV.

2033 Scenarios:

- H_Y33B_Out24_woPGV
  - Hawai'i Island 2024 IGP Plan, without future resources after Stage 3. Outage rates match 2022-2023 outage rates and includes derates.
  - Add 30 MW of onshore wind.
  - PGV is unavailable.
- H_Y33B_Out24_woPGV_w24HS
  - H_Y33B_Out24_woPGV with an additional 24 MW of hybrid solar.
- H_Y33B_Out24_woPGV_w50HS
  - H_Y33B_Out24_woPGV with an additional 50 MW of hybrid solar.
- H_Y33B_Out24_woPGV_w100HS
  - H_Y33B_Out24_woPGV with an additional 100 MW of hybrid solar.
- H_Y33B_Out24_woPGV_w150HS
  - H_Y33B_Out24_woPGV with an additional 150 MW of hybrid solar.
- H_Y33B_Out24_woPGV_w200HS
  - H_Y33B_Out24_woPGV with an additional 200 MW of hybrid solar.

After incrementally adding variable renewable capacity to the Hawai'i Island system without PGV, interpolation of scenarios suggests that approximately 140 MW of hybrid solar would be needed to achieve an LOLE of 0.1 days/year. This is shown on Figure 2-53 below, how the incremental addition of a solar hybrid resource resulted in a LOLE of 0.1 days/year.

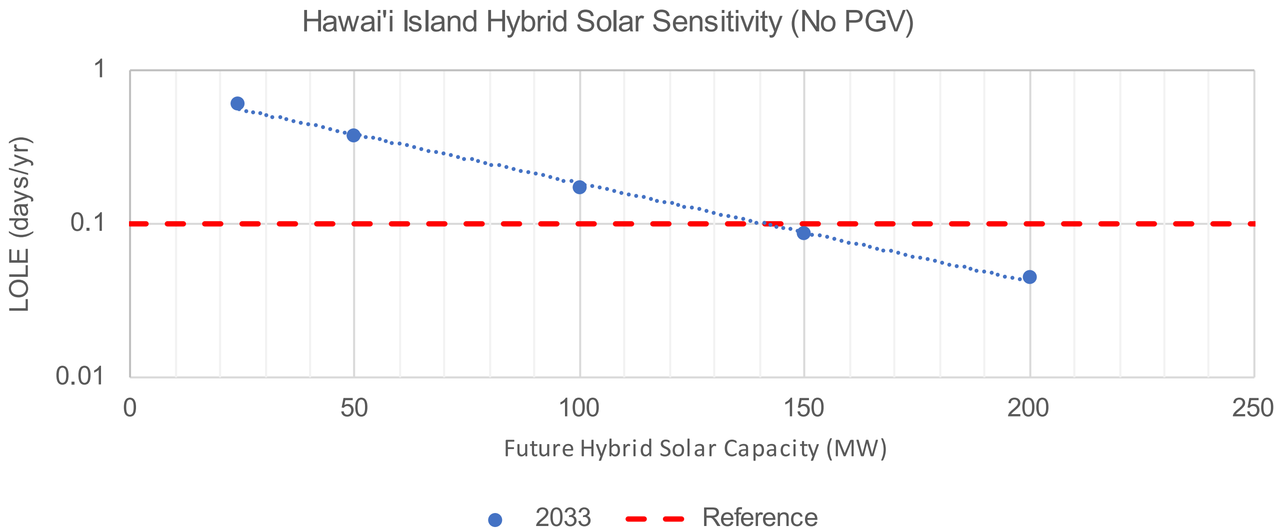

Figure 2-53: Hawaiʻi Island system reliability without PGV and resulting LOLE with incremental addition of hybrid solar capacity.

The heat maps shown in Figure 2-54 compare the unserved energy without PGV and after the addition of 150 MW of hybrid solar.

2033 Hawaiʻi Max. EUE of Mean Sample (No PGV): L – 0 MW Future HS; R – 150 MW Future HS

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.9	0.0	0.2	0.1	0.0	0.1	0.2	0.0	0.5	0.0	0.3
1	0.0	0.7	0.0	0.2	0.1	0.0	0.0	0.3	0.0	0.6	0.0	0.1
2	0.0	1.0	0.1	0.1	0.2	0.0	0.1	0.2	0.0	0.7	0.1	0.2
3	0.0	0.8	0.0	0.2	0.1	0.0	0.2	0.2	0.0	0.5	0.0	0.3
4	0.0	1.1	0.0	0.2	0.2	0.1	0.4	0.4	0.0	0.8	0.0	0.5
5	0.0	2.3	0.1	0.3	0.2	0.4	0.5	0.5	0.0	1.1	0.1	0.5
6	0.1	3.0	0.1	0.5	0.2	0.5	0.4	0.7	0.1	1.2	0.1	0.6
7	0.3	2.7	0.1	0.2	0.0	0.0	0.0	0.1	0.0	0.2	0.0	0.6
8	0.1	0.4	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.5
9	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
10	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.3
16	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.3
17	0.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.1	0.3
18	0.1	0.9	0.0	0.1	0.0	0.0	0.0	0.1	0.0	1.2	0.0	0.4
19	0.1	0.7	0.0	0.0	0.2	0.0	0.0	0.0	0.0	1.2	0.0	0.4
20	0.1	0.4	0.1	0.0	0.3	0.0	0.1	0.1	0.0	1.0	0.0	0.2
21	0.0	1.0	0.0	0.2	0.1	0.0	0.0	0.2	0.0	0.8	0.1	0.2
22	0.0	0.9	0.0	0.3	0.4	0.0	0.0	0.3	0.0	0.6	0.0	0.2
23	0.0	0.8	0.1	0.2	0.3	0.0	0.1	0.2	0.0	0.5	0.0	0.2

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
2	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
3	0.0	0.1	0.0	0.2	0.1	0.0	0.0	0.1	0.0	0.1	0.0	0.2
4	0.0	0.1	0.0	0.5	0.2	0.0	0.0	0.2	0.0	0.1	0.0	0.2
5	0.0	0.2	0.0	0.5	0.0	0.0	0.0	0.2	0.0	0.2	0.0	0.3
6	0.0	0.2	0.0	0.6	0.1	0.0	0.0	0.4	0.0	0.2	0.0	0.3
7	0.0	0.3	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
22	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1

MAX
6.6 MW
0 MW
MIN

Figure 2-54: Hawaiʻi Island EUE heat map, year 2033. Left – no future hybrid solar (H_Y33B_Out24_woPGV); Right – 150 MW of future hybrid solar (H_Y33B_Out24_woPGV_w150HS).

Table 2-26 shows the amount of resources when PGV is not in-service and how the reliability metric changes with different amounts of hybrid solar added.

Table 2-26: Hawai'i Island probabilistic analysis results summary, year 2033. Variable sensitivity.

Year 2033	H_Y33B_Out24_woPGV	H_Y33B_Out24_woPGV_w24HS	H_Y33B_Out50_woPGV_w50HS	H_Y33B_Out100_woPGV_w100HS	H_Y33B_Out150_woPGV_w150HS	H_Y33B_Out200_woPGV_w200HS
Existing Firm	100 MW	100 MW	100 MW	100 MW	100 MW	100 MW
PGV	0 MW	0 MW	0 MW	0 MW	0 MW	0 MW
Hamakua Energy	0 MW	0 MW	0 MW	0 MW	0 MW	0 MW
Existing PV	0 MW	0 MW	0 MW	0 MW	0 MW	0 MW
Existing Wind	11 MW	11 MW	11 MW	11 MW	11 MW	11 MW
Existing Hydro	3.35 MW	3.35 MW	3.35 MW	3.35 MW	3.35 MW	3.35 MW
CBRE	23 MW	23 MW	23 MW	23 MW	23 MW	23 MW
Stage 1 Waikoloa / Hale Kuawehi	60 MW	60 MW	60 MW	60 MW	60 MW	60 MW
Stage 3 Puako / Kaiwiki / Keamuku	201 MW	201 MW	201 MW	201 MW	201 MW	201 MW
Stage 3 Firm Hamakua Firm Renewable Energy	60 MW + 7.5 MW BESS	60 MW + 7.5 MW BESS	60 MW + 7.5 MW BESS	60 MW + 7.5 MW BESS	60 MW + 7.5 MW BESS	60 MW + 7.5 MW BESS
Future Hybrid Solar	0 MW	24 MW	50 MW	100 MW	150 MW	200 MW
Future Standalone Solar	0 MW	0 MW	0 MW	0 MW	0 MW	0 MW
Future Onshore Wind	30 MW	30 MW	30 MW	30 MW	30 MW	30 MW
Future Firm Units	0 MW	0 MW	0 MW	0 MW	0 MW	0 MW
Total	**488 MW**	**512 MW**	**538 MW**	**588 MW**	**638 MW**	**688 MW**
Stage 1 BESS	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh
Stage 3 BESS	201 MW / 804 MWh	201 MW / 804 MWh	201 MW / 804 MWh	201 MW / 804 MWh	201 MW / 804 MWh	201 MW / 804 MWh
Future BESS	0 MW / 0 MWh	0 MW / 0 MWh	0 MW / 0 MWh	0 MW / 0 MWh	0 MW / 0 MWh	0 MW / 0 MWh
Total	**261 MW / 1044 MWh**	**261 MW / 1044 MWh**	**261 MW / 1044 MWh**	**261 MW / 1044 MWh**	**261 MW / 1044 MWh**	**261 MW / 1044 MWh**
LOLE (days/year)	**0.89**	**0.60**	**0.37**	**0.17**	**0.08**	**0.04**
LOLEv (events/year)	**1.35**	**0.83**	**0.56**	**0.28**	**0.12**	**0.05**
LOLH (hours/year)	**3.68**	**2.35**	**1.56**	**0.70**	**0.34**	**0.16**
EUE (GWh/year)	**0.12**	**0.07**	**0.05**	**0.02**	**0.01**	**0.01**

No PGV Long-Duration Storage Sensitivity

The effects on reliability were studied for the Hawai'i system with a 24 MW standalone storage with different durations.

2033 Scenarios:

- H_Y33B_Out24_woPGV
    - Hawai'i Island 2024 IGP Plan, without future resources after Stage 3. Outage rates match 2022-2023 outage rates and includes derates.
    - Add 30 MW of onshore wind.
    - PGV is unavailable.
- H_Y33B_Out24_woPGV_w24LDS[6]
    - H_Y33B_Out24_woPGV with a 24 MW 6-hour long-duration energy storage.
- H_Y33B_Out24_woPGV_w24LDS[8]
    - H_Y33B_Out24_woPGV with a 24 MW 8-hour long-duration energy storage.
- H_Y33B_Out24_woPGV_w24LDS[12]
    - H_Y33B_Out24_woPGV with a 24 MW 12-hour long-duration energy storage.

The results shown on Figure 2-55 below there was a minimal impact to the LOLE with long duration storage in the Hawai'i system. The reliability did not improve significantly with the increase of the storage duration because there was not enough generating resources to produce energy to charge the storage.

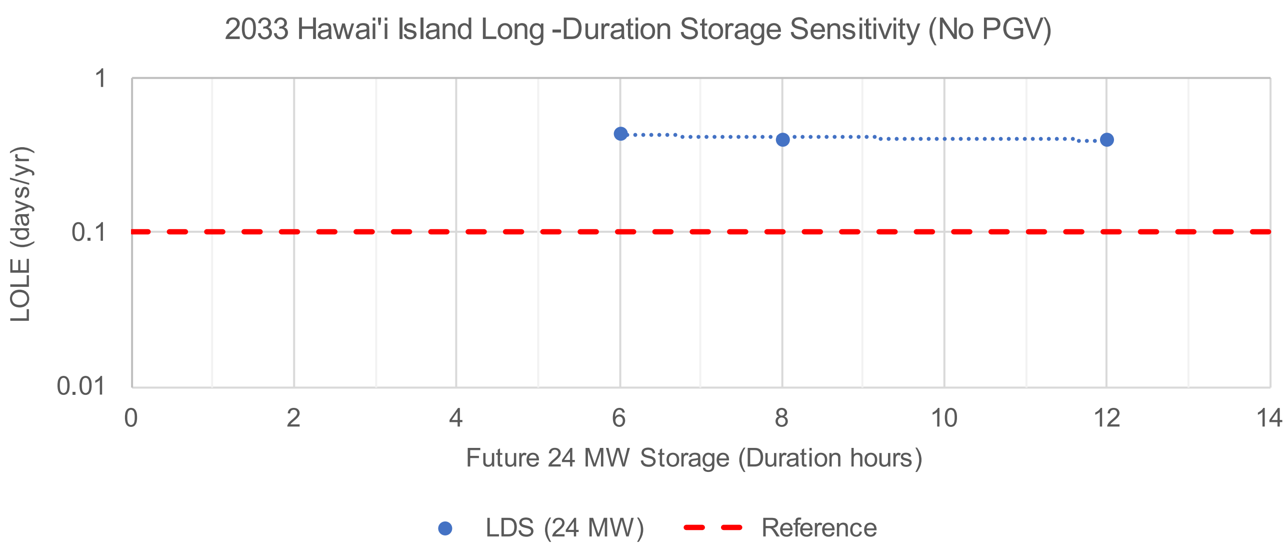

Figure 2-55: Hawai'i Island LOLE results with a 24 MW standalone battery with 6, 8, and 12 hour duration.

Figure 2-56 shows a small decrease in unserved energy in several hours of the month throughout the year but not significant enough to change the LOLE.

2033 Hawai‘i Max. EUE of Mean Sample (No PGV):
L – 0 MW Future LDS(12h); R – 24 MW Future LDS(12h)

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.9	0.0	0.2	0.1	0.0	0.1	0.2	0.0	0.5	0.0	0.3
1	0.0	0.7	0.0	0.2	0.1	0.0	0.0	0.3	0.0	0.6	0.0	0.1
2	0.0	1.0	0.1	0.1	0.2	0.0	0.1	0.2	0.0	0.7	0.1	0.2
3	0.0	0.8	0.0	0.2	0.1	0.0	0.2	0.2	0.0	0.5	0.0	0.3
4	0.0	1.1	0.0	0.2	0.2	0.1	0.4	0.4	0.0	0.8	0.0	0.5
5	0.0	2.3	0.1	0.3	0.2	0.4	0.5	0.5	0.0	1.1	0.1	0.5
6	0.1	3.0	0.1	0.5	0.2	0.5	0.4	0.7	0.1	1.2	0.1	0.6
7	0.3	2.7	0.1	0.2	0.0	0.0	0.0	0.1	0.0	0.2	0.0	0.6
8	0.1	0.4	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.5
9	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
10	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.3
16	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.3
17	0.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.1	0.3
18	0.1	0.9	0.0	0.1	0.0	0.0	0.0	0.1	0.0	1.2	0.0	0.4
19	0.1	0.7	0.0	0.0	0.2	0.0	0.0	0.0	0.0	1.2	0.0	0.4
20	0.1	0.4	0.1	0.0	0.3	0.0	0.1	0.1	0.0	1.0	0.0	0.2
21	0.0	1.0	0.0	0.2	0.1	0.0	0.0	0.2	0.0	0.8	0.1	0.2
22	0.0	0.9	0.0	0.3	0.4	0.0	0.0	0.3	0.0	0.6	0.0	0.2
23	0.0	0.8	0.1	0.2	0.3	0.0	0.1	0.2	0.0	0.5	0.0	0.2

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
1	0.1	0.7	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.2	0.0	0.1
2	0.1	0.6	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.2	0.0	0.1
3	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.2	0.0	0.2
4	0.0	0.9	0.0	0.0	0.1	0.2	0.0	0.3	0.0	0.2	0.0	0.3
5	0.0	0.9	0.0	0.2	0.1	0.1	0.0	0.4	0.0	0.5	0.1	0.4
6	0.1	1.4	0.0	0.3	0.1	0.2	0.1	0.5	0.1	0.7	0.0	0.4
7	0.1	1.4	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.3
8	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
16	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.2
17	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.3
18	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
19	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.3
20	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.3
21	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
22	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.1
23	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.2

MAX
6.6 MW
0 MW
MIN

Figure 2-56: Hawai‘i Island EUE heat map, year 2033. Left – no future long-duration storage (H_Y33B_Out24_woPGV); Right – 24 MW future long-duration storage (288 MWh) (H_Y33B_Out24_woPGV_w24LDS[12]).

Figure 2-57 is a sample dispatch of the day with the highest amount of unserved energy and includes the two days before and two days after the sample day. Like O‘ahu, unserved energy occurs over consecutive days when there are inadequate resources on the system to fully charge the long-duration storage. The day with the highest unserved energy appears to have low solar output and the days prior do not show any generation from onshore wind, contributing to the low state of charge for the long-duration storage.

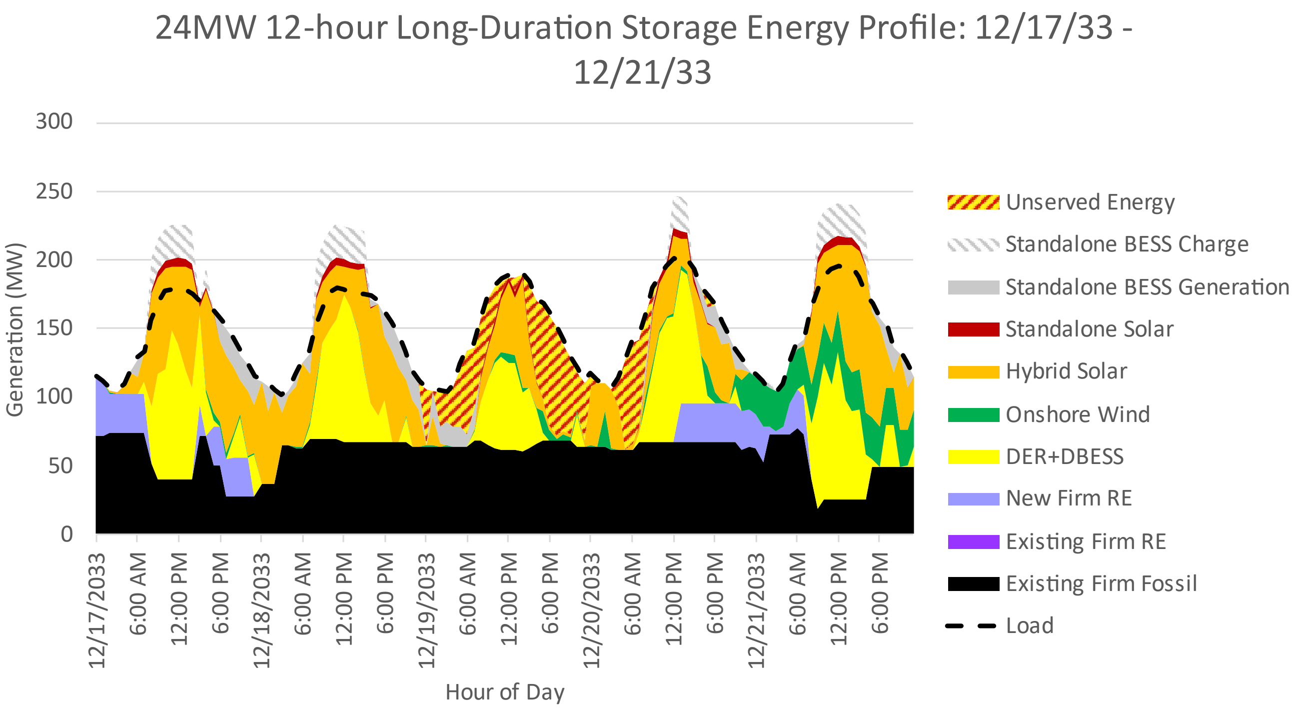

Figure 2-57: Hawai'i Island five-day sample dispatch containing the day with the highest amount of unserved energy.

Table 2-27 shows the resources assumed for the long-duration storage sensitivity and its effect on the system reliability.

Table 2-27: Hawai'i Island probabilistic analysis results summary, year 2033. Long-Duration Storage sensitivity.

Year 2033	H_Y33B_Out24_woPGV	H_Y33B_Out24_woPGV_w24LDS[6]	H_Y33B_Out24_woPGV_w24LDS[8]	H_Y33B_Out24_woPGV_w24LDS[12]
Existing Firm	100 MW	100 MW	100 MW	100 MW
PGV	0 MW	0 MW	0 MW	0 MW
Hamakua Energy	0 MW	0 MW	0 MW	0 MW
Existing PV	0 MW	0 MW	0 MW	0 MW
Existing Wind	11 MW	11 MW	11 MW	11 MW
Existing Hydro	3.35 MW	3.35 MW	3.35 MW	3.35 MW
CBRE	23 MW	23 MW	23 MW	23 MW
Stage 1 Waikoloa / Hale Kuawehi	60 MW	60 MW	60 MW	60 MW
Stage 3 Puako / Kaiwiki / Keamuku	201 MW	201 MW	201 MW	201 MW
Stage 3 Firm Hamakua Firm Renewable Energy	60 MW + 7.5 MW BESS	60 MW + 7.5 MW BESS	60 MW + 7.5 MW BESS	60 MW + 7.5 MW BESS
Future Hybrid Solar	0 MW	0 MW	0 MW	0 MW
Future Standalone Solar	0 MW	0 MW	0 MW	0 MW
Future Onshore Wind	30 MW	30 MW	30 MW	30 MW
Future Firm Units	0 MW	0 MW	0 MW	0 MW
Total	**488 MW**	**488 MW**	**488 MW**	**488 MW**
Stage 1 BESS	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh
Stage 3 BESS	201 MW / 804 MWh	201 MW / 804 MWh	201 MW / 804 MWh	201 MW / 804 MWh
Future BESS	0 MW / 0 MWh	24 MW / 72 MWh	24 MW / 96 MWh	24 MW / 144 MWh
Total	**261 MW / 1044 MWh**	**285 MW / 1116 MWh**	**285 MW / 1140 MWh**	**285 MW / 1188 MWh**
LOLE (days/year)	**0.89**	**0.44**	**0.40**	**0.40**
LOLEv (events/year)	**1.35**	**0.64**	**0.59**	**0.61**
LOLH (hours/year)	**3.68**	**1.71**	**1.63**	**1.62**
EUE (GWh/year)	**0.12**	**0.05**	**0.04**	**0.04**

2.2.3.4 Hamakua Energy Sensitivities

Given the recent challenges with equipment reliability and uncertainty regarding Hamakua Energy's return to service, we considered several sensitivities to estimate the amount of replacement resources needed if Hamakua Energy is unavailable.

No Hamakua Energy

The No Hamakua Energy sensitivity shows the impact on the reliability when Hamakua Energy is not in-service.

2029 Scenarios:

- H_Y29B_Out24_wPGV30
    - Hawai'i Island 2024 IGP Plan, without future resources after Stage 3. Outage rates match 2022-2023 outage rates and includes derates.
    - PGV output reduced to 30 MW.
    - Add 30 MW of onshore wind.
- H_Y29B_Out24_woHE_wPGV30
    - H_Y29B_Out24_wPGV30 without Hamakua Energy.

2033 Scenarios:

- H_Y33B_Out24_wPGV30
    - Hawai'i Island 2024 IGP Plan, without future resources after Stage 3. Outage rates match 2022-2023 outage rates and includes derates.
    - PGV output reduced to 30 MW.
    - Add 30 MW of onshore wind.
- H_Y33B_Out24_woHE_wPGV30
    - H_Y33B_Out24_wPGV30 without Hamakua Energy.

The heat maps shown below in Figure 2-58 and Figure 2-59 indicates that a system without Hamakua Energy will have some unserved energy.

2029 Hawai'i Max. EUE of Mean Sample (PGV at 30 MW): L – HE Available; R – HE Unavailable

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.2	0.3	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.1
1	0.0	0.1	0.1	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.1
2	0.0	0.1	0.1	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.1
3	0.0	0.1	0.2	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0
4	0.0	0.1	0.2	0.2	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.1
5	0.0	0.3	0.4	0.2	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.1
6	0.0	0.3	0.4	0.2	0.1	0.0	0.5	0.1	0.0	0.1	0.0	0.1
7	0.0	0.2	0.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
8	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
16	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
17	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
18	0.0	0.0	0.7	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1
19	0.0	0.0	0.3	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.2
20	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2
21	0.0	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2
22	0.0	0.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
23	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1

MAX	
6.6 MW	
0 MW	
MIN	

Figure 2-58: Hawai'i Island EUE heat map, year 2029. Left – Hamakua Energy is available (H_Y29B_Out24_wPGV30); Right – Hamakua Energy is unavailable (H_Y29B_Out24_woHE_wPGV30).

2033 Hawai'i Max. EUE of Mean Sample (PGV at 30 MW): L – HE Available; R – HE Unavailable

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
5	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
6	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0
7	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.2	1.4	0.2	0.1	0.0	0.0	0.3	0.0	0.2	0.0	0.1
1	0.0	0.1	0.9	0.2	0.1	0.0	0.0	0.1	0.0	0.4	0.0	0.1
2	0.0	0.2	0.5	0.2	0.1	0.0	0.0	0.2	0.0	0.2	0.0	0.1
3	0.0	0.2	0.7	0.2	0.0	0.0	0.0	0.3	0.0	0.4	0.0	0.1
4	0.0	0.4	1.3	0.7	0.2	0.0	0.0	0.4	0.0	0.3	0.0	0.3
5	0.0	1.2	2.1	0.5	0.2	0.0	0.0	0.5	0.0	0.8	0.0	0.2
6	0.0	1.7	3.8	1.1	0.3	0.0	0.0	0.7	0.0	0.9	0.1	0.3
7	0.0	1.3	2.9	0.5	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.3
8	0.0	0.1	0.8	0.2	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.4
9	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
10	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.3
16	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.3	0.0	0.2	0.0	0.3
17	0.0	0.1	1.7	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.2
18	0.0	0.0	1.6	0.1	0.0	0.0	0.0	0.2	0.0	0.1	0.0	0.3
19	0.0	0.2	1.0	0.2	0.2	0.0	0.0	0.1	0.0	0.3	0.0	0.4
20	0.0	0.3	0.6	0.0	0.2	0.0	0.0	0.1	0.0	0.3	0.0	0.3
21	0.0	0.1	0.8	0.0	0.3	0.0	0.0	0.0	0.0	0.7	0.0	0.2
22	0.0	0.3	0.9	0.1	0.2	0.0	0.0	0.1	0.0	0.3	0.0	0.2
23	0.0	0.4	1.6	0.2	0.2	0.0	0.0	0.0	0.0	0.3	0.0	0.1

MAX	
6.6 MW	
0 MW	
MIN	

Figure 2-59: Hawai'i Island EUE heat map, year 2033. Left – Hamakua Energy is available (H_Y33B_Out24_wPGV30); Right – Hamakua Energy is unavailable (H_Y33B_Out24_woHE_wPGV30).

Table 2-28 and Table 2-29 show that the reliability decreases significantly when Hamakua Energy is not on the system with LOLE of 0.32 and 0.88 days/year, in 2029 and 2033 respectively.

Table 2-28: Hawai'i Island probabilistic analysis results summary, year 2029. No Hamakua Energy sensitivity.

Year 2029	H_Y29B_Out24_wPGV30	H_Y29B_Out24_woHE_wPGV30
Existing Firm	124 MW	124 MW
PGV	30 MW	30 MW
Hamakua Energy	58 MW	0 MW
Existing PV	0 MW	0 MW
Existing Wind	11 MW	11 MW
Existing Hydro	3.35 MW	3.35 MW
CBRE	23 MW	23 MW
Stage 1 Waikoloa / Hale Kuawehi	60 MW	60 MW
Stage 3 Puako / Kaiwiki / Keamuku	115 MW	115 MW
Stage 3 Firm Hamakua Firm Renewable Energy	0 MW	0 MW
Future Hybrid Solar	0 MW	0 MW
Future Standalone Solar	0 MW	0 MW
Future Onshore Wind	30 MW	30 MW
Future Firm Units	0 MW	0 MW
Total	**454 MW**	**396 MW**
Stage 1 BESS	60 MW / 240 MWh	60 MW / 240 MWh
Stage 3 BESS	115 MW / 460 MWh	115 MW / 460 MWh
Future BESS	0 MW / 0 MWh	0 MW / 0 MWh
Total	**175 MW / 700 MWh**	**175 MW / 700 MWh**
LOLE (days/year)	**0.00**	**0.32**
LOLEv (events/year)	**0.00**	**0.49**
LOLH (hours/year)	**0.00**	**1.11**
EUE (GWh/year)	**0.00**	**0.02**

Table 2-29: Hawaiʻi Island probabilistic analysis results summary, year 2033. No Hamakua Energy sensitivity.

Year 2033	H_Y33B_Out24_wPGV30	H_Y33B_Out24_woHE_wPGV30
Existing Firm	100 MW	100 MW
PGV	30 MW	30 MW
Hamakua Energy	0 MW	0 MW
Existing PV	0 MW	0 MW
Existing Wind	11 MW	11 MW
Existing Hydro	3.35 MW	3.35 MW
CBRE	23 MW	23 MW
Stage 1 Waikoloa / Hale Kuawehi	60 MW	60 MW
Stage 3 Puako / Kaiwiki / Keamuku	201 MW	201 MW
Stage 3 Firm Hamakua Firm Renewable Energy	60 MW + 7.5 MW BESS	0 MW
Future Hybrid Solar	0 MW	0 MW
Future Standalone Solar	0 MW	0 MW
Future Onshore Wind	30 MW	30 MW
Future Firm Units	0 MW	0 MW
Total	**518 MW**	**458 MW**
Stage 1 BESS	60 MW / 240 MWh	60 MW / 240 MWh
Stage 3 BESS	201 MW / 804 MWh	201 MW / 804 MWh
Future BESS	0 MW / 0 MWh	0 MW / 0 MWh
Total	**261 MW / 1044 MWh**	**261 MW / 1044 MWh**
LOLE (days/year)	**0.02**	**0.88**
LOLEv (events/year)	**0.03**	**1.46**
LOLH (hours/year)	**0.11**	**3.48**
EUE (GWh/year)	**0.00**	**0.08**

No Hamakua Energy Firm Sensitivity

This section shows the amount of firm capacity needed in 2029 and 2033 to obtain an LOLE of 0.1 days/year without Hamakua Energy.

2029 Scenarios:

- H_Y29B_Out24_wo(IGP_HE)_wPGV30
  - Hawaiʻi Island 2024 IGP Plan, without future resources after Stage 3. Outage rates match 2022-2023 outage rates and includes derates.
  - PGV output reduced to 30 MW.
  - Hamakua Energy is unavailable.
- H_Y29B_Out24_wo(IGP_HE)_w(PGV30_16ICE)

- H_Y29B_Out24_wo(IGP_HE)_wPGV30 with 2x8.14 MW internal combustion engine.
- H_Y29B_Out24_wo(IGP_HE)_w(PGV30_24ICE)
  - H_Y29B_Out24_wo(IGP_HE)_wPGV30 with 3x8.14 MW internal combustion engine.
- H_Y29B_Out24_wo(IGP_HE)_w(PGV30_32ICE)
  - H_Y29B_Out24_wo(IGP_HE)_wPGV30 with 4x8.14 MW internal combustion engine.

2033 Scenarios:

- H_Y33B_Out24_wo(IGP_HE)_wPGV30
  - Hawai'i Island 2024 IGP Plan, without future resources after Stage 3. Outage rates match 2022-2023 outage rates and includes derates.
  - PGV output reduced to 30 MW.
  - Hamakua Energy is unavailable.
- H_Y33B_Out24_wo(IGP_HE)_w(PGV30_16ICE)
  - H_Y33B_Out24_wo(IGP_HE)_wPGV30 with 2x8.14 MW internal combustion engine.
- H_Y33B_Out24_wo(IGP_HE)_w(PGV30_24ICE)
  - H_Y33B_Out24_wo(IGP_HE)_wPGV30 with 3x8.14 MW internal combustion engine.
- H_Y33B_Out24_wo(IGP_HE)_w(PGV30_32ICE)
  - H_Y33B_Out24_wo(IGP_HE)_wPGV30 with 4x8.14 MW internal combustion engine.

Figure 2-60 below shows the amount of firm capacity needed to get an LOLE below 0.1 days/year for years 2029 and 2033, approximately 19 MW and 23 MW, respectively. These amounts are based on interpolation of scenarios.

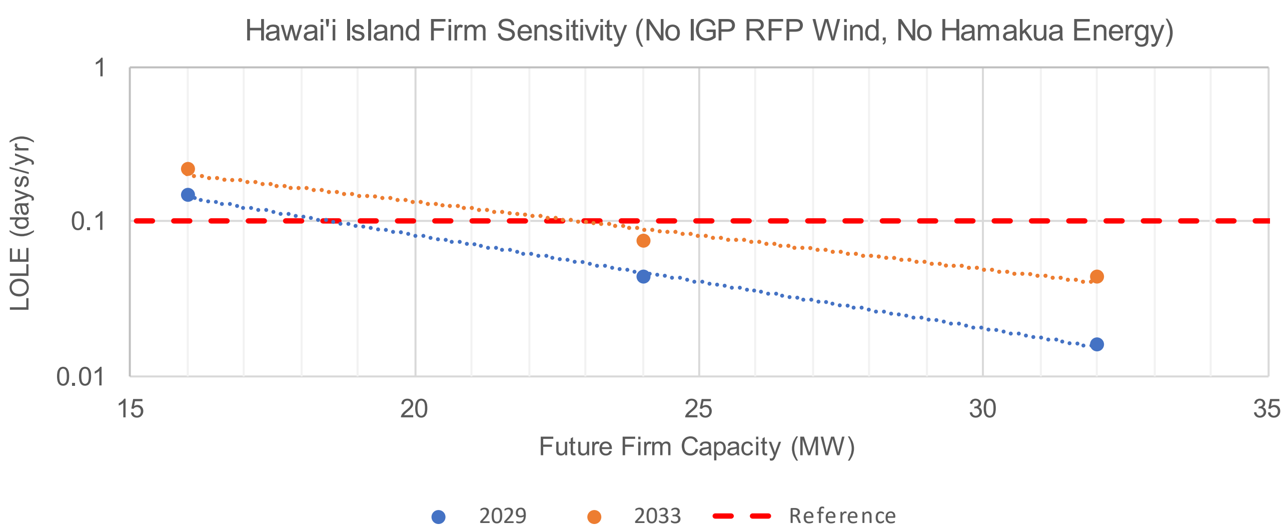

Figure 2-60: Hawai'i Island system reliability without Hamakua Energy in 2029 and 2033 and the resulting LOLE with incremental addition of firm capacity (ICEs).

The heat maps shown below in Figure 2-61 indicates that a system without Hamakua energy and without 30 MW of IGP RFP Wind resource can have unserved energy that spans most months of the year which can be reduced by adding approximately 23 MW of ICEs in year 2033.

2033 Hawai‘i Max. EUE of Mean Sample (PGV at 30 MW, no IGP RFP Wind, no Hamakua Energy):
L – 0 MW Future ICE; R – 24 MW Future ICE

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.4	1.8	0.4	0.1	0.0	0.0	0.6	0.0	0.5	0.0	0.2
1	0.0	0.3	1.7	0.5	0.2	0.0	0.0	0.6	0.0	0.5	0.0	0.2
2	0.3	0.5	1.6	0.6	0.2	0.0	0.0	0.6	0.0	0.4	0.0	0.3
3	0.5	0.9	1.9	0.5	0.1	0.0	0.0	0.6	0.0	0.5	0.1	0.5
4	0.8	1.2	2.7	0.6	0.2	0.0	0.1	0.7	0.0	0.6	0.1	0.5
5	1.0	2.1	4.8	1.1	0.5	0.0	0.2	1.0	0.0	1.3	0.1	0.5
6	1.4	2.7	6.6	1.6	0.6	0.0	0.0	1.4	0.1	1.8	0.1	1.7
7	0.9	1.4	4.7	0.7	0.2	0.0	0.0	0.2	0.0	0.0	0.1	1.3
8	0.0	0.2	1.9	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6
9	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
10	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
14	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
15	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
16	0.0	0.0	3.4	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.4
17	0.0	0.2	4.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
18	0.0	0.1	4.8	0.2	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.6
19	0.1	0.2	3.9	0.2	0.5	0.0	0.0	0.1	0.0	0.3	0.0	0.7
20	0.1	0.2	2.9	0.1	0.4	0.0	0.0	0.4	0.0	0.1	0.0	0.3
21	0.3	0.1	2.9	0.4	0.4	0.0	0.0	0.5	0.0	0.2	0.0	0.2
22	0.0	0.5	2.2	0.2	0.5	0.0	0.0	0.4	0.0	0.4	0.0	0.4
23	0.0	0.5	1.5	0.3	0.4	0.0	0.0	0.4	0.0	0.3	0.0	0.2

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
2	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.2
4	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
5	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0
6	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.3
7	0.0	0.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
16	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
19	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2
23	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0

MAX
6.6 MW
0 MW
MIN

Figure 2-61: Hawai'i Island EUE heat map, year 2033. Left – no future firm (H_Y33B_Out24_wo(IGP_HE)_wPGV30); Right – three future ICE units (24 MW) (H_Y33B_Out24_wo(IGP_HE)_w(PGV30_24ICE)).

On Table 2-30 and Table 2-31, the reliability metrics are shown for a system in 2029 and 2033 when Hamakua Energy is not in-service and without the 30 MW of onshore wind IGP placeholder with increments of ICEs in the system. As the system adds more firm renewables, this lowers the LOLE.

Table 2-30: Hawai'i Island probabilistic analysis results summary, year 2029. No Hamakua Energy Firm sensitivity.

Year 2029	H_Y29B_Out24_wo(IGP_HE)_wPGV30	H_Y29B_Out24_wo(IGP_HE)_w(PGV30_16ICE)	H_Y29B_Out24_wo(IGP_HE)_w(PGV30_24ICE)	H_Y29B_Out24_wo(IGP_HE)_w(PGV30_32ICE)
Existing Firm	124 MW	124 MW	124 MW	124 MW
PGV	30 MW	30 MW	30 MW	30 MW
Hamakua Energy	0 MW	0 MW	0 MW	0 MW
Existing PV	0 MW	0 MW	0 MW	0 MW
Existing Wind	11 MW	11 MW	11 MW	11 MW
Existing Hydro	3.35 MW	3.35 MW	3.35 MW	3.35 MW
CBRE	23 MW	23 MW	23 MW	23 MW
Stage 1 Waikoloa / Hale Kuawehi	60 MW	60 MW	60 MW	60 MW
Stage 3 Puako / Kaiwiki / Keamuku	115 MW	115 MW	115 MW	115 MW
Stage 3 Firm Hamakua Firm Renewable Energy	0 MW	0 MW	0 MW	0 MW
Future Hybrid Solar	0 MW	0 MW	0 MW	0 MW
Future Standalone Solar	0 MW	0 MW	0 MW	0 MW
Future Onshore Wind	0 MW	0 MW	0 MW	0 MW
Future Firm Units	0 MW	16 MW	24 MW	32 MW
Total	**366 MW**	**382 MW**	**390 MW**	**398 MW**
Stage 1 BESS	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh
Stage 3 BESS	115 MW / 460 MWh	115 MW / 460 MWh	115 MW / 460 MWh	115 MW / 460 MWh
Future BESS	0 MW / 0 MWh	0 MW / 0 MWh	0 MW / 0 MWh	0 MW / 0 MWh
Total	**175 MW / 700 MWh**	**175 MW / 700 MWh**	**175 MW / 700 MWh**	**175 MW / 700 MWh**
LOLE (days/year)	**0.80**	**0.15**	**0.04**	**0.02**
LOLEv (events/year)	**1.18**	**0.16**	**0.04**	**0.03**
LOLH (hours/year)	**2.66**	**0.32**	**0.06**	**0.06**
EUE (GWh/year)	**0.05**	**0.00**	**0.00**	**0.00**

Table 2-31: Hawai'i Island probabilistic analysis results summary, year 2033. No Hamakua Energy Firm sensitivity.

Year 2033	H_Y33B_Out24_wo(IGP_HE)_wPGV30	H_Y33B_Out24_wo(IGP_HE)_w(PGV30_16ICE)	H_Y33B_Out24_wo(IGP_HE)_w(PGV30_24ICE)	H_Y33B_Out24_wo(IGP_HE)_w(PGV30_32ICE)
Existing Firm	100 MW	100 MW	100 MW	100 MW
PGV	30 MW	30 MW	30 MW	30 MW
Hamakua Energy	0 MW	0 MW	0 MW	0 MW
Existing PV	0 MW	0 MW	0 MW	0 MW
Existing Wind	11 MW	11 MW	11 MW	11 MW
Existing Hydro	3.35 MW	3.35 MW	3.35 MW	3.35 MW
CBRE	23 MW	23 MW	23 MW	23 MW
Stage 1 Waikoloa / Hale Kuawehi	60 MW	60 MW	60 MW	60 MW
Stage 3 Puako / Kaiwiki / Keamuku	201 MW	201 MW	201 MW	201 MW
Stage 3 Firm Hamakua Firm Renewable Energy	0 MW	0 MW	0 MW	0 MW
Future Hybrid Solar	0 MW	0 MW	0 MW	0 MW
Future Standalone Solar	0 MW	0 MW	0 MW	0 MW
Future Onshore Wind	0 MW	0 MW	0 MW	0 MW
Future Firm Units	0 MW	16 MW	24 MW	32 MW
Total	**428 MW**	**444 MW**	**452 MW**	**460 MW**
Stage 1 BESS	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh
Stage 3 BESS	201 MW / 804 MWh	201 MW / 804 MWh	201 MW / 804 MWh	201 MW / 804 MWh
Future BESS	0 MW / 0 MWh	0 MW / 0 MWh	0 MW / 0 MWh	0 MW / 0 MWh
Total	**261 MW / 1044 MWh**	**261 MW / 1044 MWh**	**261 MW / 1044 MWh**	**261 MW / 1044 MWh**
LOLE (days/year)	**1.89**	**0.22**	**0.08**	**0.04**
LOLEv (events/year)	**3.03**	**0.35**	**0.14**	**0.07**
LOLH (hours/year)	**7.86**	**0.76**	**0.30**	**0.14**
EUE (GWh/year)	**0.19**	**0.02**	**0.01**	**0.00**

No Hamakua Energy Variable Sensitivity

This section shows the amount of hybrid solar needed in 2029 and 2033 to get to an LOLE of 0.1 days/year without Hamakua Energy.

2029 Scenarios:

- H_Y29B_Out24_wo(IGP_HE)_wPGV30
    - Hawai'i Island 2024 IGP Plan, without future resources after Stage 3. Outage rates match 2022-2023 outage rates and includes derates.

    - PGV output reduced to 30 MW.
    - Hamakua Energy is unavailable.
- H_Y29B_Out24_wo(IGP_HE)_w(PGV30_50HS)
    - H_Y29B_Out24_wo(IGP_HE)_wPGV30 with an additional 50 MW of hybrid solar.
- H_Y29B_Out24_wo(IGP_HE)_w(PGV30_100HS)
    - H_Y29B_Out24_wo(IGP_HE)_wPGV30 with an additional 100 MW of hybrid solar.
- H_Y29B_Out24_wo(IGP_HE)_w(PGV30_200HS)
    - H_Y29B_Out24_wo(IGP_HE)_wPGV30 with an additional 200 MW of hybrid solar.

2033 Scenarios:

- H_Y33B_Out24_wo(IGP_HE)_wPGV30
    - Hawaiʻi Island 2024 IGP Plan, without future resources after Stage 3. Outage rates match 2022-2023 outage rates and includes derates.
    - PGV output reduced to 30 MW.
    - Hamakua Energy is unavailable.
- H_Y33B_Out24_wo(IGP_HE)_w(PGV30_200HS)
    - H_Y33B_Out24_wo(IGP_HEP)_wPGV30 with an additional 200 MW of hybrid solar .
- H_Y33B_Out24_wo(IGP_HE)_w(PGV30_225HS)
    - H_Y33B_Out24_wo(IGP_HE)_wPGV30 with an additional 225 MW of hybrid solar .
- H_Y33B_Out24_wo(IGP_HE)_w(PGV30_250HS)
    - H_Y33B_Out24_wo(IGP_HEP)_wPGV30 with an additional 250 MW of hybrid solar .
- H_Y33B_Out24_wo(IGP_HE)_w(PGV30_275HS)
    - H_Y33B_Out24_wo(IGP_HE)_wPGV30 with an additional 275 MW of hybrid solar .

Hybrid solar capacity was incrementally added to the Hawaiʻi system after Hamakua Energy and the 30 MW onshore wind IGP resource were removed in Figure 2-62. With those two resources removed, we would need about 75 MW of hybrid solar in year 2029 and about 270 MW of a hybrid solar in year 2033 to achieve an LOLE of 0.1 days/year. These hybrid solar amounts are based on interpolation of scenarios.

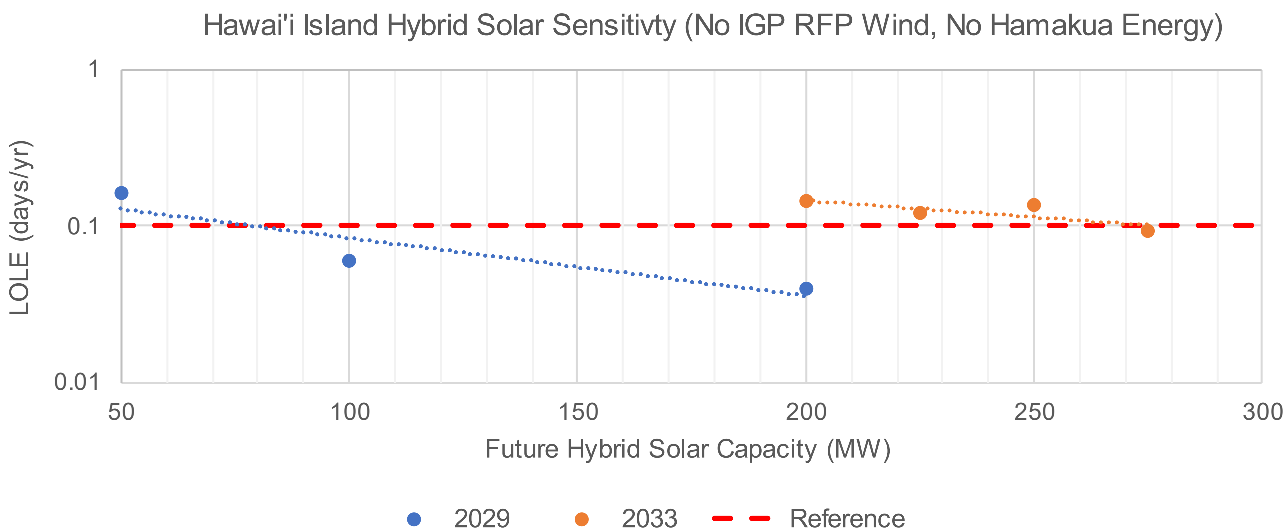

Figure 2-62: Hawaiʻi Island system reliability without Hamakua Energy in 2029 and 2033, and resulting LOLE with incremental addition of hybrid solar capacity.

Figure 2-63 below shows the comparison of unserved energy of a system without Hamakua Energy and the 30 MW onshore wind IGP resource and when adding about 275 MW of hybrid solar. After adding the 275 MW of hybrid solar, the risk of unserved energy shifts to the early morning period.

2033 Hawaiʻi Max. EUE of Mean Sample (PGV at 30 MW, no IGP RFP Wind, no Hamakua Energy):
L – 0 MW Future HS; R – 275 MW Future HS

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.4	1.8	0.4	0.1	0.0	0.0	0.6	0.0	0.5	0.0	0.2
1	0.0	0.3	1.7	0.5	0.2	0.0	0.0	0.6	0.0	0.5	0.0	0.2
2	0.3	0.5	1.6	0.6	0.2	0.0	0.0	0.6	0.0	0.4	0.0	0.3
3	0.5	0.9	1.9	0.5	0.1	0.0	0.0	0.6	0.0	0.5	0.1	0.5
4	0.8	1.2	2.7	0.6	0.2	0.0	0.1	0.7	0.0	0.6	0.1	0.5
5	1.0	2.1	4.8	1.1	0.5	0.0	0.2	1.0	0.0	1.3	0.1	0.5
6	1.4	2.7	6.6	1.6	0.6	0.0	0.0	1.4	0.1	1.8	0.1	1.7
7	0.9	1.4	4.7	0.7	0.2	0.0	0.0	0.2	0.0	0.0	0.1	1.3
8	0.0	0.2	1.9	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6
9	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
10	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
14	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
15	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
16	0.0	0.0	3.4	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.4
17	0.0	0.2	4.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
18	0.0	0.1	4.8	0.2	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.6
19	0.1	0.2	3.9	0.2	0.5	0.0	0.0	0.1	0.0	0.3	0.0	0.7
20	0.1	0.2	2.9	0.1	0.4	0.0	0.0	0.4	0.0	0.1	0.0	0.3
21	0.3	0.1	2.9	0.4	0.4	0.0	0.0	0.5	0.0	0.2	0.0	0.2
22	0.0	0.5	2.2	0.2	0.5	0.0	0.0	0.4	0.0	0.4	0.0	0.4
23	0.0	0.5	1.5	0.3	0.4	0.0	0.0	0.4	0.0	0.3	0.0	0.2

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	1.1	0.1	0.0	0.2	0.0	0.0	0.2	0.0	0.0	0.0	0.0
6	0.1	1.1	0.1	0.0	0.1	0.0	0.0	0.4	0.0	0.1	0.0	0.1
7	0.1	0.2	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
8	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

MAX
6.6 MW
0 MW
MIN

Figure 2-63: Hawaiʻi Island EUE heat map, year 2033. Left – no future hybrid solar (H_Y33B_Out24_wo(IGP_HE)_wPGV30); Right – 275 MW of hybrid solar (H_Y33B_Out24_wo(IGP_HE)_w(PGV30_275HS).

Table 2-32 and Table 2-33 shows the resources on the Hawaiʻi system in 2029 and 2033 without Hamakua Energy and the 30 MW onshore wind IGP resource while testing increments of hybrid solar.

Table 2-32: Hawai'i Island probabilistic analysis results summary, year 2029. No Hamakua Energy Variable sensitivity.

Year 2029	H_Y29B_Out24_wo(IGP_HE)_wPGV30	H_Y29B_Out24_wo(IGP_HE)_w(PGV30_50HS)	H_Y29B_Out24_wo(IGP_HE)_w(PGV30_100HS)	H_Y29B_Out24_wo(IGP_HE)_w(PGV30_200HS)
Existing Firm	124 MW	124 MW	124 MW	124 MW
PGV	30 MW	30 MW	30 MW	30 MW
Hamakua Energy	0 MW	0 MW	0 MW	0 MW
Existing PV	0 MW	0 MW	0 MW	0 MW
Existing Wind	11 MW	11 MW	11 MW	11 MW
Existing Hydro	3.35 MW	3.35 MW	3.35 MW	3.35 MW
CBRE	23 MW	23 MW	23 MW	23 MW
Stage 1 Waikoloa / Hale Kuawehi	60 MW	60 MW	60 MW	60 MW
Stage 3 Puako / Kaiwiki / Keamuku	115 MW	115 MW	115 MW	115 MW
Stage 3 Firm Hamakua Firm Renewable Energy	0 MW	0 MW	0 MW	0 MW
Future Hybrid Solar	0 MW	50 MW	100 MW	200 MW
Future Standalone Solar	0 MW	0 MW	0 MW	0 MW
Future Onshore Wind	0 MW	0 MW	0 MW	0 MW
Future Firm Units	0 MW	0 MW	0 MW	0 MW
Total	**366 MW**	**416 MW**	**466 MW**	**566 MW**
Stage 1 BESS	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh
Stage 3 BESS	115 MW / 460 MWh	115 MW / 460 MWh	115 MW / 460 MWh	115 MW / 460 MWh
Future BESS	0 MW / 0 MWh	0 MW / 0 MWh	0 MW / 0 MWh	0 MW / 0 MWh
Total	**175 MW / 700 MWh**	**175 MW / 700 MWh**	**175 MW / 700 MWh**	**175 MW / 700 MWh**
LOLE (days/year)	**0.80**	**0.16**	**0.06**	**0.04**
LOLEv (events/year)	**1.18**	**0.23**	**0.06**	**0.05**
LOLH (hours/year)	**2.66**	**0.56**	**0.19**	**0.12**
EUE (GWh/year)	**0.05**	**0.01**	**0.00**	**0.00**

Table 2-33: Hawai'i Island probabilistic analysis results summary, year 2033. No Hamakua Energy Variable sensitivity.

Year 2033	H_Y33B_Out24_wo(IGP_HE)_wPGV30	H_Y33B_Out24_wo(IGP_HE)_w(PGV30_200HS)	H_Y33B_Out24_wo(IGP_HE)_w(PGV30_225HS)	H_Y33B_Out24_wo(IGP_HE)_w(PGV30_250HS)	H_Y33B_Out24_wo(IGP_HE)_w(PGV30_275HS)
Existing Firm	100 MW	100 MW	100 MW	100 MW	100 MW
PGV	30 MW	30 MW	30 MW	30 MW	30 MW
Hamakua Energy	0 MW	0 MW	0 MW	0 MW	0 MW
Existing PV	0 MW	0 MW	0 MW	0 MW	0 MW
Existing Wind	11 MW	11 MW	11 MW	11 MW	11 MW
Existing Hydro	3.35 MW	3.35 MW	3.35 MW	3.35 MW	3.35 MW
CBRE	23 MW	23 MW	23 MW	23 MW	23 MW
Stage 1 Waikoloa / Hale Kuawehi	60 MW	60 MW	60 MW	60 MW	60 MW
Stage 3 Puako / Kaiwiki / Keamuku	201 MW	201 MW	201 MW	201 MW	201 MW
Stage 3 Firm Hamakua Firm Renewable Energy	0 MW	0 MW	0 MW	0 MW	0 MW
Future Hybrid Solar	0 MW	200 MW	225 MW	250 MW	275 MW
Future Standalone Solar	0 MW	0 MW	0 MW	0 MW	0 MW
Future Onshore Wind	0 MW	0 MW	0 MW	0 MW	0 MW
Future Firm Units	0 MW	0 MW	0 MW	0 MW	0 MW
Total	**428 MW**	**628 MW**	**653 MW**	**678 MW**	**703 MW**
Stage 1 BESS	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh
Stage 3 BESS	201 MW / 804 MWh	201 MW / 804 MWh	201 MW / 804 MWh	201 MW / 804 MWh	201 MW / 804 MWh
Future BESS	0 MW / 0 MWh	0 MW / 0 MWh	0 MW / 0 MWh	0 MW / 0 MWh	0 MW / 0 MWh
Total	**261 MW / 1044 MWh**	**261 MW / 1044 MWh**	**261 MW / 1044 MWh**	**261 MW / 1044 MWh**	**261 MW / 1044 MWh**
LOLE (days/year)	**1.89**	**0.14**	**0.12**	**0.14**	**0.09**
LOLEv (events/year)	**3.03**	**0.18**	**0.15**	**0.15**	**0.10**
LOLH (hours/year)	**7.86**	**0.42**	**0.38**	**0.37**	**0.24**
EUE (GWh/year)	**0.19**	**0.01**	**0.01**	**0.01**	**0.01**

2.2.3.5 Load Sensitivities

The Hawai'i Island analyses performed thus far assumed a base load forecast. Like O'ahu, a sensitivity was performed to see how reliability may be impacted under the Faster Technology Adoption scenario and the High Electricity Demand scenarios.

Load Sensitivity with Firm Resources

Incorporating recent firm capacity derates into the analysis, the following scenarios were tested to determine how the 2033 LOLE may be impacted under a Faster Technology Adoption scenario and a High Electricity Demand scenario. This section shows the amount of firm capacity needed to obtain an LOLE of 0.1 days/year without Hamakua Energy, for the various load forecasts. The focus was on 2033 due to its higher forecasted load compared to 2029 and planned removal of additional firm generation (CT1, CT2) in 2031. Hamakua Energy is assumed to be unavailable based on its current status.

Faster Technology Adoption with Firm Resources Scenarios:

- H_Y33B_Out24_wo(IGP_HE)_wPGV30
  - Hawaiʻi Island 2024 IGP Plan, without future resources after Stage 3. Outage rates match 2022-2023 outage rates and includes derates.
  - PGV output reduced to 30 MW.
  - Hamakua Energy is unavailable.
- H_Y33HiTechB_Out24_wo(IGP_HE)_w(PGV30_68CT)
  - H_Y33B_Out24_wo(IGP_HE)_wPGV30 with a faster customer technology adoption load forecast, 2x34 MW combustion turbines.
- H_Y33HiTechB_Out24_wo(IGP_HE)_w(PGV30_102CT)
  - H_Y33B_Out24_wo(IGP_HE)_wPGV30 with a faster customer technology adoption load forecast, 3x34 MW combustion turbines.

High Electricity Demand with Firm Resources Scenarios:

- H_Y33B_Out24_wo(IGP_HE)_wPGV30
  - Hawaiʻi Island 2024 IGP Plan, without future resources after Stage 3. Outage rates match 2022-2023 outage rates and includes derates.
  - PGV output reduced to 30 MW.
  - Hamakua Energy is unavailable.
- H_Y33HiB_Out24_wo(IGP_HE)_w(PGV30_68CT)
  - H_Y33B_Out24_wo(IGP_HE)_wPGV30 with a high load forecast, 2x34 MW combustion turbines.
- H_Y33HiB_Out24_wo(IGP_HE)_w(PGV30_102CT)
  - H_Y33B_Out24_wo(IGP_HE)_wPGV30 with a high load forecast, 3x34 MW combustion turbines.
- H_Y33HiB_Out24_wo(IGP_HE)_w(PGV30_136CT)
  - H_Y33B_Out24_wo(IGP_HE)_wPGV30 with a high load forecast, 4x34 MW combustion turbines.

Figure 2-64 below shows the amount of firm capacity tested to get an LOLE below 0.1 days/year in 2033 with a base electricity demand, faster technology adoption, and high electricity demand. As described in Section 2.2.3.4, approximately 23 MW of firm capacity is needed to achieve an LOLE of 0.1 days/year. This compares to approximately 75 MW of firm capacity under the faster technology adoption forecast and approximately

107 MW of firm capacity under the high electricity demand forecast (determined by interpolation of scenarios).

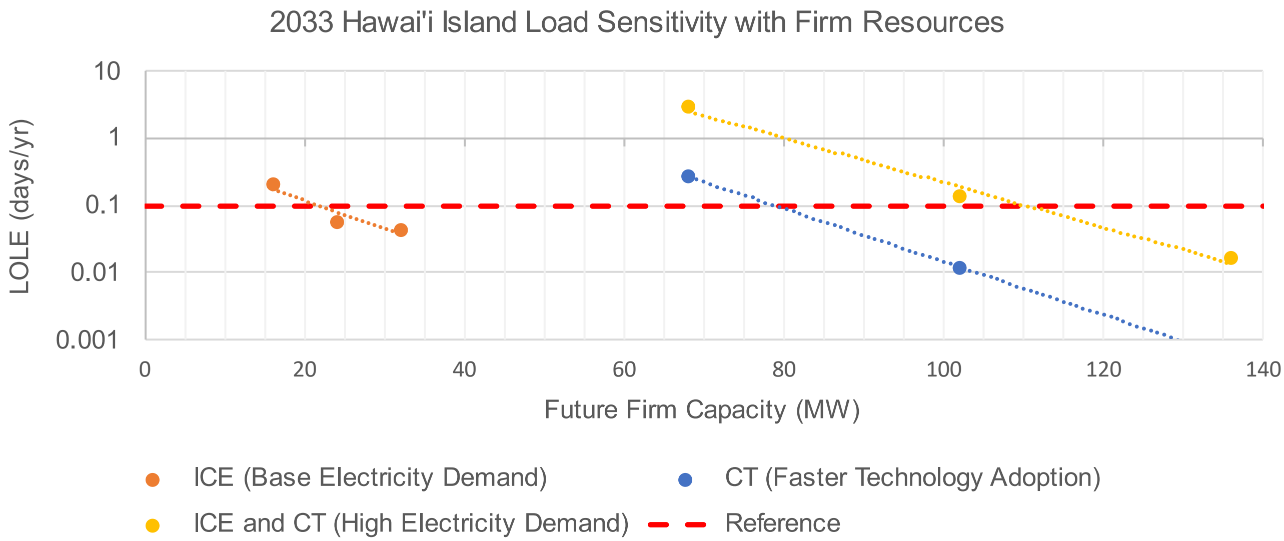

Figure 2-64: Hawai'i Island system reliability without Hamakua Energy in 2033 and resulting LOLE with incremental addition of firm capacity (ICEs and CTs) for Base Electricity Demand, High Electricity Demand, and Faster Technology Adoption.

The heat maps shown below in Figure 2-65 and Figure 2-66 indicate that for a system without Hamakua Energy and without 30 MW of IGP RFP wind resource, there is a higher need for firm generation with increased load. The addition of two combustion turbines (68 MW) results in greater unserved energy with the high load forecast compared to the faster technology adoption load forecast. Similar trends can be seen with the addition of three combustion turbines (102 MW).

2033 Hawaiʻi Max. EUE of Mean Sample (PGV at 30 MW, no IGP RFP Wind, no Hamakua Energy, 68 MW Future CT): L – Faster Tech Adoption; R – High Electricity Demand

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.1	0.2	0.0	0.0	0.0	0.0	0.7	0.0	0.6	0.0	0.1
1	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.7	0.0	1.1	0.1	0.1
2	0.0	0.2	0.3	0.0	0.0	0.0	0.0	0.7	0.0	0.9	0.0	0.1
3	0.0	0.7	0.2	0.0	0.0	0.0	0.0	0.6	0.0	0.7	0.0	0.0
4	0.0	0.9	0.2	0.0	0.0	0.0	0.0	0.7	0.0	1.0	0.0	0.0
5	0.0	0.7	0.2	0.0	0.0	0.0	0.0	0.8	0.0	1.4	0.0	0.1
6	0.2	0.9	0.4	0.1	0.0	0.0	0.0	1.1	0.0	1.5	0.1	0.2
7	0.3	0.5	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.2	0.0	0.1
8	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.1	0.1
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
22	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
23	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.5	1.8	1.9	0.5	1.0	0.4	0.4	1.7	0.8	0.3	0.4	0.6
1	0.5	0.9	1.2	0.5	0.7	0.1	0.2	1.4	0.3	0.1	0.2	0.6
2	0.4	1.2	0.9	0.6	1.1	0.1	0.1	1.0	0.2	0.6	0.2	0.4
3	0.4	1.2	0.9	0.3	0.7	0.0	0.2	1.2	0.4	0.8	0.0	0.3
4	0.4	1.5	1.2	0.8	0.9	0.1	0.2	1.2	0.6	1.5	0.1	0.4
5	0.7	2.0	1.9	0.6	1.1	0.3	0.3	1.0	1.0	1.8	0.2	0.6
6	1.3	3.1	2.3	1.1	2.0	0.6	0.4	1.2	1.2	1.8	0.8	0.9
7	1.2	2.7	1.3	0.6	0.0	0.0	0.1	0.2	0.2	0.4	0.4	1.0
8	0.2	0.0	0.5	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.2	0.3
9	0.1	0.1	0.2	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1
10	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
11	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
14	0.0	0.1	0.2	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.4
15	0.0	0.3	1.0	0.0	0.0	0.0	0.0	0.5	0.1	0.1	0.1	0.5
16	0.1	0.7	1.3	0.2	0.1	0.0	0.0	0.4	0.2	0.2	0.1	1.1
17	0.6	1.7	2.1	0.8	0.2	0.0	0.0	0.6	0.8	0.2	0.4	1.5
18	0.7	1.3	3.3	0.8	0.1	0.0	0.0	1.2	0.6	0.3	0.3	1.0
19	1.0	1.4	2.7	1.1	1.1	0.0	0.0	1.5	1.1	0.5	0.4	1.3
20	0.6	1.7	2.2	1.2	0.8	0.0	0.0	1.1	1.1	0.5	0.7	1.2
21	0.8	1.2	2.7	1.4	1.0	0.0	0.0	1.1	1.1	0.8	0.5	1.6
22	0.8	1.3	2.2	1.0	1.0	0.4	0.3	1.2	0.9	1.2	0.9	1.3
23	0.7	1.1	2.2	1.1	0.8	0.5	0.1	1.0	1.1	1.4	1.0	1.7

MAX
4.7 MW
0 MW
MIN

Figure 2-65: Hawaiʻi Island EUE heat map, year 2033. Left – Faster tech adoption (H_Y33HiTechB_Out24_wo(IGP_HE)_w(PGV30_68CT)); Right – High load (H_Y33HiB_Out24_wo(IGP_HE)_w(PGV30_68CT)).

2033 Hawaiʻi Max. EUE of Mean Sample (PGV at 30 MW, no IGP RFP Wind, no Hamakua Energy, 102 MW Future CT): L – Faster Tech Adoption; R – High Electricity Demand

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.6	0.1	0.0	0.7	0.0	0.0	0.2	0.0	0.0	0.0	0.0
1	0.0	0.1	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.1	0.1	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.7	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
17	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
19	0.0	0.0	0.3	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.1	0.6	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.5	0.0	0.2	0.0	0.0	0.0	0.0	0.1	0.0	0.0
22	0.0	0.1	0.3	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.1	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

MAX
4.7 MW
0 MW
MIN

Figure 2-66: Hawaiʻi Island EUE heat map, year 2033. Left – Faster tech adoption (H_Y33HiTechB_Out24_wo(IGP_HE)_w(PGV30_102CT)); Right – High load (H_Y33HiB_Out24_wo(IGP_HE)_w(PGV30_102CT)).

Table 2-34 provides the reliability metrics for a system under a faster technology adoption scenario in 2033 when Hamakua Energy is not in-service and without the 30 MW of onshore wind IGP placeholder with increments of new firm generation on the system. As the system adds more firm renewables, this lowers the LOLE. The faster technology adoption scenarios showed that the system might need more than 68 MW of firm renewable capacity to achieve an LOLE of 0.1 days/year, based on the modeled capacity.

Next, Table 2-35 shows the reliability metrics for a system with High Electricity Demand in 2033 when Hamakua Energy is not in-service and without the 30 MW of onshore wind IGP placeholder with increments of new firm generation on the system. These scenarios showed that the system might need more than 102 MW of firm renewable capacity to achieve an LOLE of 0.1 days/year, based on the modeled capacity.

Table 2-34: Hawai'i Island probabilistic analysis results summary, year 2033. No Hamakua Energy Firm sensitivity with Faster Customer Technology Adoption.

Year 2033	H_Y33B_Out24_wo(IGP_HE)_wPGV30	H_Y33HiTechB_Out24_wo(IGP_HE)_w(PGV30_68CT)	H_Y33HiTechB_Out24_wo(IGP_HE)_w(PGV30_102CT)
Load Forecast	Base	Faster Adoption	Faster Adoption
Existing Firm	100 MW	100 MW	100 MW
PGV	30 MW	30 MW	30 MW
Hamakua Energy	0 MW	0 MW	0 MW
Existing PV	0 MW	0 MW	0 MW
Existing Wind	11 MW	11 MW	11 MW
Existing Hydro	3.35 MW	3.35 MW	3.35 MW
CBRE	23 MW	23 MW	23 MW
Stage 1 Waikoloa / Hale Kuawehi	60 MW	60 MW	60 MW
Stage 3 Puako / Kaiwiki / Keamuku	201 MW	201 MW	201 MW
Stage 3 Firm Hamakua Firm Renewable Energy	0 MW	0 MW	0 MW
Future Hybrid Solar	0 MW	0 MW	0 MW
Future Standalone Solar	0 MW	0 MW	0 MW
Future Onshore Wind	0 MW	0 MW	0 MW
Future Firm Units	0 MW	68 MW	102 MW
Total	**428 MW**	**496 MW**	**530 MW**
Stage 1 BESS	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh
Stage 3 BESS	201 MW / 804 MWh	201 MW / 804 MWh	201 MW / 804 MWh
Future BESS	0 MW / 0 MWh	0 MW / 0 MWh	0 MW / 0 MWh
Total	**261 MW / 1044 MWh**	**261 MW / 1044 MWh**	**261 MW / 1044 MWh**
LOLE (days/year)	**1.89**	**0.26**	**0.01**
LOLEv (events/year)	**3.03**	**0.30**	**0.01**
LOLH (hours/year)	**7.86**	**0.88**	**0.01**
EUE (GWh/year)	**0.19**	**0.03**	**0.00**

Table 2-35: Hawai'i Island probabilistic analysis results summary, year 2033. No Hamakua Energy Firm sensitivity under High Electricity Demand.

Year 2033	H_Y33HiB_Out24_wo(IGP_HE)_w(PGV30_68CT)	H_Y33HiB_Out24_wo(IGP_HE)_w(PGV30_102CT)	H_Y33HiB_Out24_wo(IGP_HE)_w(PGV30_136CT)
Load Forecast	High Electricity	High Electricity	High Electricity
Existing Firm	100 MW	100 MW	100 MW
PGV	30 MW	30 MW	30 MW
Hamakua Energy	0 MW	0 MW	0 MW
Existing PV	0 MW	0 MW	0 MW
Existing Wind	11 MW	11 MW	11 MW
Existing Hydro	3.35 MW	3.35 MW	3.35 MW
CBRE	23 MW	23 MW	23 MW
Stage 1 Waikoloa / Hale Kuawehi	60 MW	60 MW	60 MW
Stage 3 Puako / Kaiwiki / Keamuku	201 MW	201 MW	201 MW
Stage 3 Firm Hamakua Firm Renewable Energy	0 MW	0 MW	0 MW
Future Hybrid Solar	0 MW	0 MW	0 MW
Future Standalone Solar	0 MW	0 MW	0 MW
Future Onshore Wind	0 MW	0 MW	0 MW
Future Firm Units	68 MW	102 MW	136 MW
Total	**496 MW**	**530 MW**	**564 MW**
Stage 1 BESS	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh
Stage 3 BESS	201 MW / 804 MWh	201 MW / 804 MWh	201 MW / 804 MWh
Future BESS	0 MW / 0 MWh	0 MW / 0 MWh	0 MW / 0 MWh
Total	**261 MW / 1044 MWh**	**261 MW / 1044 MWh**	**261 MW / 1044 MWh**
LOLE (days/year)	**2.94**	**0.14**	**0.02**
LOLEv (events/year)	**4.22**	**0.20**	**0.02**
LOLH (hours/year)	**11.57**	**0.52**	**0.02**
EUE (GWh/year)	**0.01**	**0.01**	**0.00**

Load Sensitivity with Variable Resources

This section shows the amount of hybrid solar tested needed to achieve an LOLE of 0.1 days/year under a Faster Technology Adoption scenario and a High Electricity Demand scenario. The scenarios tested are listed below.

Faster Technology Adoption with Variable Resources Scenarios:

- H_Y33B_Out24_wo(IGP_HE)_wPGV30
  - Hawai'i Island 2024 IGP Plan, without future resources after Stage 3. Outage rates match 2022-2023 outage rates and includes derates.
  - PGV output reduced to 30 MW.
  - Hamakua Energy is unavailable.
- H_Y33HiTechB_Out24_wo(IGP_HE)_w(PGV30_300HS)
  - H_Y33B_Out24_wo(IGP_HE)_wPGV30 with a faster customer technology adoption load forecast and an additional 300 MW of future hybrid solar.

High Electricity Demand with Variable Resources Scenarios:

- H_Y33B_Out24_wo(IGP_HE)_wPGV30
  - Hawai'i Island 2024 IGP Plan, without future resources after Stage 3. Outage rates match 2022-2023 outage rates and includes derates.
  - PGV output reduced to 30 MW.
  - Hamakua Energy is unavailable.
- H_Y33HiB_Out24_wo(IGP_HE)_w(PGV30_250HS)
  - H_Y33B_Out24_wo(IGP_HE)_wPGV30 with a high load forecast and an additional 250 MW of hybrid solar.
- H_Y33HiB_Out24_wo(IGP_HE)_w(PGV30_275HS)
  - H_Y33B_Out24_wo(IGP_HE)_wPGV30 with a high load forecast and an additional 275 MW of hybrid solar.
- H_Y33HiB_Out24_wo(IGP_HE)_w(PGV30_300HS)
  - H_Y33B_Out24_wo(IGP_HE)_wPGV30 with a high load forecast and an additional 300 MW of hybrid solar.

Figure 2-67 below shows the amount of hybrid solar capacity tested to get an LOLE below 0.1 days/year in 2033 under the faster technology adoption and high electricity demand forecast, compared to a base load forecast. Based on the analysis conducted, the hybrid solar in the amounts tested was unable to obtain an LOLE below 0.1 days/year. Considering that 300 MW of hybrid solar was tested and an additional 261 MW of hybrid solar is already planned to be installed for Stage 1 and Stage 3 RFP, no further scenarios were tested.

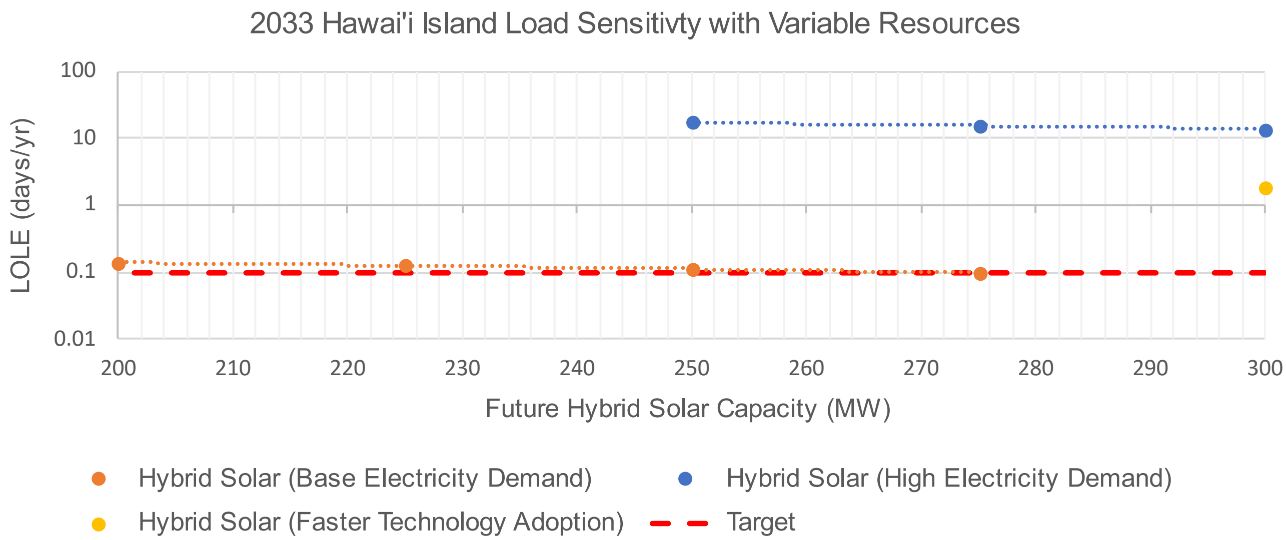

Figure 2-67: Hawai'i Island system reliability without Hamakua Energy in 2033 and resulting LOLE with incremental addition of hybrid solar capacity for base and high load scenarios.

Figure 2-68 below compares the unserved energy for a system without Hamakua Energy and the 30 MW onshore wind IGP resource, with the base load forecast and the addition of 275 MW of hybrid solar versus faster technology adoption and the addition of 300 MW of hybrid solar. The case with 275 MW solar and base load meets the 0.1 days/year LOLE criteria whereas the case with a comparable addition of 300 MW solar and faster technology adoption does not. The load forecast significantly impacts the amount of unserved energy experienced.

2033 Hawai'i Max. EUE of Mean Sample (PGV at 30 MW, no IGP RFP Wind, no Hamakua Energy):
L – Base Load, 275 MW Future HS; R – Faster Tech Adoption, 300 MW Future HS

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	1.1	0.1	0.0	0.2	0.0	0.0	0.2	0.0	0.0	0.0	0.0
6	0.1	1.1	0.1	0.0	0.1	0.0	0.0	0.4	0.0	0.1	0.0	0.1
7	0.1	0.2	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
8	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.5	1.6	0.8	0.3	0.1	0.0	0.7	0.8	0.8	1.2	0.4	1.9
1	0.9	0.7	0.6	0.3	0.0	0.2	0.5	0.8	0.6	0.8	0.4	1.7
2	0.9	0.6	0.7	0.0	0.2	0.0	0.1	0.6	0.3	0.3	0.3	1.0
3	0.4	0.3	0.6	0.0	0.1	0.0	0.2	0.5	0.2	0.1	0.1	0.2
4	0.3	0.5	0.9	0.0	0.1	0.1	0.3	0.6	0.2	0.3	0.0	0.3
5	0.6	1.4	3.4	0.1	0.1	0.2	0.8	1.1	0.6	1.4	0.5	0.9
6	1.0	2.0	4.5	0.2	0.1	0.1	0.8	1.4	0.6	1.6	1.0	2.0
7	0.4	2.5	4.7	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.4
8	0.0	0.3	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7
9	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
17	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
18	0.0	0.1	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
19	0.0	0.6	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
20	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
21	0.0	0.9	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
22	0.0	1.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1
23	0.0	1.4	0.6	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	1.3

MAX
4.7 MW
0 MW
MIN

Figure 2-68: Hawai'i Island EUE heat map, year 2033. Left – Base load, 275 MW of hybrid solar (H_Y33B_Out24_wo(IGP_HE)_w(PGV30_275HS)); Right – Faster tech adoption, 300 MW of hybrid solar (H_Y33HiTechB_Out24_wo(IGP_HE)_w(PGV30_300HS)).

Table 2-36 shows sensitivities done for 2033 under a faster customer technology adoption forecast, without Hamakua Energy and the 30 MW IGP RFP wind resource. The base load forecast without any future resources shows the LOLE to be 1.89 days/year. Adding 275 MW of hybrid solar to the base load forecast improves LOLE to 0.09 days/year. Adding 300 MW of hybrid solar to a faster customer technology adoption load forecast results in an LOLE of 1.79 days/year. Under the high load forecast, where load is even greater than the faster technology adoption forecast, 300 MW of hybrid solar has even less of an impact.

Table 2-36: Hawai'i Island probabilistic analysis results summary, year 2033. No Hamakua Energy Variable sensitivity with base load forecast and faster customer technology adoption

Year 2033	H_Y33B_Out24_wo(IGP_HE)_wPGV30	H_Y33B_Out24_wo(IGP_HE)_w(PGV30_275HS)	H_Y33HiTechB_Out24_wo(IGP_HE)_w(PGV30_300HS)
Load Forecast	Base	Base	Faster Adoption
Existing Firm	100 MW	100 MW	100 MW
PGV	30 MW	30 MW	30 MW
Hamakua Energy	0 MW	0 MW	0 MW
Existing PV	0 MW	0 MW	0 MW
Existing Wind	11 MW	11 MW	11 MW
Existing Hydro	3.35 MW	3.35 MW	3.35 MW
CBRE	23 MW	23 MW	23 MW
Stage 1 Waikoloa / Hale Kuawehi	60 MW	60 MW	60 MW
Stage 3 Puako / Kaiwiki / Keamuku	201 MW	201 MW	201 MW
Stage 3 Firm Hamakua Firm Renewable Energy	0 MW	0 MW	0 MW
Future Hybrid Solar	0 MW	275 MW	300 MW
Future Standalone Solar	0 MW	0 MW	0 MW
Future Onshore Wind	0 MW	0 MW	0 MW
Future Firm Units	0 MW	0 MW	0 MW
Total	**428 MW**	**703 MW**	**728 MW**
Stage 1 BESS	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh
Stage 3 BESS	201 MW / 804 MWh	201 MW / 804 MWh	201 MW / 804 MWh
Future BESS	0 MW / 0 MWh	0 MW / 0 MWh	0 MW / 0 MWh
Total	**261 MW / 1044 MWh**	**261 MW / 1044 MWh**	**261 MW / 1044 MWh**
LOLE (days/year)	**1.89**	**0.09**	**1.79**
LOLEv (events/year)	**3.03**	**0.10**	**2.66**
LOLH (hours/year)	**7.86**	**0.24**	**6.56**
EUE (GWh/year)	**0.19**	**0.01**	**0.18**

Table 2-37 shows sensitivities done for 2033 under a high load forecast, without Hamakua Energy and the 30 MW onshore wind IGP RFP resource. Increments of hybrid solar were added to test their effects on system reliability. Despite adding 300 MW of hybrid solar, the resulting LOLE was 13 days/year.

Table 2-37: Hawai'i Island probabilistic analysis results summary, year 2033. No Hamakua Energy Variable sensitivity with High load

Year 2033	H_Y33B_Out24_wo(IGP_HE)_wPGV30	H_Y33HiB_Out24_wo(IGP_HE)_w(PGV30_250HS)	H_Y33HiB_Out24_wo(IGP_HE)_w(PGV30_275HS)	H_Y33HiB_Out24_wo(IGP_HE)_w(PGV30_300HS)
Load Forecast	Base	High Electricity	High Electricity	High Electricity
Existing Firm	100 MW	100 MW	100 MW	100 MW
PGV	30 MW	30 MW	30 MW	30 MW
Hamakua Energy	0 MW	0 MW	0 MW	0 MW
Existing PV	30 MW	30 MW	30 MW	30 MW
Existing Wind	11 MW	11 MW	11 MW	11 MW
Existing Hydro	3.35 MW	3.35 MW	3.35 MW	3.35 MW
CBRE	23 MW	23 MW	23 MW	23 MW
Stage 1 Waikoloa / Hale Kuawehi	60 MW	60 MW	60 MW	60 MW
Stage 3 Puako / Kaiwiki / Keamuku	201 MW	201 MW	201 MW	201 MW
Stage 3 Firm Hamakua Firm Renewable Energy	0 MW	0 MW	0 MW	0 MW
Future Hybrid Solar	0 MW	250 MW	275 MW	300 MW
Future Standalone Solar	0 MW	0 MW	0 MW	0 MW
Future Onshore Wind	0 MW	0 MW	0 MW	0 MW
Future Firm Units	0 MW	0 MW	0 MW	0 MW
Total	**428 MW**	**678 MW**	**703 MW**	**728 MW**
Stage 1 BESS	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh
Stage 3 BESS	201 MW / 804 MWh	201 MW / 804 MWh	201 MW / 804 MWh	201 MW / 804 MWh
Future BESS	0 MW / 0 MWh	0 MW / 0 MWh	0 MW / 0 MWh	0 MW / 0 MWh
Total	**261 MW / 1044 MWh**	**261 MW / 1044 MWh**	**261 MW / 1044 MWh**	**261 MW / 1044 MWh**
LOLE (days/year)	**1.89**	**16.98**	**15.25**	**13.78**
LOLEv (events/year)	**3.03**	**22.12**	**19.70**	**17.65**
LOLH (hours/year)	**7.86**	**89.07**	**77.37**	**67.74**
EUE (GWh/year)	**0.19**	**3.48**	**2.98**	**2.55**

2.2.3.6 Stage 3 RFP Sensitivity

Based on experience from past RFPs, there is a possibility that some of the selected proposals from the Stage 3 RFP may experience delays or withdraw completely. As a result, sensitivities were performed to examine how the LOLE may be affected if one of the awarded Stage 3 RFP projects does not go into service. A sensitivity was run without Kaiwiki Solar (55 MW hybrid solar paired with a 4-hour BESS). The focus was on 2029 since both Kaiwiki and Puako from Stage 3 are expected to be in service. The remaining Stage 3 projects, Keamuku Solar and Hamakua Energy, would be in-service by 2030 and 2031, respectively.

2029 Scenario:

- H_Y29B_Out24_woIGP_wPGV30
  - Hawaiʻi Island 2024 IGP Plan, without future resources after Stage 3. Outage rates match 2022-2023 outage rates and includes derates.
  - PGV output reduced to 30 MW.
- H_Y29B_Out24_wo(IGP_Kaiwiki)
  - H_Y29B_Out24_woIGP_wPGV30, excluding Kaiwiki Solar from the resource plan.

Figure 2-69 below shows the resulting LOLE before and after Kaiwiki Solar is removed from the resource plan. With Puako in-service and Kaiwiki removed, LOLE is above 0.1 days/year.

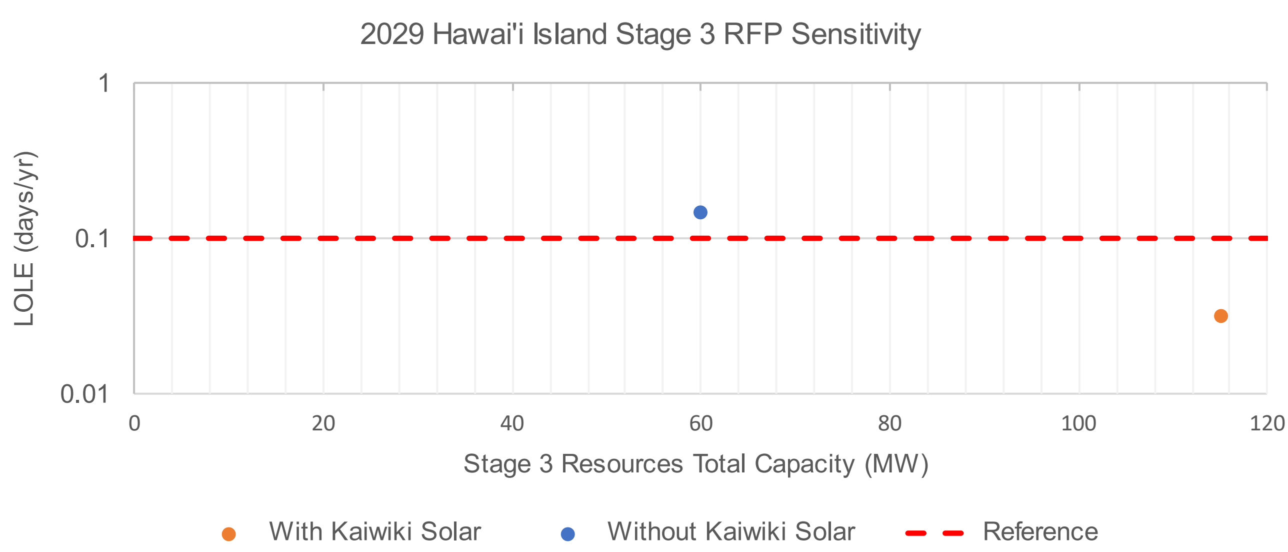

Figure 2-69: Hawaiʻi system reliability with and without Kaiwiki Solar in 2029 and resulting LOLE values.

Figure 2-70 below compares the unserved energy of a system with Kaiwiki Solar versus a system without Kaiwiki Solar.

2029 Hawai‘i Max. EUE of Mean Sample (PGV at 30 MW, no IGP RFP Wind): L With Kaiwiki Solar; R No Kaiwiki Solar

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.3	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
7	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0
20	0.0	0.1	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0

MAX
6.6 MW
0 MW
MIN

Figure 2-70: Hawai‘i Island EUE heat map, year 2029. Left – with Kaiwiki Solar (H_Y29B_Out24_woIGP_wPGV30); Right – without Kaiwiki Solar (H_Y29B_Out24_wo(IGP_Kaiwiki));

Table 2-38 below summarizes reliability metrics when Kaiwiki is removed from the resource plan. It is preferable to keep Kaiwiki in the resource plan to maintain LOLE below 0.1 days/year.

Table 2-38: Hawai'i Island probabilistic analysis results summary, year 2029, Stage 3 RFP sensitivity

Year 2029	H_Y29B_Out24_woIGP_wPGV30	H_Y29B_Out24_wo(IGP_Kaiwiki)_wPGV30
Load Forecast	Base	Base
Existing Firm	124 MW	124 MW
PGV	30 MW	30 MW
Hamakua Energy	58 MW	58 MW
Existing PV	0 MW	0 MW
Existing Wind	11 MW	11 MW
Existing Hydro	3.35 MW	3.35 MW
CBRE	23 MW	23 MW
Stage 1 Waikoloa / Hale Kuawehi	60 MW	60 MW
Stage 3 Puako / Kaiwiki / Keamuku	115 MW	60 MW
Stage 3 Firm Hamakua Firm Renewable Energy	0 MW	0 MW
Future Hybrid Solar	0 MW	0 MW
Future Standalone Solar	0 MW	0 MW
Future Onshore Wind	0 MW	0 MW
Future Firm Units	0 MW	0 MW
Total	**424 MW**	**369 MW**
Stage 1 BESS	60 MW / 240 MWh	60 MW / 240 MWh
Stage 3 BESS	60 MW / 240 MWh	60 MW / 240 MWh
Future BESS	0 MW / 0 MWh	0 MW / 0 MWh
Total	**120 MW / 480 MWh**	**120 MW / 480 MWh**
LOLE (days/year)	**0.03**	**0.15**
LOLEv (events/year)	**0.04**	**0.18**
LOLH (hours/year)	**0.10**	**0.32**
EUE (GWh/year)	**0.00**	**0.00**

2.2.4 Maui

The awarded capacity and energy from projects awarded in the Stage 3 RFP met the RFP's capacity target but did not meet the RFP's energy target for Maui. Due to the August 2023 wildfires and ongoing recovery efforts, Maui will not have a first round IGP RFP to seek the remaining energy from the Stage 3 RFP and instead, allow time to work with the community to develop a plan for future renewable projects. Maui will have a second round IGP RFP target of 176 GWh in service by December 1, 2032 to replace any IPP resource which may expire by the end of 2033.

Despite not meeting the energy target for the Stage 3 RFP, the Maui system is anticipated to be reliable at a 2033 LOLE less than 0.1 once the planned projects from prior RFPs and awarded projects from the Stage 3 RFP are in service. Given that there is no target for the first round IGP RFP, the Maui analyses focused on contingency planning to examine the reliability impacts if projects are delayed or withdrawn.

On May 24, 2024, AES withdrew the 20 MW Pu'u Hao Solar project from the Stage 3 RFP.[28] Based on the analyses conducted herein, Maui is still expected to achieve a 2033 LOLE below 0.1 days/year with the planned projects from prior RFPs and the second round IGP RFP.

Updates to Outage Assumptions

An extensive probabilistic analysis was performed to understand how reliability is impacted by the resources procured through the prior Stage 3 RFP. The methodology that was established during the IGP process and presented in the IGP Final Report was improved upon in this analysis by incorporating generator derates. This analysis looked at the availability of the existing generators in 2022 and 2023, including any derated performance.

Shown below in Figure 2-71 is the number of hours that the utility-owned generators experienced a forced outage/forced derate between 2022 and 2023. Figure 2-72 shows the number of hours that the utility-owned generators experienced a maintenance outage/maintenance derate between 2022 and 2023. In both figures, the outages are categorized based on the type of generator and the size of the outage. These figures compare actual performance in 2022 and 2023 to the outage rates assumed in the IGP.

[28] See May 31, 2024 letter AES Clean Energy Development, LLC Notice of Withdrawal – Puu Hao Solar in Docket No. 2017-0352.

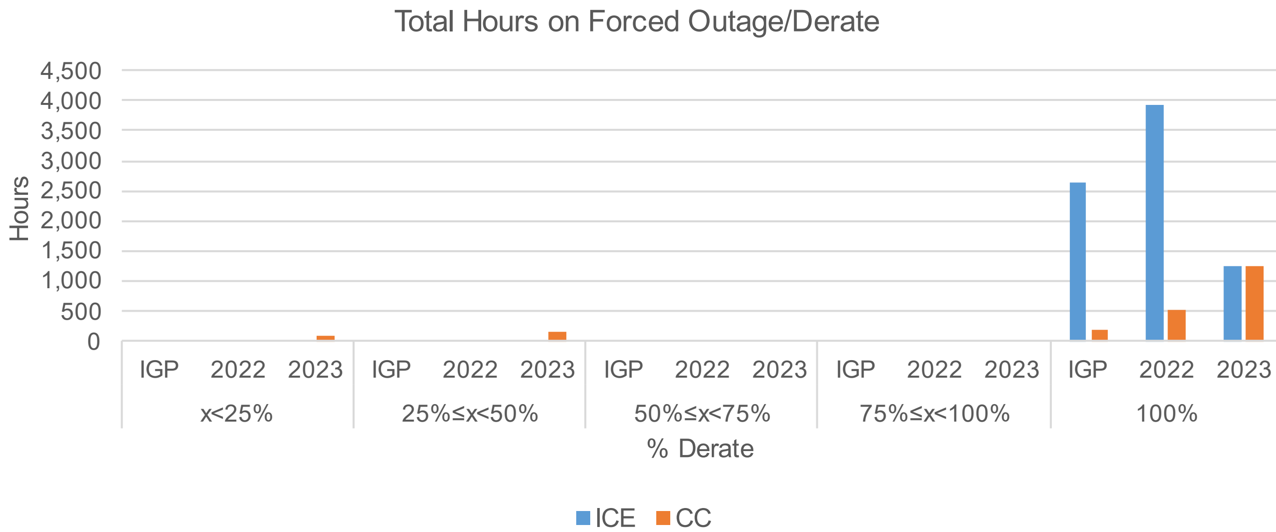

Figure 2-71: Total hours on forced outage/forced derates in 2022-2023 for utility-owned generators on Maui.

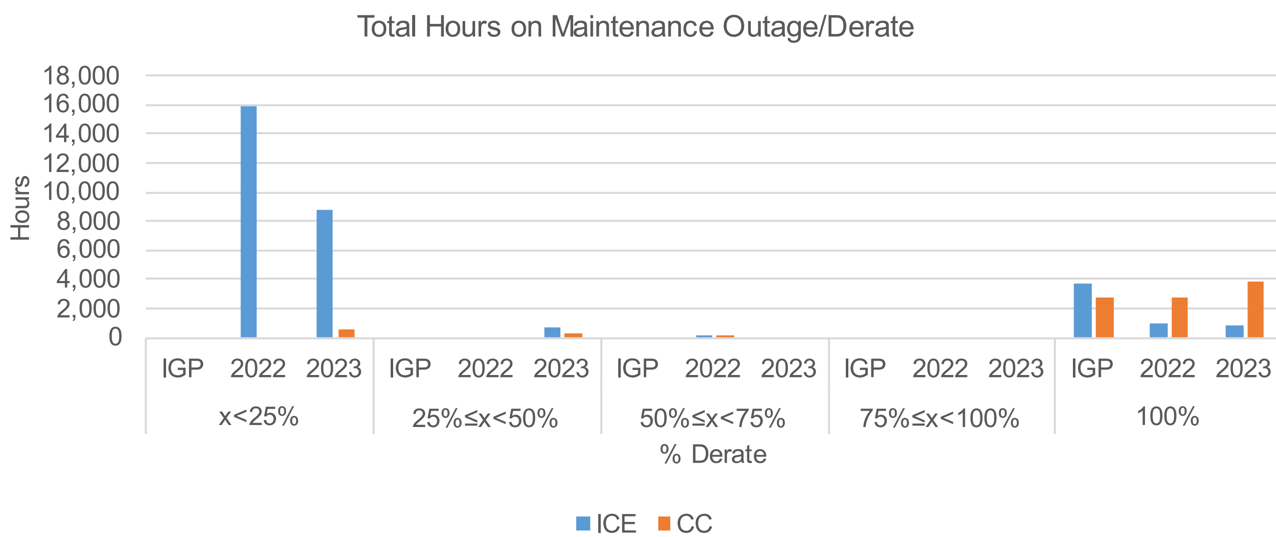

Figure 2-72: Total hours on maintenance outage/maintenance derates in 2022-2023 for utility-owned generators on Maui.

As shown in Figure 2-71, the forced outage rate assumptions used in the IGP may have understated the full outages the combined cycle plants have been experiencing in recent years. Also, as shown in Figure 2-72, the IGP assumptions may have understated the derates that occurred in recent years. While a significant portion of the maintenance derates were less than 25% of the installed capacity, they covered a significant fraction of the year, and when occurring simultaneously, can represent a significant amount of firm capacity. This is evident in Figure 2-73 and Figure 2-74 shown below.

Figure 2-73 and Figure 2-74 take the forced outages and maintenance outages, respectively, from each utility-owned generator and categorize the outages based on the size of the derate. Similar to the above figures, this highlights the impact that the derates can have on the availability of a generator. For example, as shown below, several of the generators were derated up to 25% of their installed capacity for almost half the year. The 2022 and 2023 outage data were used to update assumptions regarding the duration of the outage, the size of the outage/derate, and the frequency.

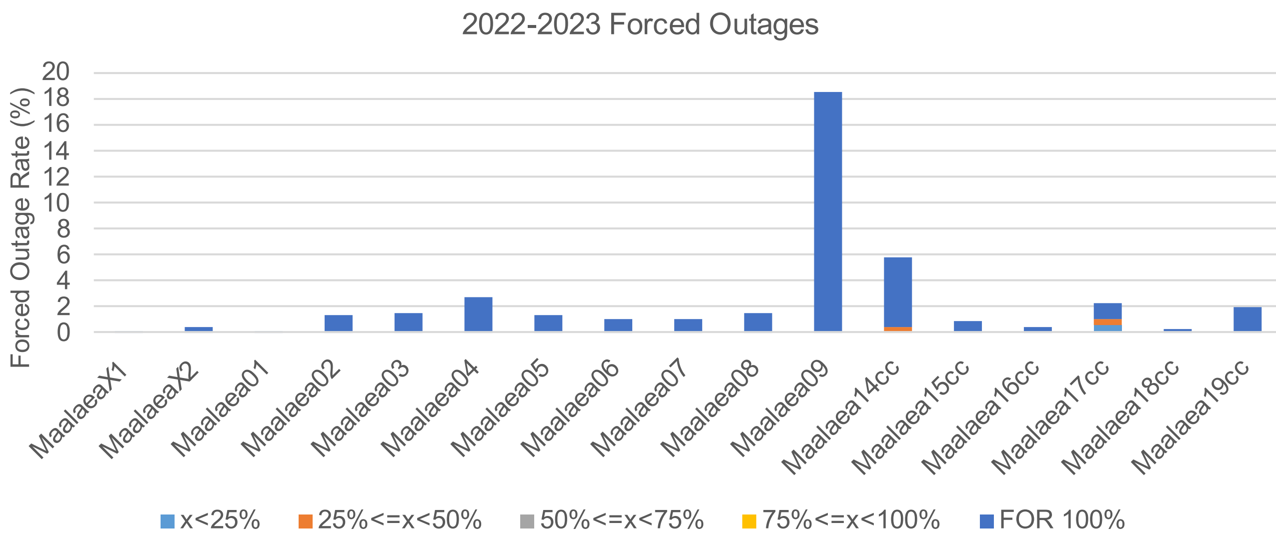

Figure 2-73: Modeled forced outage rates for utility-owned generators on Maui using 2022-2023 data.

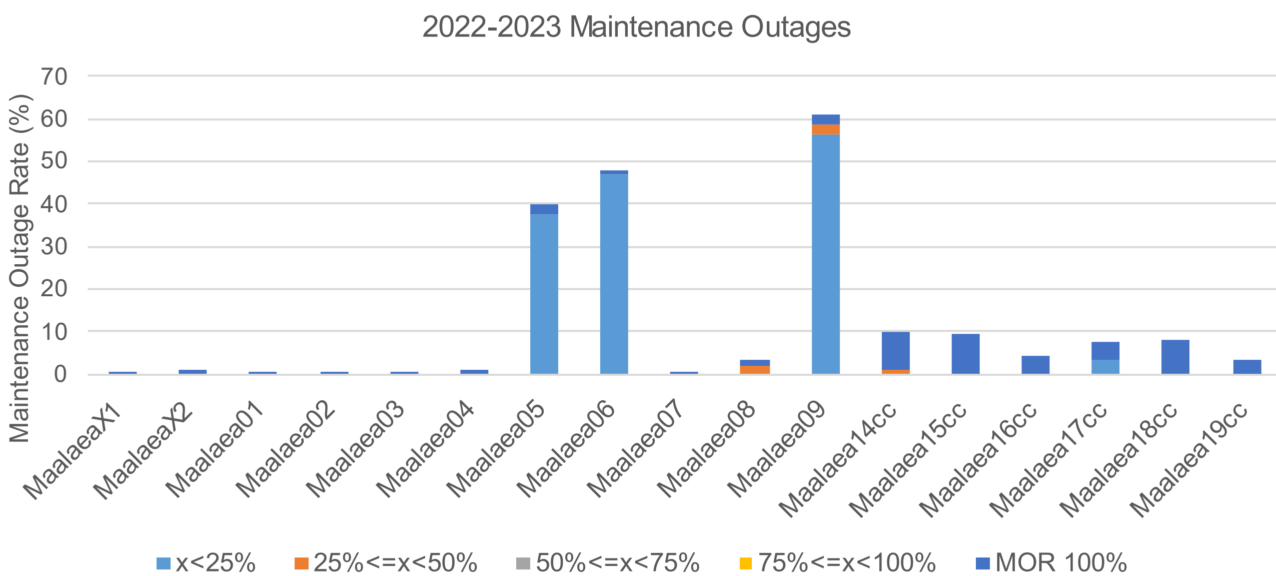

Figure 2-74: Modeled maintenance outage rates for utility-owned generators on Maui using 2022-2023 data.

Given the impact that derated generators are having on the reliability of our system, the probabilistic analysis was updated to directly model derates instead of approximating their impact through equivalent full unit outages. Shown below in Figure 2-75 is the total capacity on outage that was simulated in the probabilistic analysis for 2033. This figure shows that periodically, the equivalent capacity of a combined cycle plant at Māʻalaea (approximately 50 MW) can be on outage.

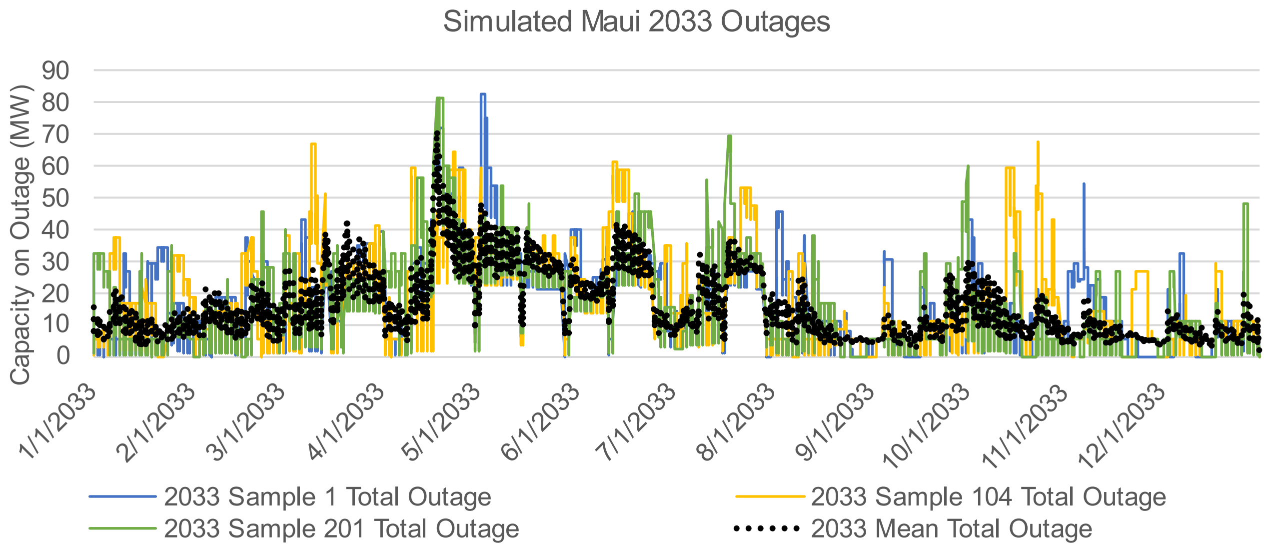

Figure 2-75: Simulated outages incorporating latest derate trends on Maui.

Unless otherwise noted, the scenarios examined in this analysis include partial derates and are based on 2022-2023 outage data.

Updates to Planned Removal from Service Assumptions

The following units were assumed to be deactivated in this analysis. These are the same generating units assumed deactivated in the IGP Final Report.

- 2027: Mā'alaea 10-13
- 2028: Kahului 1-4
- 2030: Mā'alaea 1-9

Analyses Performed

Using the updated outage rates with the derates and starting with the Maui 2024 IGP Plan provided in Section 3.3 with planned resources expected through the Stage 3 RFP, the following probabilistic cases were performed:

- Derate Sensitivity: The cases compare the 2029 and 2033 reliability metrics when the IGP outage rates are used versus recent outage rates with derates. The cases include proxy variable resources for the energy target in the second round IGP RFP (40 MW onshore wind).
- Variable Sensitivity: The cases remove the Pu'u Hao Solar (20 MW hybrid solar) and Kaheawa Wind 1 (30 MW onshore wind) that were awarded in the Stage 3 RFP as well as proxy variable resources for the energy target in the second round IGP RFP (40 MW onshore wind) to determine the impact they have on the 2033 reliability metrics.
- Stage 3 RFP Sensitivity – Variable Renewable Projects: The cases build upon the analyses in the Variable Sensitivity and further test how the reliability of the system may change if one or more of the

awarded hybrid solar projects from the Stage 3 RFP do not come into service, and what is needed to bring the 2033 LOLE below 0.1 days/year.

- Stage 3 RFP Sensitivity - ʻŪkiu Energy: The cases test how the reliability of the system may change if the Stage 3 RFP project ʻŪkiu Energy (40 MW firm) does not come into service, and the amount of future firm generation that is needed to bring the 2033 LOLE below 0.1 days/year, both with and without the deactivation of Māʻalaea 1-9.
- Long-Duration Energy Storage Sensitivity: The cases remove the proxy variable resource for the energy targets in the second round IGP RFP (40 MW Wind) and Stage 3 RFP project Kaheawa Wind 1 (30 MW onshore wind) then look at the feasibility of substituting any firm generation need with long-duration storage.
- Load Sensitivity: The cases test how the reliability metrics may change based on the load forecast and how much firm generation may be needed to achieve a 2033 LOLE below 0.1 days/year.

Conclusions

Below are some of the conclusions determined from the above analysis.

- Derate Sensitivity: Incorporation of derates into the analysis did not drastically impact the results of the reliability analysis. This is due to the similar magnitude of outage rates for most generating units assumed in IGP and in this analysis based on 2022-2023 outage data.
- Variable Sensitivity: In 2033, no future onshore wind is needed from the second round IGP RFP (40 MW Wind) to achieve a 2033 LOLE below 0.1 days/year based on the modeled capacity, assuming the base load forecast and all resources expected from past procurements are in service.
- Stage 3 RFP Sensitivity – Variable Renewable Projects:[29] In 2033, if 20 MW of Stage 3 hybrid solar withdraws, we may need up to 40 MW of future onshore wind to achieve a 2033 LOLE below 0.1 days/year based on modeled capacity.
- Stage 3 RFP Sensitivity – ʻŪkiu Energy:[30]
    - If ʻŪkiu Energy withdraws from the Stage 3 RFP and we do not get any future onshore wind from the second round IGP RFP, we need around 45 MW of future firm generation to achieve a 2033 LOLE below 0.1 days/year based on interpolation of the scenarios.
    - If ʻŪkiu Energy withdraws from the Stage 3 RFP and we get 40 MW of future onshore wind from the second round IGP RFP, we need around 35 MW of future firm generation to achieve a 2033 LOLE below 0.1 days/year based on interpolation of the scenarios.
    - If ʻŪkiu Energy withdraws from the Stage 3 RFP, we delay the deactivation of Māʻalaea 1-9, and we do not get any future onshore wind from the second round IGP RFP, we need around

[29] These scenarios are for illustrative purposes only to demonstrate the reliability impacts of certain projects and project capacity not reaching commercial operations.

[30] These scenarios are for illustrative purposes only to demonstrate the reliability impacts of certain projects and project capacity not reaching commercial operations.

15 MW of future firm generation to achieve a 2033 LOLE below 0.1 days/year based on interpolation of the scenarios.
    - If ʻŪkiu Energy withdraws from the Stage 3 RFP, we delay the deactivation of Māʻalaea 1-9, and we get 40 MW of future onshore wind from the second round IGP RFP, we need around 5 MW of future firm generation to achieve a 2033 LOLE below 0.1 days/year based on interpolation of the scenarios.
- Long-Duration Energy Storage Sensitivity: Long-duration energy storage could not be utilized in place of firm generation. While 12-hour long-duration energy storage did improve reliability, it did not achieve a 2033 LOLE below 0.1 days/year based on interpolation of the scenarios.
- Load Sensitivity: If the load exceeds the base load forecast, we may have a 2033 LOLE significantly above 0.1 days/year, even if we meet the energy target for the second round IGP RFP (40 MW Wind).
    - In a faster technology adoption scenario, approximately 1 MW of future firm generation would be needed to bring the 2033 LOLE below 0.1 days/year based on interpolation of the scenarios.
    - In a high load scenario, approximately 36 MW of future firm generation would be needed to bring the 2033 LOLE below 0.1 days/year based on interpolation of the scenarios.

RFP Targets

The recommended Maui RFP targets based on the extensive analysis detailed in this report are summarized below.

First Round IGP RFP Targets

- Energy Target: none
- Firm Capacity Target: none

Second Round IGP RFP Targets

- Energy Target: 176 GWh in service by December 1, 2032.
    - Target may increase because of withdrawn projects from previous procurements.

While the total energy from projects awarded in the Stage 3 RFP did not meet the RFP's target, the analysis indicates Maui will still achieve an LOLE below 0.1 days/year if all planned resources in the near term achieve commercial operations. As a result, there is no target for a first round IGP RFP. We will, instead, focus our efforts on engaging with the community on rebuilding West Maui.

Additional details on the probabilistic analysis performed to support the conclusions above can be found in the following sections.

2.2.4.1 Derate Sensitivity

Incorporating recent derates into the analysis, the following scenarios were tested.

2029 Scenarios:

- M_Y29B_OutIGP

    - Maui 2024 IGP Plan, without future resources after Stage 3. Outage rates match the IGP outage rates.
- M_Y29B_Out24
    - Maui 2024 IGP Plan, without future resources after Stage 3. Outage rates match 2022-2023 outage rates and includes derates.

2033 Scenarios:

- M_Y33B_OutIGP
    - Maui 2024 IGP Plan, without future resources after Stage 3. Outage rates match the IGP outage rates.
    - Add Second Round IGP RFP future onshore wind.
    - The additional 40 MW of future onshore wind is replacement capacity for existing IPPs that are expiring from 2029 through 2033 and represent the 176 GWh energy target of the Second Round IGP RFP.
- M_Y33B_Out24
    - Maui 2024 IGP Plan, without future resources after Stage 3. Outage rates match 2022-2023 outage rates and includes derates.
    - Add 40 MW future onshore wind.

The probabilistic analysis looks at 250 combinations of outage schedules and weather years. The unserved energy shown in the heat maps below is derived from the average of those 250 samples to account for all the outage/weather combinations and to correlate with LOLE. The maximum unserved energy of the average sample is shown for each time period in the heat maps.

Shown below in Figure 2-76 are heat maps for 2033. These heat maps show when we expect to experience unserved energy when using the IGP outage rates (left) versus when using the updated outage rates including derates (right).

2033 Maui Max. EUE of Mean Sample (with Second Round IGP RFP (40 MW Wind)):
L - IGP Outage Rates; R - Updated Outage Rates

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

MAX
12 MW
0 MW
MIN

Figure 2-76: Maui EUE heat map, year 2033, with Second Round IGP RFP. Left - IGP outage rates (M_Y33B_OutIGP); Right – updated outage rates with firm derates (M_Y33B_Out24).

Shown below in Table 2-39 and Table 2-40 are the resources on the system in 2029 and 2033, respectively. Any changes that were made between the cases are highlighted. At the bottom of the table are the resulting changes in the reliability metrics. Using the latest outage rates, which include derates, the 2033 LOLE improved. The reason for this is due to random forced outage on Dual Train Combined Cycle 2 while Dual Train Combined Cycle 1 was on maintenance. As stated earlier, Maui does not have a first round IGP RFP due to the time needed to recover from the August 2023 wildfires. Evident in Table 2-39 below, however, the 2029 LOLE should be significantly below 0.1 days/year without a first round IGP RFP, assuming we get all the resources that were planned through the Stage 3 RFP. Therefore, the following analysis will focus on 2033 and the second round IGP RFP needs.

Table 2-39: Maui probabilistic analysis results summary, year 2029. Derate sensitivity.

Year 2029	M_Y29B_OutIGP	M_Y29B_Out24
Outage Rate	IGP	Updated Rates with Derate
Firm	**199 MW**	**199 MW**
Existing Firm	159 MW	159 MW
Stage 3 Firm ʻŪkiu Energy	40 MW	40 MW
PV (+BESS)	**166 MW**	**166 MW**
Existing PV (SMRR / Kuia)	6 MW	6 MW
CBRE	21 MW	21 MW
Stage 1 PV+BESS Kuihelani	60 MW	60 MW
Stage 3 PV+BESS Kuihelani Ph2 / Pūlehu / Puʻu Hao	80 MW	80 MW
Wind	**72 MW**	**72 MW**
Existing Wind (AWE / KWP2)	42 MW	42 MW
Stage 3 Wind KWP1	30 MW	30 MW
BESS	**180 MW / 720 MWh**	**180 MW / 720 MWh**
Stage 1 BESS	60 MW / 240 MWh	60 MW / 240 MWh
Stage 2 BESS	40 MW / 160 MWh	40 MW / 160 MWh
Stage 3 BESS	80 MW / 320 MWh	80 MW / 320 MWh
Future		
Future Hybrid Solar	0 MW	0 MW
Future Standalone Solar	0 MW	0 MW
Future Onshore Wind	0 MW	0 MW
Future Firm Units	0 MW	0 MW
Future BESS	0 MW / 0 MWh	0 MW / 0 MWh
LOLE (days/year)	**0.00**	**0.00**
LOLEv (events/year)	**0.00**	**0.00**
LOLH (hours/year)	**0.00**	**0.00**
EUE (GWh/year)	**0.00**	**0.00**

Table 2-40: Maui probabilistic analysis results summary, year 2033. Derate sensitivity

Year 2033	M_Y33B_OutIGP	M_Y33B_Out24
Outage Rate	IGP	Updated Rates with Derate
Firm	**159 MW**	**159 MW**
Existing Firm	119 MW	119 MW
Stage 3 Firm ‘Ūkiu Energy	40 MW	40 MW
PV (+BESS)	**166 MW**	**166 MW**
Existing PV (SMRR / Kuia)	6 MW	6 MW
CBRE	21 MW	21 MW
Stage 1 PV+BESS Kuihelani	60 MW	60 MW
Stage 3 PV+BESS Kuihelani Ph2 / Pūlehu / Pu’u Hao	80 MW	80 MW
Wind	**30 MW**	**30 MW**
Existing Wind (AWE / KWP2)	0 MW	0 MW
Stage 3 Wind KWP1	30 MW	30 MW
BESS	**180 MW / 720 MWh**	**180 MW / 720 MWh**
Stage 1 BESS	60 MW / 240 MWh	60 MW / 240 MWh
Stage 2 BESS	40 MW / 160 MWh	40 MW / 160 MWh
Stage 3 BESS	80 MW / 320 MWh	80 MW / 320 MWh
Future		
Future Hybrid Solar	0 MW	0 MW
Future Standalone Solar	0 MW	0 MW
Future Onshore Wind	40 MW	40 MW
Future Firm Units	0 MW	0 MW
Future BESS	0 MW / 0 MWh	0 MW / 0 MWh
LOLE (days/year)	**0.02**	**0.00**
LOLEv (events/year)	**0.04**	**0.00**
LOLH (hours/year)	**0.07**	**0.00**
EUE (GWh/year)	**0.00**	**0.00**

2.2.4.2 Variable Sensitivity

During the second round IGP RFP, Maui plans on targeting 176 GWh of renewable energy in service by December 1, 2032 to replace any IPP resource which may expire by EOY 2033. This equates to approximately 40 MW of future onshore wind. Incorporating recent firm capacity derates into the analysis, the following scenarios were tested to determine how much future onshore wind is needed in the second round IGP RFP to maintain a 2033 LOLE below 0.1 days/year.

- M_Y33B_Out24
  - Maui 2024 IGP Plan, without future resources after Stage 3. Outage rates match 2022-2023 outage rates and includes derates.
  - Add 40 MW future onshore wind.
- M_Y33B_Out24_wo40Wind
  - Maui 2024 IGP Plan, without future resources after Stage 3. Outage rates match 2022-2023 outage rates and includes derates.
- M_Y33B_Out24_wo(40Wind_KWP1)
  - Maui 2024 IGP Plan, without future resources after Stage 3. Outage rates match 2022-2023 outage rates and includes derates.
  - Remove Kaheawa Wind 1 (30 MW onshore wind) from Stage 3 RFP.
- M_Y33B_Out24_wo(40Wind_20HS)
  - Maui 2024 IGP Plan, without future resources after Stage 3. Outage rates match 2022-2023 outage rates and includes derates.
  - Remove Puʻu Hao Solar (20 MW hybrid solar) from Stage 3 RFP.

Shown below in Figure 2-77 is the relationship between wind resources and 2033 LOLE. As expected, as more onshore wind is added to the system, the 2033 LOLE decreases. The results indicate that, assuming we get all the resources through the Stage 3 RFP including the 30 MW Onshore Wind (KWP1), we may be able to achieve a 2033 LOLE below 0.1 days/year without any future onshore wind from the second round IGP RFP. If, however, the onshore wind or one of the hybrid solar projects from the Stage 3 RFP withdraws, we may not achieve a 2033 LOLE below 0.1 days/year if we do not get any future resources from the second round IGP RFP.

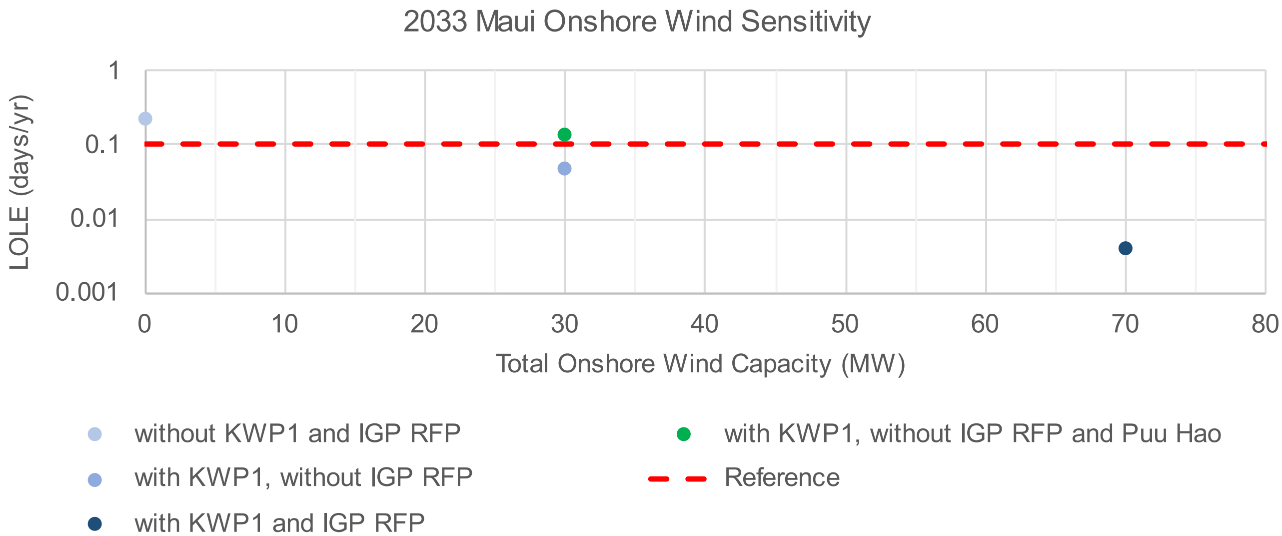

Figure 2-77: Maui LOLE vs total onshore wind in 2033. Variable sensitivity.

Figure 2-78 is a heat map showing when we may expect to experience unserved energy without KWP1 and second round IGP RFP (40 MW Wind) (left) and with KWP1 and second round IGP RFP (40 MW Wind) (right). The results show that while we may be able to achieve a 2033 LOLE below 0.1 days/year without any future onshore wind, we may still experience some unserved energy.

2033 Maui Max. EUE of Mean Sample:
L – without KWP1, Second Round IGP RFP (40 MW Wind);
R – with KWP1, Second Round IGP RFP (40 MW Wind)

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.5	0.0	0.0	0.0	0.0
1	0.0	0.0	0.3	0.2	0.2	0.0	0.1	0.5	0.0	0.0	0.0	0.0
2	0.0	0.0	0.2	0.2	0.1	0.0	0.2	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.1	0.5	0.4	0.0	0.1	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.2	0.1	0.3	0.0	0.1	0.0	0.0	0.0	0.0	0.1
7	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.4	0.1	0.1	0.0	0.1	0.2	0.0	0.0	0.0	0.0
19	0.0	0.0	0.2	0.9	0.1	0.0	0.0	0.3	0.0	0.0	0.0	0.0
20	0.0	0.0	0.1	0.4	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.3	0.0	0.0	0.0	0.0
22	0.0	0.0	0.2	0.0	0.1	0.0	0.2	0.4	0.0	0.0	0.0	0.0
23	0.0	0.0	0.1	0.2	0.2	0.0	0.0	0.5	0.0	0.0	0.0	0.0

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

MAX
12 MW
0 MW
MIN

Figure 2-78: EUE heat map, year 2033. Left - without KWP1 and Second Round IGP RFP (40 MW Wind) (M_Y33B_Out24_wo(40Wind_KWP1)). Right – with KWP1 and Second Round IGP RFP (40 MW Wind) (M_Y33B_Out24)

Shown below in Table 2-41 are the capacity of the resources on the system. Any changes that were made between the cases are highlighted. At the bottom of the table are the resulting changes in the reliability metrics. Similar to Figure 2-78 above, Table 2-41 shows that if we obtain all resources expected through the Stage 3 RFP, we may be able to achieve a 2033 LOLE below 0.1 days/year without the second round IGP RFP (40 MW Wind). If, however, a Stage 3 RFP hybrid solar project withdraws, we will need resources from the second round IGP RFP to achieve a 2033 LOLE below 0.1 days/year.

Table 2-41: Maui probabilistic analysis results summary, year 2033, Variable sensitivity.

Year 2033	M_Y33B_Out24	M_Y33B_Out24_ wo40Wind	M_Y33B_Out24_ wo(40Wind_KWP1)	M_Y33B_Out24 _wo(40Wind_20HS)
Firm	**159 MW**	**159 MW**	**159 MW**	**159 MW**
Existing Firm	119 MW	119 MW	119 MW	119 MW
Stage 3 Firm ʻŪkiu Energy	40 MW	40 MW	40 MW	40 MW
PV (+BESS)	**166 MW**	**166 MW**	**166 MW**	**146 MW**
Existing PV (SMRR / Kuia)	6 MW	6 MW	6 MW	6 MW
CBRE	21 MW	21 MW	21 MW	21 MW
Stage 1 PV+BESS Kuihelani	60 MW	60 MW	60 MW	60 MW
Stage 3 PV+BESS Kuihelani Ph2 / Pūlehu / Puʻu Hao	80 MW	80 MW	80 MW	60 MW
Wind	**30 MW**	**30 MW**	**0 MW**	**30 MW**
Existing Wind (AWE / KWP2)	0 MW	0 MW	0 MW	0 MW
Stage 3 Wind KWP1	30 MW	30 MW	0 MW	30 MW
BESS	**180 MW / 720 MWh**	**180 MW / 720 MWh**	**180 MW / 720 MWh**	**160 MW / 640 MWh**
Stage 1 BESS	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh
Stage 2 BESS	40 MW / 160 MWh	40 MW / 160 MWh	40 MW / 160 MWh	40 MW / 160 MWh
Stage 3 BESS	80 MW / 320 MWh	80 MW / 320 MWh	80 MW / 320 MWh	60 MW / 240 MWh
Future				
Future Hybrid Solar	0 MW	0 MW	0 MW	0 MW
Future Standalone Solar	0 MW	0 MW	0 MW	0 MW
Future Onshore Wind	40 MW	0 MW	0 MW	0 MW
Future Firm Units	0 MW	0 MW	0 MW	0 MW
Future BESS	0 MW / 0 MWh	0 MW / 0 MWh	0 MW / 0 MWh	0 MW / 0 MWh
LOLE (days/year)	**0.00**	**0.05**	**0.23**	**0.14**
LOLEv (events/year)	**0.00**	**0.09**	**0.40**	**0.24**
LOLH (hours/year)	**0.00**	**0.18**	**0.81**	**0.48**
EUE (GWh/year)	**0.00**	**0.00**	**0.01**	**0.01**

2.2.4.3 Stage 3 RFP Sensitivity – Variable Renewable Projects

As shown in the previous section, assuming we get all the resources from the Stage 3 and 40 MW of onshore wind from the second round IGP RFP, Maui should have a 2033 LOLE below 0.1 days/year. Based on experience from past RFPs, however, there is a possibility that some of the selected proposals from the Stage 3 RFP may experience delays or withdraw completely. As a result, sensitivities were performed looking at how the 2033 LOLE may be affected if some of the Stage 3 variable projects do not come into service.

Hybrid Solar Sensitivity

Incorporating recent firm capacity derates into the analysis, the following scenarios were tested to determine how much Stage 3 hybrid solar can be withdrawn while maintaining a 2033 LOLE below 0.1 days/year.

- M_Y33B_Out24_wo20HS
  - Maui 2024 IGP Plan, without future resources after Stage 3. Outage rates match 2022-2023 outage rates and includes derates.
  - Add 40 MW future onshore wind.
  - Remove Pu'u Hao (20 MW hybrid solar) from Stage 3.
- M_Y33B_Out24_wo40HS
  - Maui 2024 IGP Plan, without future resources after Stage 3. Outage rates match 2022-2023 outage rates and includes derates.
  - Add 40 MW future onshore wind.
  - Remove Pu'u Hao, Pulehu (40 MW hybrid solar) from Stage 3.
- M_Y33B_Out24_wo80HS
  - Maui 2024 IGP Plan, without future resources after Stage 3. Outage rates match 2022-2023 outage rates and includes derates.
  - Add 40 MW future onshore wind.
  - Remove Pu'u Hao, Pulehu, Kuihelani (80 MW hybrid solar) from Stage 3
- M_Y33B_Out24_wo(40Wind_20HS)
  - Maui 2024 IGP Plan, without future resources after Stage 3. Outage rates match 2022-2023 outage rates and includes derates.
  - Remove Pu'u Hao (20 MW hybrid solar) from Stage 3.

Shown below in Figure 2-79 is the relationship between Stage 3 hybrid solar and 2033 LOLE. The trendline shows the relationship between the 2033 LOLE and the amount of Stage 3 hybrid solar. It is important to note that the trendline assumes that 40 MW of future onshore wind is obtained from the second round IGP RFP. The trendline indicates that if we get 40 MW of future onshore wind from the second round IGP RFP, around 40 MW of hybrid solar may withdraw from the Stage 3 RFP and we may still have a 2033 LOLE below 0.1 days/year. As shown in the figure, however, without the 40 MW of future onshore wind from the second round IGP RFP, if we lose any hybrid solar project from the Stage 3 RFP, the 2033 LOLE may be higher than 0.1 days/year.

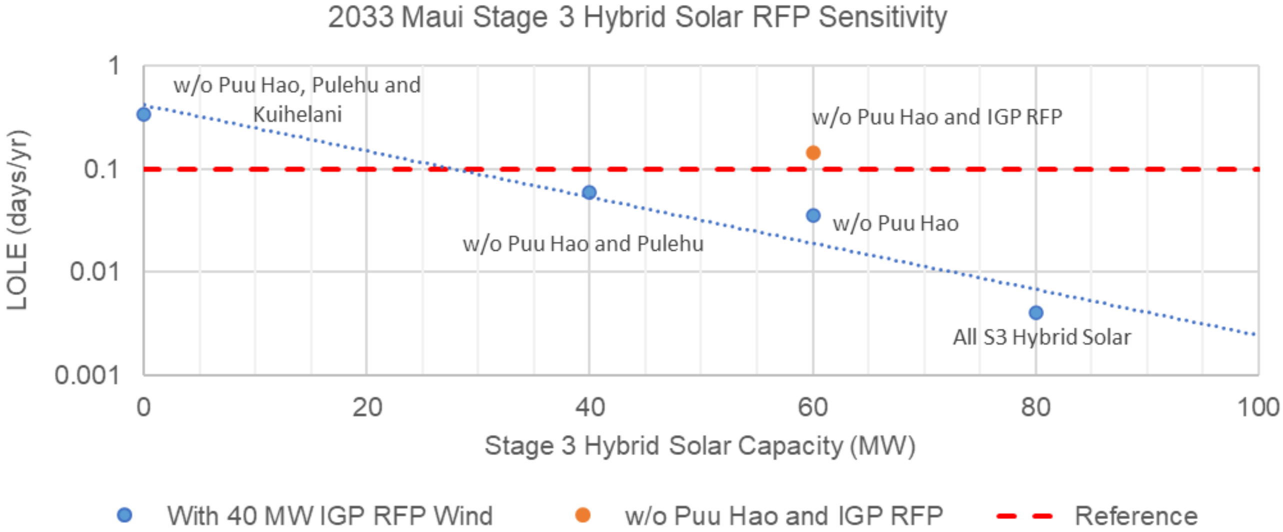

Figure 2-79: Maui LOLE vs Stage 3 hybrid solar in 2033. Hybrid solar sensitivity. Stage 3 RFP – Variable Renewable Projects.

Figure 2-80 are heat maps showing when we may expect to experience unserved energy without any Stage 3 hybrid solar projects (left) and with every Stage 3 hybrid solar project (right). The results show the drastic impact that the Stage 3 variable projects have on reducing the frequency and magnitude of unserved energy.

2033 Maui Max. EUE of Mean Sample:
L – without Stage 3 Hybrid Solar ; R – with Stage 3 Hybrid Solar

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.1	0.1	0.1	0.0	0.1	0.0	0.0	0.1	0.0	0.1
1	0.0	0.0	0.0	0.3	0.2	0.0	0.0	0.0	0.1	0.0	0.0	0.1
2	0.0	0.0	0.0	0.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.1
3	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.1
4	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.1
5	0.0	0.0	0.0	0.1	0.3	0.0	0.1	0.0	0.0	0.0	0.0	0.1
6	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0	0.1	0.0	0.1
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.3	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0
17	0.0	0.0	0.0	0.0	0.3	0.0	0.1	0.0	0.0	0.0	0.0	0.2
18	0.0	0.0	0.2	0.4	0.1	0.0	0.2	0.1	0.0	0.0	0.1	0.2
19	0.0	0.0	0.1	0.1	0.2	0.0	0.5	0.0	0.0	0.0	0.0	0.4
20	0.0	0.0	0.1	0.4	0.2	0.2	0.5	0.0	0.0	0.1	0.0	0.4
21	0.0	0.0	0.1	0.2	0.2	0.2	0.1	0.0	0.0	0.2	0.0	0.1
22	0.0	0.0	0.0	0.5	0.3	0.1	0.2	0.0	0.0	0.0	0.0	0.1
23	0.0	0.0	0.1	0.3	0.1	0.1	0.2	0.0	0.0	0.0	0.0	0.1

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

MAX
12 MW
0 MW
MIN

Figure 2-80: Maui EUE heat map, year 2033, with Second Round IGP RFP. Left - without any Stage 3 hybrid solar projects (M_Y33B_Out24_wo80HS). Right – with all Stage 3 hybrid solar projects (M_Y33B_Out24)

Shown below in Table 2-42 are the capacity of the resources on the system. Any changes that were made between the cases are highlighted. At the bottom of the table are the resulting changes in the reliability metrics. Similar to Figure 2-80 above, Table 2-42 indicates that we may be able to achieve a 2033 LOLE below 0.1 days/year if 40 MW of hybrid solar from Stage 3 RFP withdraws, assuming that we obtain 40 MW of future onshore wind from the second round IGP RFP. If we do not obtain any future onshore wind from the second round IGP RFP, however, we may not achieve a 2033 LOLE below 0.1 days/year if any hybrid solar projects from the Stage 3 RFP withdraws.

Table 2-42: Maui probabilistic analysis results summary, year 2033, Variable sensitivity. Stage 3 RFP sensitivity.

Year 2033	M_Y33B_Out24	M_Y33B_Out24_ wo20HS	M_Y33B_Out24_ wo40HS	M_Y33B_Out24 _wo80HS	M_Y33B_Out24 _wo(40Wind_20HS)
Firm	**159 MW**	**159 MW**	**159 MW**	**159 MW**	**159 MW**
Existing Firm	119 MW	119 MW	119 MW	119 MW	119 MW
Stage 3 Firm ʻŪkiu Energy	40 MW	40 MW	40 MW	40 MW	40 MW
PV (+BESS)	**166 MW**	**146 MW**	**126 MW**	**86 MW**	**146 MW**
Existing PV (SMRR / Kuia)	6 MW	6 MW	6 MW	6 MW	6 MW
CBRE	21 MW	21 MW	21 MW	21 MW	21 MW
Stage 1 PV+BESS Kuihelani	60 MW	60 MW	60 MW	60 MW	60 MW
Stage 3 PV+BESS Kuihelani Ph2 / Pūlehu / Pu'u Hao	80 MW	60 MW	40 MW	0 MW	60 MW
Wind	**30 MW**	**30 MW**	**30 MW**	**30 MW**	**30 MW**
Existing Wind (AWE / KWP2)	0 MW	0 MW	0 MW	0 MW	0 MW
Stage 3 Wind KWP1	30 MW	30 MW	30 MW	30 MW	30 MW
BESS	**180 MW / 720 MWh**	**160 MW / 640 MWh**	**140 MW / 560 MWh**	**100 MW / 400 MWh**	**160 MW / 640 MWh**
Stage 1 BESS	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh
Stage 2 BESS	40 MW / 160 MWh	40 MW / 160 MWh	40 MW / 160 MWh	40 MW / 160 MWh	40 MW / 160 MWh
Stage 3 BESS	80 MW / 320 MWh	60 MW / 240 MWh	40 MW / 160 MWh	0 MW / 0 MWh	60 MW / 240 MWh
Future					
Future Hybrid Solar	0 MW	0 MW	0 MW	0 MW	0 MW
Future Standalone Solar	0 MW	0 MW	0 MW	0 MW	0 MW
Future Onshore Wind	40 MW	40 MW	40 MW	40 MW	0 MW
Future Firm Units	0 MW	0 MW	0 MW	0 MW	0 MW
Future BESS	0 MW / 0 MWh	0 MW / 0 MWh	0 MW / 0 MWh	0 MW / 0 MWh	0 MW / 0 MWh
LOLE (days/year)	**0.00**	**0.04**	**0.06**	**0.34**	**0.14**
LOLEv (events/year)	**0.00**	**0.05**	**0.09**	**0.55**	**0.24**
LOLH (hours/year)	**0.00**	**0.07**	**0.14**	**1.16**	**0.48**
EUE (GWh/year)	**0.00**	**0.00**	**0.00**	**0.02**	**0.01**

2.2.4.4 Stage 3 RFP Sensitivity - ʻŪkiu Energy

ʻŪkiu Energy was the only firm proposal awarded for the island of Maui during the Stage 3 RFP. Ūkiu Energy is a set of internal combustion engines with a total output of 40 MW, and is needed to maintain reliability after the planned deactivation of Māʻalaea 1-9 in 2030. If Ūkiu Energy does not reach commercial operation, we may need to delay the planned deactivation of existing firm generation, as well as, procure additional firm generation.

Firm Sensitivity

Incorporating recent firm capacity derates into the analysis, the following scenarios were tested to determine, how much future firm capacity is needed to achieve a 2033 LOLE below 0.1 days/year, assuming ʻŪkiu Energy withdraws, both with and without the 40 MW of future onshore wind.

- M_Y33B_Out24_wo(Ukiu_40Wind)
    - Maui 2024 IGP Plan, without future resources after Stage 3. Outage rates match the IGP outage rates.
    - Remove ʻŪkiu Energy.
- M_Y33B_Out24_wo(Ukiu_40Wind)_w16ICE
    - M_Y33B_Out24_wo(Ukiu_40Wind) with 2x8.14 MW internal combustion engines.
- M_Y33B_Out24_wo(Ukiu_40Wind)_w33ICE
    - M_Y33B_Out24_wo(Ukiu_40Wind) with 4x8.14 MW internal combustion engines.
- M_Y33B_Out24_wo(Ukiu_40Wind)_w41ICE
    - M_Y33B_Out24_wo(Ukiu_40Wind) with 5x8.14 MW internal combustion engines.
- M_Y33B_Out24_wo(Ukiu_40Wind)_w49ICE
    - M_Y33B_Out24_wo(Ukiu_40Wind) with 6x8.14 MW internal combustion engines.

- M_Y33B_Out24_woUkiu
    - Maui 2024 IGP Plan, without future resources after Stage 3. Outage rates match the IGP outage rates.
    - Remove ʻŪkiu Energy.
    - Add 40 MW future onshore wind.
- M_Y33B_Out24_woUkiu_w33ICE
    - M_Y33B_Out24_woUkiu with 4x8.14 MW internal combustion engines.
- M_Y33B_Out24_woUkiu_w41ICE
    - M_Y33B_Out24_woUkiu with 5x8.14 MW internal combustion engines.

Shown below in Figure 2-81 is the relationship between future firm and 2033 LOLE. As expected, the results show that higher amounts of future firm capacity results in a lower LOLE. The results indicate that if ʻŪkiu Energy does not reach commercial operation but we get 40 MW of future onshore wind during the second round IGP RFP, we may need around 40 MW of future firm generation to achieve a 2033 LOLE below 0.1 days/year based on the modeled capacity, assuming all other acquired resources through the Stage 3 RFP go into service. If, however, ʻŪkiu Energy does not reach commercial operation and we do not get any resources during the second round IGP RFP, we may need up to 50 MW of firm generation to achieve a 2033 LOLE below 0.1 days/year based on the modeled capacity, again assuming all other acquired resources through the Stage 3 RFP go into service.

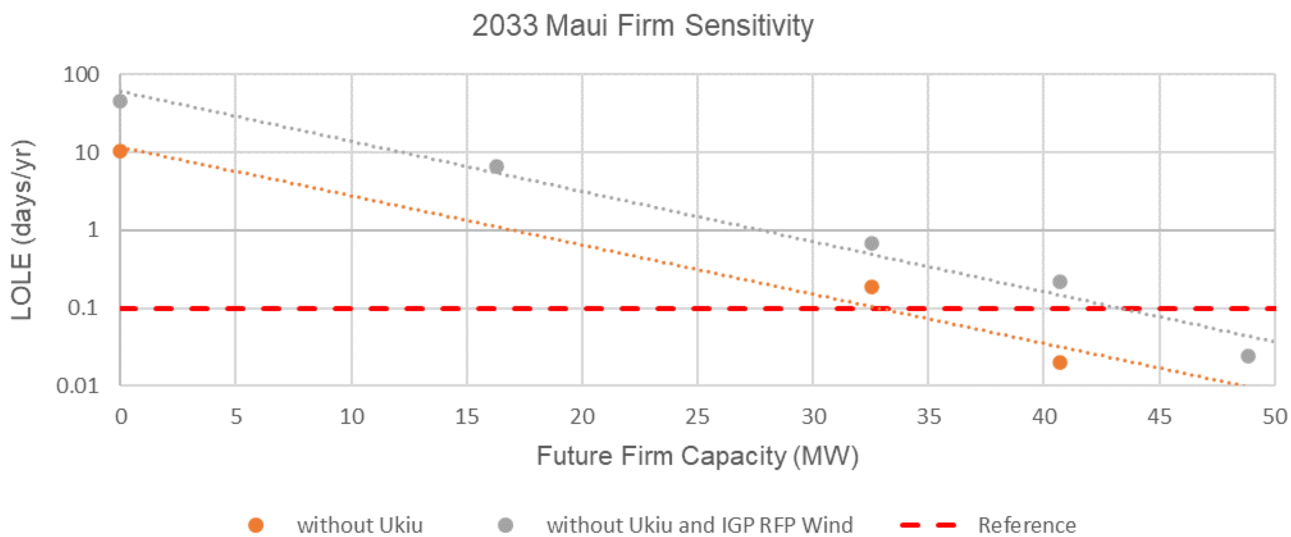

Figure 2-81: Maui LOLE vs. future firm capacity in 2033, Firm sensitivity. Stage 3 RFP – ʻŪkiu Energy sensitivity.

Figure 2-82 and Figure 2-83 are heat maps showing when we may expect to experience unserved energy without any future firm generation (left) and with 5x8.14 MW or 6x8.14 MW internal combustion engines (right) respectfully. The results show that adding firm generation should reduce the frequency and magnitude of unserved energy.

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	1.0	1.2	1.4	5.0	5.5	2.3	3.8	1.7	1.5	1.9	1.4	3.0
1	1.8	1.6	3.7	8.8	8.6	6.7	11.0	5.5	2.6	3.8	3.9	4.9
2	1.2	1.8	3.7	10.0	7.1	5.1	8.0	2.3	2.3	3.1	1.7	3.6
3	0.8	1.1	2.5	6.6	7.6	4.1	7.7	1.8	2.3	2.4	1.2	3.1
4	1.0	1.2	2.5	7.5	6.7	5.8	9.9	2.1	1.5	2.3	1.5	2.6
5	1.5	1.9	3.4	8.2	10.0	7.1	10.9	4.0	2.0	3.1	3.3	4.3
6	1.9	2.6	5.2	12.0	10.0	4.7	8.5	5.3	2.3	3.9	4.4	8.2
7	2.2	2.1	3.5	4.8	3.1	0.5	1.3	2.2	0.4	1.9	3.8	6.5
8	0.3	1.0	1.8	1.0	1.6	0.1	0.4	1.2	0.0	0.3	0.7	4.8
9	0.0	0.1	0.5	0.0	0.1	0.0	0.0	0.5	0.0	0.0	0.1	0.6
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	1.1
15	0.0	0.0	0.1	0.0	0.7	0.0	0.0	0.0	0.0	0.3	0.8	1.1
16	0.2	0.8	0.6	2.2	2.0	0.1	1.6	0.8	0.3	2.5	3.2	4.8
17	1.5	1.5	1.6	5.3	5.1	0.9	4.0	2.1	1.0	2.8	4.6	7.3
18	1.3	1.4	2.7	8.0	8.1	3.0	6.4	3.7	2.7	3.0	4.3	8.7
19	1.8	1.5	3.0	7.7	8.4	4.3	7.7	3.7	1.6	3.7	5.8	7.5
20	1.2	2.0	2.7	6.8	7.1	4.1	7.2	2.9	1.7	3.6	5.5	7.7
21	0.9	1.5	2.0	8.0	6.9	4.3	8.5	4.5	1.9	3.3	4.5	7.1
22	1.2	1.6	2.5	7.5	9.6	5.0	10.4	4.6	1.8	4.4	3.2	6.8
23	1.0	1.3	2.5	7.4	7.5	5.0	7.0	3.1	2.0	2.9	4.1	4.3

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

MAX	
12 MW	
0 MW	
MIN	

Figure 2-82: Maui EUE heat map, year 2033, without ʻŪkiu Energy and future onshore wind. Left – without future firm generation (M_Y33B_Out24_wo(Ukiu_40Wind)); Right – with 6x8.14 MW internal combustion engines (M_Y33B_Out24_wo(Ukiu_40Wind)_w49ICE).

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	1.1	0.4	0.2	2.9	1.5	0.8	0.9	0.3	0.7	1.3	0.2	1.7
1	1.0	0.8	0.6	3.9	3.7	0.8	1.0	1.0	0.9	1.9	0.7	2.3
2	0.5	0.6	0.4	3.1	2.3	0.6	1.1	0.5	0.9	1.2	0.5	1.6
3	0.6	0.5	0.3	2.6	2.0	0.8	0.5	0.5	0.7	1.1	0.5	1.7
4	0.5	0.7	0.4	2.7	2.6	0.3	0.4	0.3	0.7	1.1	0.5	1.6
5	1.0	0.8	0.7	4.1	3.8	1.0	1.0	0.8	0.8	1.1	0.6	2.1
6	0.9	1.1	1.3	4.9	3.4	0.5	0.4	1.1	0.7	1.5	0.7	3.3
7	1.1	0.9	0.4	1.1	0.5	0.0	0.1	0.8	0.1	1.1	0.4	3.0
8	0.2	0.5	0.3	0.5	0.7	0.0	0.1	0.4	0.0	0.1	0.1	2.0
9	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.3	0.0	0.0	0.1	0.4
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
15	0.0	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.7
16	0.3	0.2	0.1	0.9	0.4	0.0	0.1	0.0	0.2	1.2	0.2	3.4
17	0.7	0.6	0.2	3.3	1.4	0.1	0.6	0.3	0.3	1.3	0.4	6.9
18	0.3	0.6	0.5	5.8	2.2	0.3	0.9	0.5	1.7	1.6	0.4	6.5
19	0.6	1.0	0.5	4.2	2.3	0.2	1.0	1.2	0.7	1.4	0.5	6.0
20	0.6	0.6	0.6	4.2	1.6	0.3	1.3	0.7	0.8	1.6	1.0	5.0
21	0.4	0.8	0.5	3.9	1.6	0.3	0.5	0.5	0.6	1.6	0.5	6.2
22	0.3	1.0	0.3	4.0	2.4	0.6	0.7	0.8	0.9	1.9	0.5	4.1
23	0.4	0.6	0.4	3.2	2.5	0.6	0.7	0.6	0.9	1.0	0.3	3.3

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

MAX
12 MW
0 MW
MIN

Figure 2-83: Maui EUE heat map, year 2033, without ʻŪkiu Energy. Left – without future firm generation (M_Y33B_Out24_woUkiu); Right – with 5x8.14 MW internal combustion engines (M_Y33B_Out24_woUkiu_w41ICE).

Shown below in Table 2-43 and Table 2-44 are the capacity of the resources on the system. Any changes that were made between the cases are highlighted. At the bottom of the table are the resulting changes in the reliability metrics. Similar to Figure 2-81 above, Table 2-43 and Table 2-44 below shows that adding around 40-50 MW of future firm generation should result in an LOLE below 0.1 days/year.

Table 2-43: Maui probabilistic analysis results summary, year 2033, without ʻŪkiu Energy and future onshore wind, Firm Sensitivity. Stage 3 RFP sensitivity.

Year 2033	M_Y33B_Out24_ wo(Ukiu_40Wind)	M_Y33B_Out24_ wo(Ukiu_40Wind)_ w16ICE	M_Y33B_Out24_ wo(Ukiu_40Wind)_ w33ICE	M_Y33B_Out24_ wo(Ukiu_40Wind)_ w41ICE	M_Y33B_Out24_ wo(Ukiu_40Wind)_ w49ICE
Firm	**119 MW**	**119 MW**	**119 MW**	**119 MW**	**119 MW**
Existing Firm	119 MW	119 MW	119 MW	119 MW	119 MW
Stage 3 Firm ʻŪkiu Energy	0 MW	0 MW	0 MW	0 MW	0 MW
PV (+BESS)	**166 MW**	**166 MW**	**166 MW**	**166 MW**	**166 MW**
Existing PV (SMRR / Kuia)	6 MW	6 MW	6 MW	6 MW	6 MW
CBRE	21 MW	21 MW	21 MW	21 MW	21 MW
Stage 1 PV+BESS Kuihelani	60 MW	60 MW	60 MW	60 MW	60 MW
Stage 3 PV+BESS Kuihelani Ph2 / Pūlehu / Puʻu Hao	80 MW	80 MW	80 MW	80 MW	80 MW
Wind	**30 MW**	**30 MW**	**30 MW**	**30 MW**	**30 MW**
Existing Wind (AWE / KWP2)	0 MW	0 MW	0 MW	0 MW	0 MW
Stage 3 Wind KWP1	30 MW	30 MW	30 MW	30 MW	30 MW
BESS	**180 MW / 720 MWh**	**180 MW / 720 MWh**	**180 MW / 720 MWh**	**180 MW / 720 MWh**	**180 MW / 720 MWh**
Stage 1 BESS	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh
Stage 2 BESS	40 MW / 160 MWh	40 MW / 160 MWh	40 MW / 160 MWh	40 MW / 160 MWh	40 MW / 160 MWh
Stage 3 BESS	80 MW / 320 MWh	80 MW / 320 MWh	80 MW / 320 MWh	80 MW / 320 MWh	80 MW / 320 MWh
Future					
Future Hybrid Solar	0 MW	0 MW	0 MW	0 MW	0 MW
Future Standalone Solar	0 MW	0 MW	0 MW	0 MW	0 MW
Future Onshore Wind	0 MW	0 MW	0 MW	0 MW	0 MW
Future Firm Units	0 MW	16 MW	33 MW	41 MW	49 MW
Future BESS	0 MW / 0 MWh	0 MW / 0 MWh	0 MW / 0 MWh	0 MW / 0 MWh	0 MW / 0 MWh
LOLE (days/year)	**45.31**	**6.54**	**0.69**	**0.22**	**0.02**
LOLEv (events/year)	**104.04**	**13.33**	**1.27**	**0.42**	**0.04**
LOLH (hours/year)	**253.76**	**29.90**	**2.58**	**0.62**	**0.05**
EUE (GWh/year)	**5.24**	**0.57**	**0.04**	**0.01**	**0.00**

Table 2-44: Maui probabilistic analysis results summary, year 2033, without ʻŪkiu Energy, Firm Sensitivity. Stage 3 RFP sensitivity.

Year 2033	M_Y33B_Out24_ woUkiu	M_Y33B_Out24_ woUkiu_w33ICE	M_Y33B_Out24_ woUkiu_w41ICE
Firm	**119 MW**	**119 MW**	**119 MW**
Existing Firm	119 MW	119 MW	119 MW
Stage 3 Firm ʻŪkiu Energy	0 MW	0 MW	0 MW
PV (+BESS)	**166 MW**	**166 MW**	**166 MW**
Existing PV (SMRR / Kuia)	6 MW	6 MW	6 MW
CBRE	21 MW	21 MW	21 MW
Stage 1 PV+BESS Kuihelani	60 MW	60 MW	60 MW
Stage 3 PV+BESS Kuihelani Ph2 / Pūlehu / Puʻu Hao	80 MW	80 MW	80 MW
Wind	**30 MW**	**30 MW**	**30 MW**
Existing Wind (AWE / KWP2)	0 MW	0 MW	0 MW
Stage 3 Wind KWP1	30 MW	30 MW	30 MW
BESS	**180 MW / 720 MWh**	**180 MW / 720 MWh**	**180 MW / 720 MWh**
Stage 1 BESS	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh
Stage 2 BESS	40 MW / 160 MWh	40 MW / 160 MWh	40 MW / 160 MWh
Stage 3 BESS	80 MW / 320 MWh	80 MW / 320 MWh	80 MW / 320 MWh
Future			
Future Hybrid Solar	0 MW	0 MW	0 MW
Future Standalone Solar	0 MW	0 MW	0 MW
Future Onshore Wind	40 MW	40 MW	40 MW
Future Firm Units	0 MW	33 MW	41 MW
Future BESS	0 MW / 0 MWh	0 MW / 0 MWh	0 MW / 0 MWh
LOLE (days/year)	**10.47**	**0.19**	**0.02**
LOLEv (events/year)	**23.12**	**0.30**	**0.04**
LOLH (hours/year)	**55.13**	**0.75**	**0.09**
EUE (GWh/year)	**1.03**	**0.02**	**0.00**

Deactivation Schedule Sensitivity

The IGP plan assumed the deactivation of 40.5 MW of firm generation at Māʻalaea in 2030. The deactivation was primarily due to the age of the generators and potential parts obsolescence in the future. Therefore, an analysis was done to determine if the 2033 LOLE could be lower than 0.1 days/year if ʻŪkiu Energy does not reach commercial operation and we delay the deactivation of the firm generation. Incorporating recent firm capacity derates into the analysis, the following scenarios were tested to determine how much future firm is needed to achieve a 2033 LOLE below 0.1 days/year.

Delayed Māʻalaea 1-9 Deactivation with No ʻŪkiu Energy Scenarios:

- M_Y33B_Out24_woUkiu_wM1-9
    - Maui 2024 IGP Plan, without future resources after Stage 3. Outage rates match the IGP outage rates.
    - Remove ʻŪkiu Energy.
    - Add second round IGP RFP (40 MW) Future Onshore Wind.
    - Māʻalaea 1-9 remain in service.
- M_Y33B_Out24_woUkiu_w(M1-9_8ICE)
    - M_Y33B_Out24_woUkiu_wM1-9 with 1x8.14 MW internal combustion engines.

Delayed Māʻalaea 1-9 Deactivation with No ʻŪkiu Energy and No 40 MW Future Onshore Wind Scenarios:

- M_Y33B_Out24_wo(Ukiu_40Wind)_wM1-9
    - Maui 2024 IGP Plan, without future resources after Stage 3. Outage rates match the IGP outage rates.
    - Remove ʻŪkiu Energy.
    - Māʻalaea 1-9 remain in service.
- M_Y33B_Out24_wo(Ukiu_40Wind)_w(M1-9_8ICE)
    - M_Y33B_Out24_wo(Ukiu_40Wind)_wM1-9 with 1x8.14 MW internal combustion engines.
- M_Y33B_Out24_wo(Ukiu_40Wind)_w(M1-9_16ICE)
    - M_Y33B_Out24_wo(Ukiu_40Wind)_wM1-9 with 2x8.14 MW internal combustion engines.

Shown below in Figure 2-84 is the relationship between future firm and 2033 LOLE. As expected, the results show that higher amounts of future firm results in a lower LOLE. From the figure, it appears that even if we delayed the deactivation of 40.5 MW of firm generation at Māʻalaea, we still need around 8-16 MW of firm generation to achieve a 2033 LOLE below 0.1 days/year based on the modeled capacity. However, if these generators are not deactivated, they will likely have worsening reliability, especially given that they will be around 60 years old.

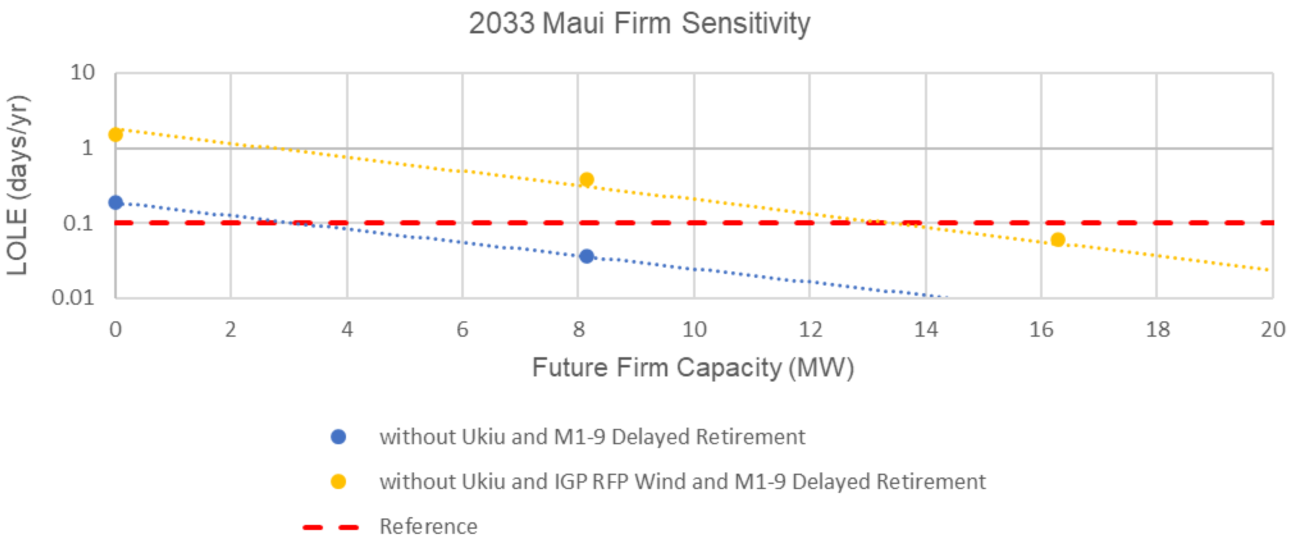

Figure 2-84: Maui LOLE vs. future firm capacity in 2033, Deactivation Schedule Sensitivity. Stage 3 RFP – ʻŪkiu Energy sensitivity.

Figure 2-85 are heat maps showing when we may expect to experience unserved energy without ʻŪkiu Energy, without 40 MW of future onshore wind from the second round IGP RFP, and with Māʻalaea 1-9 deactivations delayed (left) and with 2x8.14 MW internal combustion engines (right). Figure 2-86 are heat maps showing when we may expect to experience unserved energy without ʻŪkiu Energy, with 40 MW of future onshore wind from the second round IGP RFP, and with Māʻalaea 1-9 deactivations delayed (left) and with 1x8.14 MW internal combustion engines (right). The results show that adding firm generation should reduce the frequency and magnitude of unserved energy events.

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.1	0.1	0.4	0.4	0.1	0.3	0.4	0.3	0.3	0.1	0.2
1	0.0	0.1	0.1	0.3	0.8	0.1	0.6	0.3	0.2	0.4	0.0	0.2
2	0.1	0.2	0.1	0.4	1.0	0.1	0.7	0.1	0.1	0.5	0.2	0.3
3	0.0	0.0	0.3	0.3	1.5	0.1	0.4	0.1	0.3	0.1	0.2	0.2
4	0.0	0.0	0.1	0.1	0.5	0.1	0.1	0.0	0.2	0.2	0.1	0.0
5	0.0	0.0	0.1	0.1	0.7	0.1	0.2	0.1	0.1	0.1	0.0	0.1
6	0.0	0.1	0.2	0.2	0.9	0.0	0.2	0.1	0.1	0.1	0.3	0.1
7	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
8	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1
17	0.0	0.1	0.0	0.0	0.2	0.0	0.1	0.0	0.0	0.2	0.2	0.2
18	0.0	0.1	0.1	0.4	0.1	0.0	0.3	0.3	0.0	0.3	0.1	0.4
19	0.0	0.1	0.0	0.6	0.3	0.0	0.6	0.1	0.0	0.1	0.1	0.3
20	0.0	0.1	0.0	0.2	0.3	0.2	0.3	0.5	0.0	0.1	0.1	0.2
21	0.0	0.0	0.0	0.2	0.4	0.1	0.5	0.1	0.0	0.1	0.0	0.1
22	0.0	0.0	0.0	0.2	0.5	0.1	0.6	0.3	0.0	0.3	0.2	0.1
23	0.0	0.0	0.5	0.1	0.7	0.0	0.4	0.0	0.0	0.3	0.0	0.2

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
2	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.2
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.3
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0

MAX	
12 MW	
0 MW	
MIN	

Figure 2-85: Maui EUE heat map, year 2033, with delayed Māʻalaea 1-9, without ʻŪkiu Energy and future onshore wind. Left – without future firm generation (M_Y33B_Out24_wo(Ukiu_40Wind)_wM1-9); Right – with 2-8.14 MW internal combustion engines (M_Y33B_Out24_wo(Ukiu_40Wind)_w(M1-9_16ICE)).

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.1	0.2	0.0	0.1	0.0	0.0	0.0	0.0	0.2
1	0.0	0.0	0.1	0.1	0.3	0.1	0.2	0.0	0.1	0.1	0.0	0.0
2	0.0	0.0	0.0	0.0	0.3	0.2	0.0	0.0	0.1	0.1	0.0	0.1
3	0.0	0.0	0.0	0.2	0.4	0.0	0.1	0.0	0.0	0.1	0.0	0.0
4	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0
6	0.0	0.0	0.0	0.1	0.3	0.0	0.1	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.2
18	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
19	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.2	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.1	0.0	0.2	0.0	0.0	0.3	0.0	0.2
23	0.0	0.1	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.1

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1
2	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1
3	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

MAX
12 MW
0 MW
MIN

Figure 2-86: Maui EUE heat map, year 2033, with delayed Māʻalaea 1-9, without ʻŪkiu Energy. Left – without future firm generation (M_Y33B_Out24_woUkiu_wM1-9) Right – with 1-8.14 MW internal combustion engines (M_Y33B_Out24_woUkiu_w(M1-9_8ICE)).

Shown below in Table 2-45 are the capacity of the resources on the system. Any changes that were made between the cases are highlighted. At the bottom of the table are the resulting changes in the reliability metrics. Similar to Figure 2-84 above, Table 2-45 shows that adding around 8-16 MW of future firm generation should result in a 2033 LOLE below 0.1 days/year.

Table 2-45: Maui probabilistic analysis results summary, year 2033, without ʻŪkiu Energy, Deactivation Sensitivity. Stage 3 RFP sensitivity.

Year 2033	M_Y33B_Out24_woUkiu_wM1-9	M_Y33B_Out24_woUkiu_w(M1-9_8ICE)	M_Y33B_Out24_wo(Ukiu_40Wind)_wM1-9	M_Y33B_Out24_wo(Ukiu_40Wind)_w(M1-9_8ICE)	M_Y33B_Out24_wo(Ukiu_40Wind)_w(M1-9_16ICE)
Firm	**159 MW**	**159 MW**	**159 MW**	**159 MW**	**159 MW**
Existing Firm	159 MW	159 MW	159 MW	159 MW	159 MW
Stage 3 Firm ʻŪkiu Energy	0 MW	0 MW	0 MW	0 MW	0 MW
PV (+BESS)	**166 MW**	**166 MW**	**166 MW**	**166 MW**	**166 MW**
Existing PV (SMRR / Kuia)	6 MW	6 MW	6 MW	6 MW	6 MW
CBRE	21 MW	21 MW	21 MW	21 MW	21 MW
Stage 1 PV+BESS Kuihelani	60 MW	60 MW	60 MW	60 MW	60 MW
Stage 3 PV+BESS Kuihelani Ph2 / Pūlehu / Pu'u Hao	80 MW	80 MW	80 MW	80 MW	80 MW
Wind	**30 MW**	**30 MW**	**30 MW**	**30 MW**	**30 MW**
Existing Wind (AWE / KWP2)	0 MW	0 MW	0 MW	0 MW	0 MW
Stage 3 Wind KWP1	30 MW	30 MW	30 MW	30 MW	30 MW
BESS	**180 MW / 720 MWh**	**180 MW / 720 MWh**	**180 MW / 720 MWh**	**180 MW / 720 MWh**	**180 MW / 720 MWh**
Stage 1 BESS	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh
Stage 2 BESS	40 MW / 160 MWh	40 MW / 160 MWh	40 MW / 160 MWh	40 MW / 160 MWh	40 MW / 160 MWh
Stage 3 BESS	80 MW / 320 MWh	80 MW / 320 MWh	80 MW / 320 MWh	80 MW / 320 MWh	80 MW / 320 MWh
Future					
Future Hybrid Solar	0 MW	0 MW	0 MW	0 MW	0 MW
Future Standalone Solar	0 MW	0 MW	0 MW	0 MW	0 MW
Future Onshore Wind	40 MW	40 MW	0 MW	0 MW	0 MW
Future Firm Units	0 MW	8 MW	0 MW	8 MW	16 MW
Future BESS	0 MW / 0 MWh	0 MW / 0 MWh	0 MW / 0 MWh	0 MW / 0 MWh	0 MW / 0 MWh
LOLE (days/year)	**0.19**	**0.04**	**1.50**	**0.38**	**0.06**
LOLEv (events/year)	**0.26**	**0.04**	**2.34**	**0.58**	**0.08**
LOLH (hours/year)	**0.49**	**0.08**	**4.36**	**0.94**	**0.13**
EUE (GWh/year)	**0.01**	**0.00**	**0.07**	**0.01**	**0.00**

2.2.4.5 Long-Duration Energy Storage Sensitivity

Incorporating recent firm capacity derates into the analysis, the following scenarios were tested to determine whether long-duration energy storage could be utilized in place of wind generation to reduce the 2033 LOLE below 0.1 days/year. Scenarios adjusting either the power output (MW) or the capacity (MWh) were tested. The cases were tested with the 40 MW IGP RFP onshore wind and 30 MW Kaheawa Wind Power 1 removed to assess whether the addition of long-duration storage could improve reliability below a 0.1 LOLE.

Battery Power Output Scenarios:

- M_Y33B_Out24_wo(40Wind_KWP1)
  - Maui 2024 IGP Plan, without Stage 3 KWP 1 Wind and 2033 IGP RFP Wind
- M_Y33B_Out24_wo(40Wind_KWP1)_w_16LDS[12]
  - M_Y33B_Out24_wo(40Wind_KWP1) with a 16 MW 12-hour long-duration energy storage.
- M_Y33B_Out24_wo(40Wind_KWP1)_w_24LDS[12]
  - M_Y33B_Out24_wo(40Wind_KWP1) with a 24 MW 12-hour long-duration energy storage.
- M_Y33B_Out24_wo(40Wind_KWP1)_w_48LDS[12]
  - M_Y33B_Out24_wo(40Wind_KWP1) with a 48 MW 12-hour long-duration energy storage.

Battery Capacity Scenarios:

- M_Y33B_Out24_wo(40Wind_KWP1)_w_24LDS[6]
  - M_Y33B_Out24_wo(40Wind_KWP1) with a 24 MW 6-hour long-duration energy storage
- M_Y33B_Out24_wo(40Wind_KWP1)_w_24LDS[8]
  - M_Y33B_Out24_wo(40Wind_KWP1) with a 24 MW 8-hour long-duration energy storage
- M_Y33B_Out24_wo(40Wind_KWP1)_w_24LDS[12]
  - M_Y33B_Out24_wo(40Wind_KWP1) with a 24 MW 12-hour long-duration energy storage

Shown below in Figure 2-87 is the relationship between the 2033 LOLE and the power output of a 12-hr long-duration storage. Figure 2-88 shows the relationship between the 2033 LOLE and the storage capacity of a 24 MW long-duration storage. As shown in both figures, while long-duration storage may help reduce the LOLE, there are diminishing returns on LOLE reductions. Greater amounts of additional long-duration storage require more non-storage generating resources on the system to charge it.

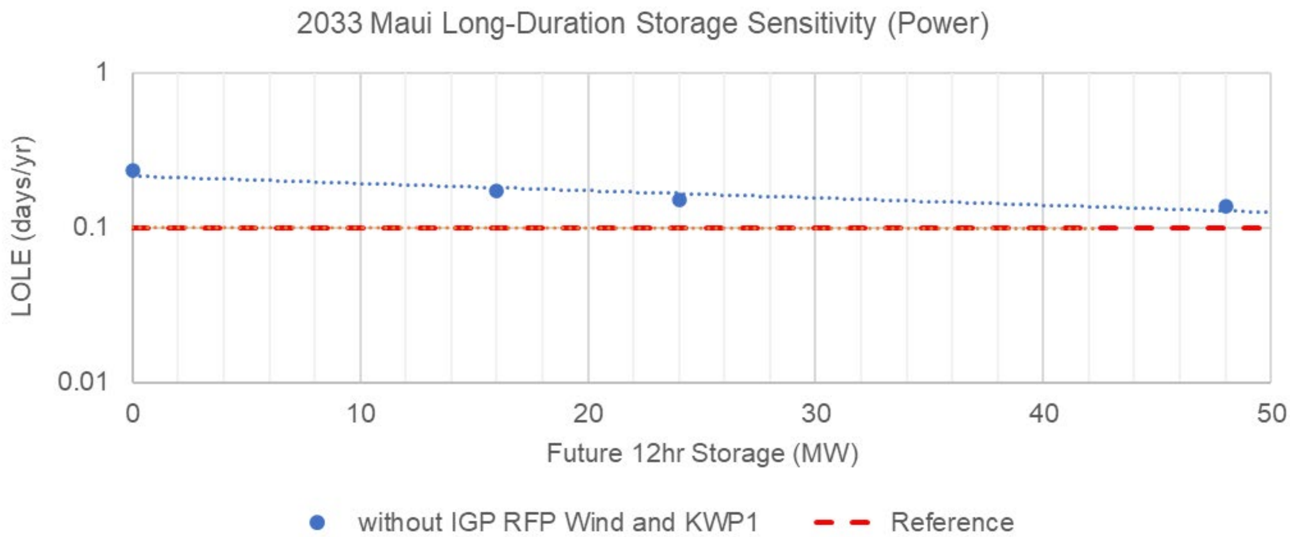

Figure 2-87: Maui LOLE vs. power output of 12-hr long-duration storage in 2033. Long-duration storage sensitivity.

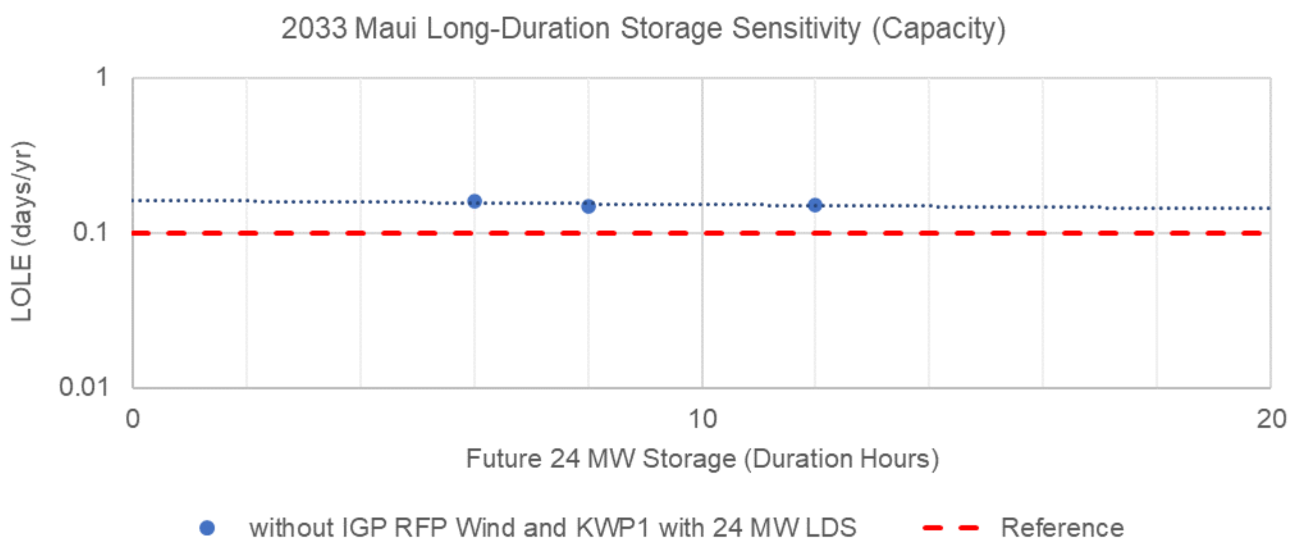

Figure 2-88: Maui LOLE vs. capacity of 12-hr long-duration storage in 2033. Long-duration storage sensitivity.

In Figure 2-89 are heat maps showing when we may expect to experience unserved energy without any long-duration storage (left) and with a 24 MW 12-hr long-duration storage (right). While long-duration storage addresses some of the unserved energy, the impact is not as drastic when compared to installing firm generation, as was shown earlier.

2033 Maui Max. EUE of Mean Sample (No KWP1, Second Round IGP RFP (40 MW Wind)):
L – 0 MW Future LDS; R – 24 MW Future LDS(12hr)

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.5	0.0	0.0	0.0	0.0
1	0.0	0.0	0.3	0.2	0.2	0.0	0.1	0.5	0.0	0.0	0.0	0.0
2	0.0	0.0	0.2	0.2	0.1	0.0	0.2	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.1	0.5	0.4	0.0	0.1	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.2	0.1	0.3	0.0	0.1	0.0	0.0	0.0	0.0	0.1
7	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.4	0.1	0.1	0.0	0.1	0.2	0.0	0.0	0.0	0.0
19	0.0	0.0	0.2	0.9	0.1	0.0	0.0	0.3	0.0	0.0	0.0	0.0
20	0.0	0.0	0.1	0.4	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.3	0.0	0.0	0.0	0.0
22	0.0	0.0	0.2	0.0	0.1	0.0	0.2	0.4	0.0	0.0	0.0	0.0
23	0.0	0.0	0.1	0.2	0.2	0.0	0.0	0.5	0.0	0.0	0.0	0.0

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.1	0.2	0.0	0.2	0.1	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.1	0.2	0.0	0.2	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.1	0.0	0.2	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.1	0.2	0.0	0.2	0.1	0.0	0.0	0.0	0.0
6	0.0	0.0	0.1	0.1	0.2	0.0	0.2	0.2	0.0	0.0	0.0	0.0
7	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.2	0.0	0.1	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.2	0.0	0.1	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.1	0.1	0.0	0.2	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1

MAX
12 MW
0 MW
MIN

Figure 2-89: Maui EUE heat map, year 2033, without Second Round IGP RFP and KWP1. Left - without Long-Duration Energy Storage (M_Y33B_Out24_wo(40Wind_KWP1)). Right – with 24 MW 12-hour Long-Duration Energy Storage (M_Y33B_Out24_wo(40Wind_KWP1)_w_24LDS[12])

Shown below in Table 2-46 and Table 2-47 are the capacity of the resources on the system. Any changes that were made between the cases are highlighted. At the bottom of the table are the resulting changes in the reliability metrics. The tables show that while increasing the power (MW) or capacity (MWh) of long-duration storage may help reduce the LOLE, unlike the addition of future firm resources, the impact of additional long-duration storage on reducing LOLE becomes minimal. The 2033 LOLE is still above 0.1 days/year, even with 24 MW / 288 MWh of future storage added.

Table 2-46: Maui probabilistic analysis results summary, year 2033, Long-duration energy storage sensitivity. Power output scenarios.

Year 2033	M_Y33B_Out24_ wo(40Wind_KWP1)	M_Y33B_Out24_ wo(40Wind_KWP1) _w_16LDS[12]	M_Y33B_Out24_ wo(40Wind_KWP1) _w_24LDS[12]	M_Y33B_Out24_ wo(40Wind_KWP1) _w_48LDS[12]
Firm	**159 MW**	**159 MW**	**159 MW**	**159 MW**
Existing Firm	119 MW	119 MW	119 MW	119 MW
Stage 3 Firm ʻŪkiu Energy	40 MW	40 MW	40 MW	40 MW
PV (+BESS)	**166 MW**	**166 MW**	**166 MW**	**166 MW**
Existing PV (SMRR / Kuia)	6 MW	6 MW	6 MW	6 MW
CBRE	21 MW	21 MW	21 MW	21 MW
Stage 1 PV+BESS Kuihelani	60 MW	60 MW	60 MW	60 MW
Stage 3 PV+BESS Kuihelani Ph2 / Pūlehu / Puʻu Hao	80 MW	80 MW	80 MW	80 MW
Wind	**0 MW**	**0 MW**	**0 MW**	**0 MW**
Existing Wind (AWE / KWP2)	0 MW	0 MW	0 MW	0 MW
Stage 3 Wind KWP1	0 MW	0 MW	0 MW	0 MW
BESS	**180 MW / 720 MWh**	**180 MW / 720 MWh**	**180 MW / 720 MWh**	**180 MW / 720 MWh**
Stage 1 BESS	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh
Stage 2 BESS	40 MW / 160 MWh	40 MW / 160 MWh	40 MW / 160 MWh	40 MW / 160 MWh
Stage 3 BESS	80 MW / 320 MWh	80 MW / 320 MWh	80 MW / 320 MWh	80 MW / 320 MWh
Future				
Future Hybrid Solar	0 MW	0 MW	0 MW	0 MW
Future Standalone Solar	0 MW	0 MW	0 MW	0 MW
Future Onshore Wind	0 MW	0 MW	0 MW	0 MW
Future Firm Units	0 MW	0 MW	0 MW	0 MW
Future BESS	0 MW / 0 MWh	16 MW / 192 MWh	24 MW / 288 MWh	48 MW / 576 MWh
LOLE (days/year)	**0.23**	**0.17**	**0.15**	**0.14**
LOLEv (events/year)	**0.40**	**0.27**	**0.27**	**0.21**
LOLH (hours/year)	**0.81**	**0.52**	**0.57**	**0.42**
EUE (GWh/year)	**0.01**	**0.01**	**0.01**	**0.01**

Table 2-47: Maui probabilistic analysis results summary, year 2033, Long-duration energy storage sensitivity. Capacity scenarios.

Year 2033	M_Y33B_Out24_ wo(40Wind_KWP1)	M_Y33B_Out24_ wo(40Wind_KWP1) _w_24LDS[6]	M_Y33B_Out24_ wo(40Wind_KWP1) _w_24LDS[8]	M_Y33B_Out24_ wo(40Wind_KWP1) _w_24LDS[12]
Firm	**159 MW**	**159 MW**	**159 MW**	**159 MW**
Existing Firm	119 MW	119 MW	119 MW	119 MW
Stage 3 Firm ʻŪkiu Energy	40 MW	40 MW	40 MW	40 MW
PV (+BESS)	**166 MW**	**166 MW**	**166 MW**	**166 MW**
Existing PV (SMRR / Kuia)	6 MW	6 MW	6 MW	6 MW
CBRE	21 MW	21 MW	21 MW	21 MW
Stage 1 PV+BESS Kuihelani	60 MW	60 MW	60 MW	60 MW
Stage 3 PV+BESS Kuihelani Ph2 / Pūlehu / Puʻu Hao	80 MW	80 MW	80 MW	80 MW
Wind	**0 MW**	**0 MW**	**0 MW**	**0 MW**
Existing Wind (AWE / KWP2)	0 MW	0 MW	0 MW	0 MW
Stage 3 Wind KWP1	0 MW	0 MW	0 MW	0 MW
BESS	**180 MW / 720 MWh**	**180 MW / 720 MWh**	**180 MW / 720 MWh**	**180 MW / 720 MWh**
Stage 1 BESS	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh
Stage 2 BESS	40 MW / 160 MWh	40 MW / 160 MWh	40 MW / 160 MWh	40 MW / 160 MWh
Stage 3 BESS	80 MW / 320 MWh	80 MW / 320 MWh	80 MW / 320 MWh	80 MW / 320 MWh
Future				
Future Hybrid Solar	0 MW	0 MW	0 MW	0 MW
Future Standalone Solar	0 MW	0 MW	0 MW	0 MW
Future Onshore Wind	0 MW	0 MW	0 MW	0 MW
Future Firm Units	0 MW	0 MW	0 MW	0 MW
Future BESS	0 MW / 0 MWh	24 MW / 144 MWh	24 MW / 192 MWh	24 MW / 288 MWh
LOLE (days/year)	**0.23**	**0.16**	**0.15**	**0.15**
LOLEv (events/year)	**0.40**	**0.29**	**0.26**	**0.27**
LOLH (hours/year)	**0.81**	**0.51**	**0.52**	**0.57**
EUE (GWh/year)	**0.01**	**0.01**	**0.01**	**0.01**

Figure 2-90 is a sample dispatch of the day with the highest amount of unserved energy as well as the two days before and after. In general, unserved energy occurs over consecutive days, where there are not enough resources on the system to charge the long-duration storage.

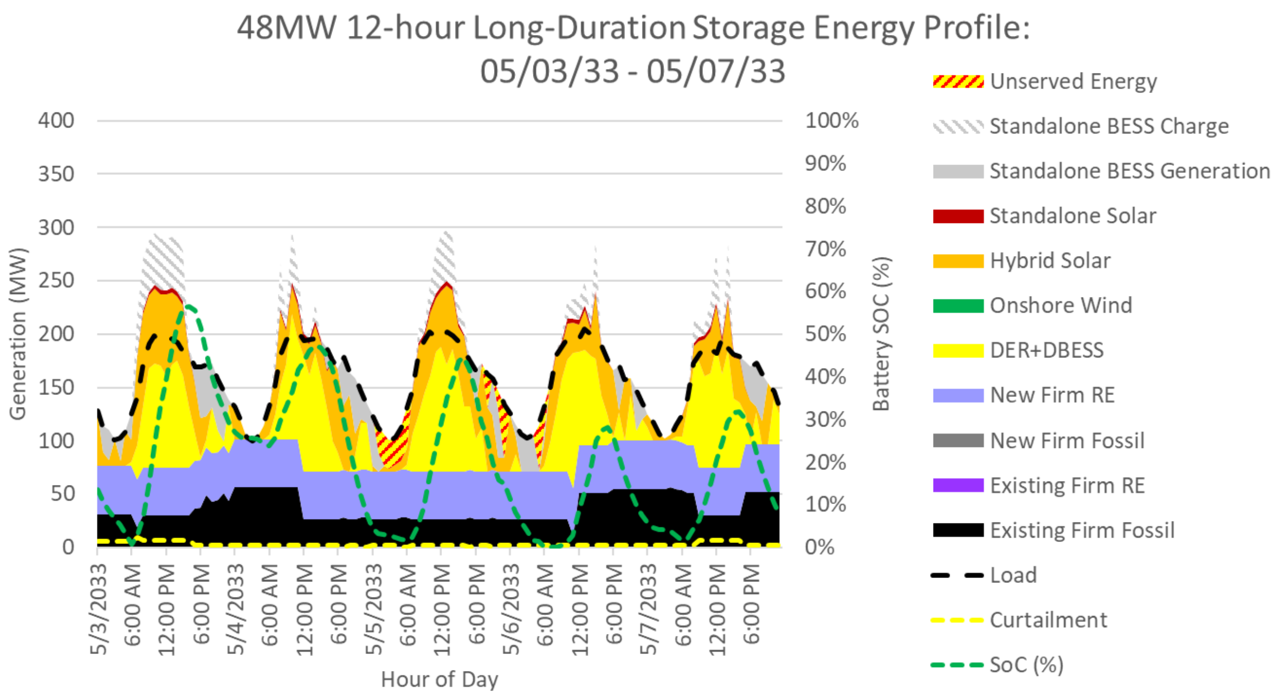

Figure 2-90: Maui five-day sample dispatch containing the day with the highest amount of unserved energy

2.2.4.6 Load Sensitivity

The analysis performed thus far assumed a base load forecast. Given the amount of time that lapses between the issuance of an RFP and commercial operation, a sensitivity was performed to see how reliability may be impacted under the faster technology adoption scenario and the high electricity demand scenario. Both scenarios were introduced in the IGP and result in a higher load forecast than the base forecast. Faster technology adoption assumes faster customer adoption of managed EV charging, EE, and DER. High electricity demand assumes faster customer adoption of unmanaged EV charging and slower customer adoption of EE and DER.

Incorporating recent firm capacity derates into the analysis, the following scenarios were tested to determine how the 2033 LOLE may be impacted under a faster technology adoption scenario and a high electricity demand scenario.

Base Electricity Demand Scenarios:

- M_Y33B_Out24
  - Maui 2024 IGP Plan, without future resources after Stage 3. Outage rates match the IGP outage rates.
  - Add 40 MW future onshore wind.

Faster Technology Adoption Scenarios:

- M_Y33HiTechB_Out24
  - M_Y33B_Out24 with a faster technology adoption load forecast.
  - Add 40 MW future onshore wind.
- M_Y33HiTechB_Out24_w8ICE
  - M_Y33HiTechB_Out24 with 1x8.14 MW internal combustion engines.

High Electricity Demand Scenarios:

- M_Y33HiB_Out24
  - M _Y33B_Out24 with a high electricity load forecast.
  - Add 40 MW future onshore wind.
- M_Y33HiB_Out24_w16ICE
  - M_Y33HiB_Out24 with 2x8.14 MW internal combustion engines.
- M_Y33HiB_Out24_w24ICE
  - M_Y33HiB_Out24 with 3x8.14 MW internal combustion engines.
- M_Y33HiB_Out24_w33ICE
  - M_Y33HiB_Out24 with 4x8.14 MW internal combustion engines.
- M_Y33HiB_Out24_w41ICE
  - M_Y33HiB_Out24 with 5x8.14 MW internal combustion engines.

Shown below Figure 2-91 is the relationship between future firm capacity and 2033 LOLE under the high electricity demand forecast, and the faster technology adoption forecast. The results show how the LOLE may change if our load forecast exceeds the base forecast, and that we may have a 2033 LOLE significantly exceeds 0.1 days/year. Based on the results in Figure 2-91, under a faster technology adoption scenario, we may need around 1 MW of future firm capacity to achieve a 2033 LOLE below 0.1 days/year, and under a high electricity demand scenario, we may need around 36 MW of future firm capacity to achieve a 2033 LOLE below 0.1 days/year based on interpolation of the scenarios.

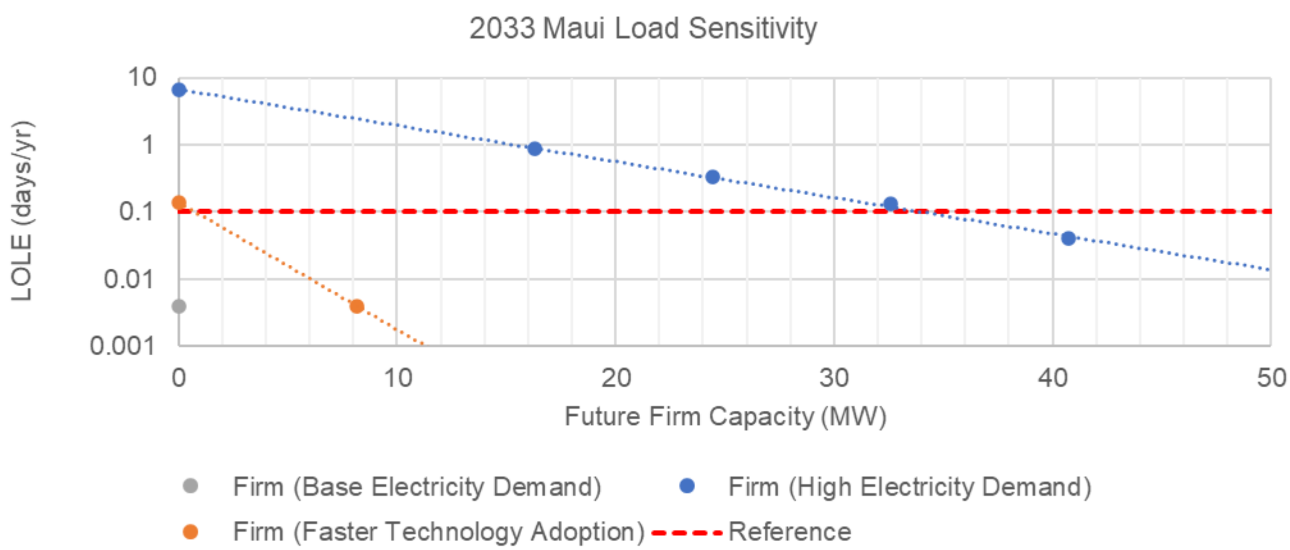

Figure 2-91: Maui LOLE vs. future firm in 2033. Load sensitivity.

Figure 2-92 is a heat map showing when we may expect to experience unserved energy with the resources shown in Section 3.3 using the base load forecast (left) and the high electricity demand forecast (right). The results show that the unserved energy may drastically increase if the load drastically exceeds the base forecast.

2033 Maui Max. EUE of Mean Sample (with Second Round IGP RFP (40 MW Wind)):
L – Base Load; R –High Load

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

HOURS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0.2	0.4	0.3	2.9	1.7	0.3	1.0	0.6	0.5	0.8	0.5	1.0
1	0.1	0.3	0.2	1.7	1.6	0.3	0.4	0.4	0.1	0.6	0.3	0.5
2	0.0	0.1	0.1	0.9	0.7	0.2	0.2	0.2	0.2	0.2	0.3	0.2
3	0.0	0.1	0.1	0.4	0.9	0.1	0.1	0.1	0.1	0.2	0.3	0.1
4	0.1	0.0	0.1	0.2	0.6	0.2	0.1	0.1	0.1	0.2	0.3	0.2
5	0.0	0.1	0.2	0.3	0.7	0.2	0.2	0.2	0.2	0.2	0.4	0.2
6	0.2	0.2	0.3	0.6	1.0	0.1	0.1	0.4	0.1	0.5	0.6	0.6
7	0.3	0.2	0.1	0.2	0.1	0.0	0.0	0.2	0.0	0.2	0.2	0.6
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
15	0.0	0.1	0.0	0.1	0.2	0.0	0.1	0.0	0.0	0.3	0.2	2.0
16	0.0	0.1	0.2	2.3	0.5	0.0	0.2	0.0	0.2	1.1	0.2	3.0
17	0.3	0.6	0.6	5.6	1.9	0.1	0.4	0.6	0.5	1.3	0.7	3.6
18	0.4	0.7	0.7	5.3	2.3	0.6	1.0	0.7	0.9	1.9	0.8	3.9
19	0.2	0.6	0.7	5.6	2.0	0.3	1.0	0.6	0.5	1.2	0.6	2.9
20	0.2	0.8	0.5	5.6	2.1	0.4	1.1	0.9	0.6	1.4	1.0	2.4
21	0.3	0.3	0.4	4.2	2.3	0.3	0.7	0.8	0.3	0.9	0.5	2.0
22	0.4	0.4	0.7	4.4	3.3	0.4	0.6	0.8	0.5	1.0	0.5	2.0
23	0.2	0.7	0.6	4.1	2.4	0.3	0.8	0.6	0.2	1.3	0.3	1.4

MAX
12 MW
0 MW
MIN

Figure 2-92: Maui EUE heat map, year 2033, with Second Round IGP RFP. Left – Base load (M_Y33B_Out24); Right – High load (M_Y33HiB_Out24).

Shown below in Table 2-48 and Table 2-49 are the capacity of the resources on the system. Any changes that were made between the cases are highlighted. At the bottom of the table are the resulting changes in the reliability metrics. The results indicate that we may experience higher amounts of unserved energy if our load increases towards the high load forecast. The tables show that under the faster technology adoption scenario, we may need around 1 MW of future firm generation to achieve a 2033 LOLE below 0.1 days/year, and under the high electricity demand scenario, we may need around 36 MW of future firm generation to achieve a 2033 LOLE below 0.1 days/year based on interpolation of the scenarios.

Table 2-48: Maui probabilistic analysis results summary, year 2033. High electricity demand scenario. Load sensitivity.

Year 2033	M_Y33B_Out24	M_Y33HiB_Out24	M_Y33HiB_Out24_ w33ICE	M_Y33HiB_Out24_ w41ICE
Load Forecast	Base	High Electricity	High Electricity	High Electricity
Firm	**159 MW**	**159 MW**	**159 MW**	**159 MW**
Existing Firm	119 MW	119 MW	119 MW	119 MW
Stage 3 Firm ʻŪkiu Energy	40 MW	40 MW	40 MW	40 MW
PV (+BESS)	**166 MW**	**166 MW**	**166 MW**	**166 MW**
Existing PV (SMRR / Kuia)	6 MW	6 MW	6 MW	6 MW
CBRE	21 MW	21 MW	21 MW	21 MW
Stage 1 PV+BESS Kuihelani	60 MW	60 MW	60 MW	60 MW
Stage 3 PV+BESS Kuihelani Ph2 / Pūlehu / Puʻu Hao	80 MW	80 MW	80 MW	80 MW
Wind	**30 MW**	**30 MW**	**30 MW**	**30 MW**
Existing Wind (AWE / KWP2)	0 MW	0 MW	0 MW	0 MW
Stage 3 Wind KWP1	30 MW	30 MW	30 MW	30 MW
BESS	**180 MW / 720 MWh**	**180 MW / 720 MWh**	**180 MW / 720 MWh**	**180 MW / 720 MWh**
Stage 1 BESS	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh
Stage 2 BESS	40 MW / 160 MWh	40 MW / 160 MWh	40 MW / 160 MWh	40 MW / 160 MWh
Stage 3 BESS	80 MW / 320 MWh	80 MW / 320 MWh	80 MW / 320 MWh	80 MW / 320 MWh
Future				
Future Hybrid Solar	0 MW	0 MW	0 MW	0 MW
Future Standalone Solar	0 MW	0 MW	0 MW	0 MW
Future Onshore Wind	40 MW	40 MW	40 MW	40 MW
Future Firm Units	0 MW	0 MW	33 MW	41 MW
Future BESS	0 MW / 0 MWh	0 MW / 0 MWh	0 MW / 0 MWh	0 MW / 0 MWh
LOLE (days/year)	**0.00**	**6.63**	**0.13**	**0.04**
LOLEv (events/year)	**0.00**	**12.20**	**0.20**	**0.08**
LOLH (hours/year)	**0.00**	**29.63**	**0.43**	**0.14**
EUE (GWh/year)	**0.00**	**0.53**	**0.01**	**0.00**

Table 2-49: Maui probabilistic analysis results summary, year 2033. Faster technology adoption scenario. Load sensitivity.

Year 2033	M_Y33B_Out24	M_Y33HiTechB_Out24	M_Y33HiTechB_Out24_ w1ICE
Load Forecast	Base	Faster Adoption	Faster Adoption
Firm	**159 MW**	**159 MW**	**159 MW**
Existing Firm	119 MW	119 MW	119 MW
Stage 3 Firm ʻŪkiu Energy	40 MW	40 MW	40 MW
PV (+BESS)	**166 MW**	**166 MW**	**166 MW**
Existing PV (SMRR / Kuia)	6 MW	6 MW	6 MW
CBRE	21 MW	21 MW	21 MW
Stage 1 PV+BESS Kuihelani	60 MW	60 MW	60 MW
Stage 3 PV+BESS Kuihelani Ph2 / Pūlehu / Pu'u Hao	80 MW	80 MW	80 MW
Wind	**30 MW**	**30 MW**	**30 MW**
Existing Wind (AWE / KWP2)	0 MW	0 MW	0 MW
Stage 3 Wind KWP1	30 MW	30 MW	30 MW
BESS	**180 MW / 720 MWh**	**180 MW / 720 MWh**	**180 MW / 720 MWh**
Stage 1 BESS	60 MW / 240 MWh	60 MW / 240 MWh	60 MW / 240 MWh
Stage 2 BESS	40 MW / 160 MWh	40 MW / 160 MWh	40 MW / 160 MWh
Stage 3 BESS	80 MW / 320 MWh	80 MW / 320 MWh	80 MW / 320 MWh
Future			
Future Hybrid Solar	0 MW	0 MW	0 MW
Future Standalone Solar	0 MW	0 MW	0 MW
Future Onshore Wind	40 MW	40 MW	40 MW
Future Firm Units	0 MW	0 MW	8 MW
Future BESS	0 MW / 0 MWh	0 MW / 0 MWh	0 MW / 0 MWh
LOLE (days/year)	**0.00**	**0.14**	**0.00**
LOLEv (events/year)	**0.00**	**0.20**	**0.00**
LOLH (hours/year)	**0.00**	**0.30**	**0.01**
EUE (GWh/year)	**0.00**	**0.00**	**0.00**

3 2024 IGP Plan

The 2024 IGP Plan began with the 2023 IGP Supplement Plan that was filed on November 14, 2023 and was updated with the awarded projects from the Stage 3 RFP and CBRE RFP. Commercial operations dates for planned projects from previous RFPs were updated, placeholders for the first round IGP RFP and second round IGP RFP were added, and a placeholder for the Long-Term RFP replaced generic resource additions.

This section provides an updated timeline that reflects near term changes in resource timing and summary tables of the 2023 IGP Supplement Plan, the 2024 IGP Plan, and description of changes made in the 2024 IGP Plan.

The proposed timeline for the addition/retirement of resources provided in the 2024 IGP Plan is shown below in Figure 3-1, updated in the near term for years 2029 and 2033, which were analyzed in the grid needs assessment for the IGP RFP. The long term for years 2035 through 2050 is based on the previous timeline provided in the November 2023 Supplemental Integrated Grid Plan Report.[31]

Changes to this figure reflect:

- Awarded Stage 3 RFP projects
- Proposed targets for Round 1 and Round 2 of the IGP RFP
- Changes in utility retirements and deactivations based on the awarded Waiau Repower project and concerns for spare parts availability for older units on Hawaiʻi Island

[31] The long term CO_2 emissions reductions were updated for the corrections provided in the Companies' response to PUC-HECO-IR-45 in the instant docket.

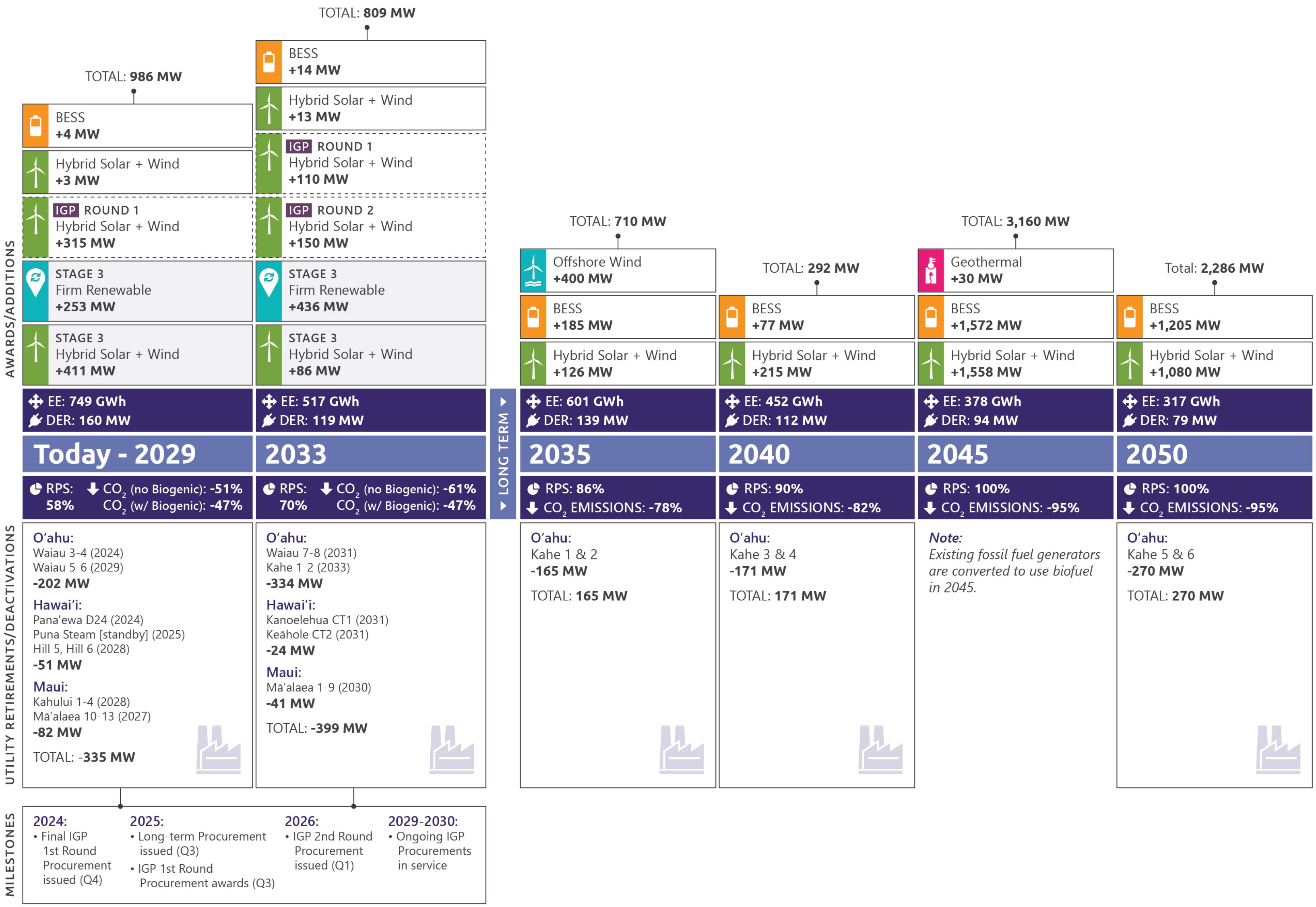

Figure 3-1: Proposed timeline of adding renewable resources, retiring or deactivating fossil fuel-based generation and reducing carbon emissions

3.1 O‘ahu

Table 3-1: O‘ahu Resource Plan

O‘ahu Resource Plan				
Year	**2023 IGP Supplement Plan**	**2024 IGP Plan - Redline**	**2024 IGP Plan**	**Changes**
2023	Install 3 MW of CBRE Ph 1 PV Install 12.5 MW 50 MWh West O‘ahu Install 39 MW 156 MWh Mililani Solar (COD: July 31, 2022) Install 36 MW 144 MWh Waiawa Solar Install 185 MW Kapolei Energy Storage Install 60 MW Load Build 3 Install 60 MW Load Reduce 3	Install 3 MW of CBRE Ph 1 PV ~~Install 12.5 MW 50 MWh West O‘ahu~~ Install 39 MW 156 MWh Mililani Solar (COD: July 31, 2022) Install 36 MW 144 MWh Waiawa Solar Install 185 MW Kapolei Energy Storage Install 60 MW Load Build 3 Install 60 MW Load Reduce 3	Install 3 MW of CBRE Ph 1 PV Install 39 MW 156 MWh Mililani Solar (COD: July 31, 2022) Install 36 MW 144 MWh Waiawa Solar Install 185 MW Kapolei Energy Storage Install 60 MW Load Build 3 Install 60 MW Load Reduce 3	Updated West O‘ahu COD from 6/2023 to 2/2024
2024	Install 2 MW of CBRE Ph 1 PV Install 52 MW 208 MWh Ho‘ohana Solar Install 7 MW 35 MWh Mountain View Solar Install 30 MW 240 MWh Waiawa Ph 2 Solar Install 42 MW 168 MWh Kūpono Solar Remove 93.5 MW Waiau 3-4	~~Install 2 MW of CBRE Ph 1 PV~~[32] Install 52 MW 208 MWh Ho‘ohana Solar Install 12.5 MW 50 MWh West O‘ahu Install 7 MW 35 MWh Mountain View Solar Install 30 MW 240 MWh Waiawa Ph 2 Solar Install 42 MW 168 MWh Kūpono Solar Remove 93.5 MW Waiau 3-4	Install 52 MW 208 MWh Ho‘ohana Solar Install 12.5 MW 50 MWh West O‘ahu Install 7 MW 35 MWh Mountain View Solar Install 30 MW 240 MWh Waiawa Ph 2 Solar Install 42 MW 168 MWh Kūpono Solar Remove 93.5 MW Waiau 3-4	Updated CBRE Ph 1 PV project (KHLS) COD from 8/2023 to 1/2025 Updated West O‘ahu COD from 6/2023 to 2/2024
2025		Install 1.7 MW KHLS	Install 1.7 MW KHLS	Updated CBRE Ph 1 PV project (KHLS) COD from 8/2023 to 1/2025

[32] KHLS was terminated on 10/20/23. The project was reinstated on 3/26/2024 as noted in the Docket No. 2021-0024 April 2024 Monthly Update but was not included in the analysis.

O'ahu Resource Plan				
Year	**2023 IGP Supplement Plan**	**2024 IGP Plan - Redline**	**2024 IGP Plan**	**Changes**
2026	Remove 15 MW Load Build Remove 26 MW Load Reduce	Remove 15 MW Load Build Remove 26 MW Load Reduce Install 6 MW LMI Kaukonahua Standalone Solar ~~Install 8 MW 38.54 MWh Savio Solar Māʻili CBRE T1~~[33] Install 6 MW 30 MWh Pu'uloa Solar S3 RFP	Remove 15 MW Load Build Remove 26 MW Load Reduce Install 6 MW LMI Kaukonahua Standalone Solar Install 6 MW 30 MWh Pu'uloa Solar S3 RFP	Added CBRE LMI awarded project Added Stage 3 awarded project
2027	Install 75 MW of CBRE Ph 2 RFP PV Install 30 MW of CBRE Ph 2 Small PV Install 470 MW RFP 3 Hybrid Solar Remove 108.1 MW Waiau 5-6	~~Install 75 MW of CBRE Ph 2 RFP PV~~ ~~Install 30 MW of CBRE Ph 2 Small PV~~ ~~Install 470 MW RFP 3 Hybrid Solar~~ ~~Remove 108.1 MW Waiau 5-6~~ Install 30 MW Par Hawai'i Renewable Combined Heat and Power S3 RFP Install 120 MW 480 MWh Mahi Solar and Storage S3 RFP Install 80 MW 480 MWh Makana Lā Solar S3 RFP	Install 30 MW Par Hawai'i Renewable Combined Heat and Power S3 RFP Install 120 MW 480 MWh Mahi Solar and Storage S3 RFP Install 80 MW 480 MWh Makana Lā Solar S3 RFP	Removed CBRE placeholders due to awarded projects withdrawing Replaced Stage 3 RFP placeholder (RFP 3 Hybrid Solar) with awarded projects (Pu'uloa Solar, Mahi Solar, Makana Lā Solar) Updated Waiau 5-6 deactivation schedule per Stage 3 proposal from 2027 to 2029 Add Stage 3 variable and firm awarded projects
2028		Install 99 MW Pu'uloa Energy 1 S3 RFP	Install 99 MW Pu'uloa Energy 1 S3 RFP	Added Stage 3 firm awarded project

[33] Savio Solar Māʻili withdrew from the Phase 2 Tranche 1 RFP process on June 14, 2024 as noted in Docket No. 2015-0389. The project was assumed in service in the analysis.

Oʻahu Resource Plan				
Year	**2023 IGP Supplement Plan**	**2024 IGP Plan - Redline**	**2024 IGP Plan**	**Changes**
2029	Install 75 MW of CBRE Ph 2 RFP PV Install 300 MW RFP 3 CT Remove 169.1 MW Waiau 7-8 Install 29 MW 116 MWh Standalone BESS	Install 75 MW of CBRE Ph 2 RFP PV ~~Install 300 MW RFP 3 CT~~ ~~Remove 169.1 MW Waiau 7-8~~ Install 84.2 MW Waiau 11-12, Waiau Repower S3 RFP Remove 108.1 MW Waiau 5-6 IGP RFP: First Round - Install 589 GWh Renewable Energy + 270 MW GFM (285 MW hybrid solar)	Install 75 MW of CBRE Ph 2 RFP PV Install 84.2 MW Waiau 11-12, Waiau Repower S3 RFP Remove 108.1 MW Waiau 5-6 IGP RFP: First Round - Install 589 GWh Renewable Energy + 270 MW GFM (285 MW hybrid solar)	Replaced Stage 3 firm placeholder (RFP 3 CT) with awarded projects (Par Hawaiʻi Renewable Combined Heat and Power, Pu'uloa Energy, Waiau Repower) Updated Waiau 7-8 deactivation schedule per Stage 3 proposal from 2029 to 2031 Added Stage 3 firm awarded project Updated Waiau 5-6 deactivation schedule per Stage 3 proposal from 2027 to 2029 Added First Round IGP RFP
2030	Install 25 MW 100 MWh Standalone BESS	~~Install 25 MW 100 MWh Standalone BESS~~		Included 25 MW 100 MWh Standalone BESS as part of First Round IGP RFP
2031	Remove 30 MW Kahuku Wind	Remove 30 MW Kahuku Wind Install 84.2 MW Waiau 13-14, Waiau Repower S3 RFP Remove 169.1 MW Waiau 7-8	Remove 30 MW Kahuku Wind Install 84.2 MW Waiau 13-14, Waiau Repower S3 RFP Remove 169.1 MW Waiau 7-8	Added Stage 3 awarded project Updated Waiau 7-8 deactivation schedule per Stage 3 proposal from 2029 to 2031
2032	Remove 1 MW Kapolei Sustainable Energy Park	Remove 1 MW Kapolei Sustainable Energy Park Remove 69 MW Kawailoa Wind IGP RFP: First Round - Install 50 MW Firm IGP RFP: Second Round - Install 232 GWh Renewable Energy (11 MW Standalone Solar, 99 MW Onshore Wind) IGP RFP: Second Round - Replace prior RFP withdrawals or shortfall from First Round IGP RFP	Remove 1 MW Kapolei Sustainable Energy Park Remove 69 MW Kawailoa Wind IGP RFP: First Round - Install 50 MW Firm IGP RFP: Second Round - Install 232 GWh Renewable Energy (11 MW Standalone Solar, 99 MW Onshore Wind) IGP RFP: Second Round - Replace prior RFP withdrawals or shortfall from First Round IGP RFP	Updated IPP PPA expiration from 1/2038 to 11/2032[34] Added First Round IGP RFP – Firm Added Second Round IGP RFP

[34] The term length for Kawailoa Wind was corrected to 20 years for achievement of the PPA's step-down pricing terms.

O'ahu Resource Plan				
Year	**2023 IGP Supplement Plan**	**2024 IGP Plan - Redline**	**2024 IGP Plan**	**Changes**
2033	Remove 5 MW Kalaeloa Solar Two Remove 164.9 MW Kahe 1-2 Remove 60 MW Load Build 3 Remove 60 MW Load Reduce 3 Remove 208 MW KPLP Install 208 MW RFP 3 CC	Remove 5 MW Kalaeloa Solar Two Remove 5 MW Kalaeloa Renewable Energy Park Remove 164.9 MW Kahe 1-2 Remove 60 MW Load Build 3 Remove 60 MW Load Reduce 3 ~~Remove 208 MW KPLP~~ ~~Install 208 MW RFP 3 CC~~ 208 MW KPLP Biodiesel Conversion S3 RFP Install 84.2 MW Waiau 15-16, Waiau Repower S3 RFP	Remove 5 MW Kalaeloa Solar Two Remove 5 MW Kalaeloa Renewable Energy Park Remove 164.9 MW Kahe 1-2 Remove 60 MW Load Build 3 Remove 60 MW Load Reduce 3 208 MW KPLP Biodiesel Conversion S3 RFP Install 84.2 MW Waiau 15-16, Waiau Repower S3 RFP	Updated IPP PPA expiration from 1/2034 to 12/2033. Replaced Stage 3 firm placeholder (RFP 3 CC) with awarded projects (KPLP Biodiesel Conversion) Added Stage 3 awarded project
2034	Remove 5 MW Kalaeloa Renewable Energy Park	~~Remove 5 MW Kalaeloa Renewable Energy Park~~		Updated IPP PPA expiration from 1/2034 to 12/2033.
2035	Install 140 MW 560 MWh Standalone BESS Install 30 MW Recovered Wind Potential Install 400 MW New Offshore Wind	~~Install 140 MW 560 MWh Standalone BESS~~ ~~Install 30 MW Recovered Wind Potential~~ ~~Install 400 MW New Offshore Wind~~		Included 30 MW Recovered Wind as part of Second Round IGP RFP Included 400 MW New Offshore Wind and 140 MW 560 MWh Standalone BESS as part of Long Term RFP
2036		LT RFP: Install 2,230 GWH Renewable Energy (400 MW Offshore Wind and 140 MW 560 MWh Standalone BESS)	LT RFP: Install 2,230 GWH Renewable Energy (400 MW Offshore Wind and 140 MW 560 MWh Standalone BESS)	Added Long Term RFP
2037	Remove 171.5 MW Kahe 3-4	Remove 171.5 MW Kahe 3-4	Remove 171.5 MW Kahe 3-4	
2038	Remove 69 MW Kawailoa Wind	~~Remove 69 MW Kawailoa Wind~~		Updated IPP PPA expiration from 1/2038 to 11/2032
2039	Remove 27.6 MW Waianae Solar	Remove 27.6 MW Waianae Solar	Remove 27.6 MW Waianae Solar	

O‘ahu Resource Plan				
Year	**2023 IGP Supplement Plan**	**2024 IGP Plan - Redline**	**2024 IGP Plan**	**Changes**
2040	Remove 24 MW Nā Pua Makani Wind Install 12 MW 48 MWh Standalone BESS Install 39 MW Recovered PV Potential Install 93 MW Recovered Wind Potential	Remove 24 MW Nā Pua Makani Wind Install 12 MW 48 MWh Standalone BESS ~~Install 39 MW Recovered PV Potential~~ ~~Install 93 MW Recovered Wind Potential~~ Install 28 MW Recovered PV Potential Install 24 MW Recovered Wind Potential	Remove 24 MW Nā Pua Makani Wind Install 12 MW 48 MWh Standalone BESS Install 28 MW Recovered PV Potential Install 24 MW Recovered Wind Potential	Revised remainder of new additions after Second Round IGP RFP (11 MW of Recovered PV Potential and 69 MW of Recovered Wind Potential being sought in 2032 as part of the Second Round IGP RFP)
2041	Remove 109.6 MW Clearway Projects	Remove 109.6 MW Clearway Projects	Remove 109.6 MW Clearway Projects	
2042				
2043				
2044	Remove 20 MW West Loch Solar	Remove 20 MW West Loch Solar	Remove 20 MW West Loch Solar	
2045	Install 182 MW 728 MWh Standalone BESS Install 1,310 MW 2,619 MWh Aggregated DER BESS Install 1,310 MW Aggregated DER Install 129 MW Recovered PV Potential Biodiesel Conversion on all firm units	Install 182 MW 728 MWh Standalone BESS Install 1,310 MW 2,619 MWh Aggregated DER BESS Install 1,310 MW Aggregated DER Install 129 MW Recovered PV Potential Biodiesel Conversion on all firm units	Install 182 MW 728 MWh Standalone BESS Install 1,310 MW 2,619 MWh Aggregated DER BESS Install 1,310 MW Aggregated DER Install 129 MW Recovered PV Potential Biodiesel Conversion on all firm units	
2046	Remove 269.5 MW Kahe 5-6	Remove 269.5 MW Kahe 5-6	Remove 269.5 MW Kahe 5-6	
2047				
2048				
2049				
2050	Install 127 MW 508 MWh Standalone BESS Install 947 MW 1,894 MWh Aggregated DER BESS Install 947 MW Aggregated DER	Install 127 MW 508 MWh Standalone BESS Install 947 MW 1,894 MWh Aggregated DER BESS Install 947 MW Aggregated DER	Install 127 MW 508 MWh Standalone BESS Install 947 MW 1,894 MWh Aggregated DER BESS Install 947 MW Aggregated DER	

3.2 Hawai'i Island

Table 3-2: Hawai'i Island Resource Plan

Hawai'i Island Resource Plan				
Year	**2023 IGP Supplement Plan**	**2024 IGP Plan - Redline**	**2024 IGP Plan**	**Description of Changes**
2023	Install 0.75 MW CBRE PV 1 Install 30 MW 120 MWh Waikoloa	Remove 0.75 MW Waiau Hydro Remove 58 MW Hamakua Energy Install 30 MW 120 MWh Waikoloa Solar	Remove 0.75 MW Waiau Hydro Remove 58 MW Hamakua Energy Install 30 MW 120 MWh Waikoloa Solar	Hamakua Energy out-of-service based on its actual status
2024	Install 30 MW 120 MWh Hale Kuawehi Solar	Remove 1.25 MW Pana'ewa D24 Return 58 MW Hamakua Energy Install 0.75 MW CBRE Ka Lae Energy Install 30 MW 120 MWh Hale Kuawehi Solar	Remove 1.25 MW Pana'ewa D24 Install 0.75 MW CBRE Ka Lae Energy Install 30 MW 120 MWh Hale Kuawehi Solar	Updated Ka Lae Energy COD from 5/2023 to 4/2024
2025	Remove 15.5 MW Puna Steam	~~Removed 15.5 MW Puna Steam~~ On Standby 15.5 MW Puna Steam	Return 58 MW Hamakua Energy On Standby 15.5 MW Puna Steam	Hamakua Energy expected to return to normal service in 2025 Puna Steam on standby for reliability
2026	Remove 3.17 MW Load Build Remove 4 MW Load Reduction Waiau capacity increased to 2 MW PGV capacity increased to 46 MW	Remove 3.17 MW Load Build Remove 4 MW Load Reduction ~~Waiau capacity increase to 2 MW~~ ~~PGV capacity increase to 46 MW~~ Install 3.4 MW 13.7 MWh LMI Nā'ālehu Solar Install 3.4 MW 13.7 MWh LMI Kalaoa Solar A Install 3.4 MW 13.7 MWh LMI Kalaoa Solar B	Remove 3.17 MW Load Build Remove 4 MW Load Reduction Install 3.4 MW 13.7 MWh LMI Nā'ālehu Solar Install 3.4 MW 13.7 MWh LMI Kalaoa Solar A Install 3.4 MW 13.7 MWh LMI Kalaoa Solar B	PGV expansion delayed from 1/2027 to 3/2028 Added CBRE LMI awarded projects

Hawaiʻi Island Resource Plan				
Year	**2023 IGP Supplement Plan**	**2024 IGP Plan - Redline**	**2024 IGP Plan**	**Description of Changes**
2027	Install 12.5 MW 50 MWh CBRE PV Phase 2 T1 RFP Hybrid Solar[35] Install 7.5 MW CBRE PV Phase 2 Small Remove 33.8 MW Hill5-6	Remove 20.5 MW Tawhiri ~~Install 12.5 MW 50 MWh CBRE PV Phase 2 T1 RFP Hybrid Solar~~ ~~Install 0.5 MW Ka Lae Solar Farm~~ ~~Install 2.5 MW Waikoloa Community Solar~~ ~~Install 7.5 MW CBRE PV Phase 2 Small~~ ~~Remove 33.8 MW Hill5-6~~	Remove 20.5 MW Tawhiri	Removed CBRE placeholders due to awarded projects withdrawing Hill 5-6 retirement delayed
2028	Remove 7 MW Tawhiri-A Wind Remove 13.5 MW Tawhiri-B Wind	~~Remove 7 MW Tawhiri-A Wind~~ ~~Remove 13.5 MW Tawhiri-B Wind~~ Remove 33.8 MW Hill 5-6 Remove 12.1 MW Wailuku Hydro PGV capacity increase to 46 MW Install 60 MW 240 MWh Puako Solar S3 RFP Install 55 MW 220 MWh Kaiwiki Solar S3 RFP	Remove 33.8 MW Hill5-6 Remove 12.1 MW Wailuku Hydro PGV capacity increase to 46 MW Install 60 MW 240 MWh Puako Solar S3 RFP Install 55 MW 220 MWh Kaiwiki Solar S3 RFP	Updated Hill 5-6 deactivation from 1/2027 to 12/2028 Updated Tawhiri expiration from 1/2028 to 4/2027 Updated Wailuku Hydro's status from continuing operation thru the planning horizon to expiring on 5/2028[36] PGV expansion delayed from 1/2027 to 3/2028 Added Stage 3 awarded projects
2029	Install 12.5 MW 50 MWh CBRE PV Phase 2 T2 RFP Hybrid Solar Install 7 MW 28 MWh Standalone BESS Install 48 MW Wind New AggA	~~Install 7 MW 28 MWh Standalone BESS~~ ~~Install 48 MW Wind New AggA~~ Install 12.5 MW 50 MWh CBRE PV Phase 2 T2 RFP Hybrid Solar IGP RFP: First Round - Install 134 GWh Renewable Energy (30 MW onshore wind)	Install 12.5 MW 50 MWh CBRE PV Phase 2 T2 RFP Hybrid Solar IGP RFP: First Round - Install 134 GWh Renewable Energy (30 MW onshore wind)	Added First Round IGP RFP Removed 7 MW standalone BESS and 48 MW wind because the Stage 3 RFP energy target was exceeded

[35] Ka Lae Solar Farm and Ka Lae 2 Solar Farm M2 Phase 2 projects were disqualified on 5/13/2024. Waikoloa Community Solar 1 and Waikoloa Community Solar 2 withdrew on 10/18/2023.

[36] Wailuku Hydro PPA expiration date based on the second amendment to the power purchase contract filed on April 28, 2023.

Hawai'i Island Resource Plan				
Year	**2023 IGP Supplement Plan**	**2024 IGP Plan - Redline**	**2024 IGP Plan**	**Description of Changes**
2030	Install 140 MW 560 MWh PV Stage 3 RFP Hybrid Solar	~~Install 140 MW 560 MWh PV Stage 3 RFP Hybrid Solar~~ Install 86 MW 344 MWh Keamuku Solar S3 RFP Biodiesel Conversion 60 MW Hamakua Firm Renewable Energy Install 7.5 MW 30 MWh Hamakua Firm Renewable Energy Battery IGP RFP: First Round - Install 60 MW Firm	Install 86 MW 344 MWh Keamuku Solar S3 RFP Biodiesel Conversion 60 MW Hamakua Firm Renewable Energy Install 7.5 MW 30 MWh Hamakua Firm Renewable Energy Battery IGP RFP: First Round - Install 60 MW Firm	Replaced Stage 3 RFP placeholder with awarded projects Added First Round IGP RFP
2031	Remove 57.6 MW HEP Combined Cycle	~~Remove 57.6 MW HEP Combined Cycle~~ Remove 10.25 MW Kanoelehua CT1 Remove 13.8 MW Keāhole CT2	Remove 10.25 MW Kanoelehua CT1 Remove 13.8 MW Keāhole CT2	Added Hamakua Energy as awarded project in Stage 3 RFP Removed CT1 and CT2 due to age and spare parts concerns
2032		IGP RFP: Second Round to replace possible Stage 3 RFP withdrawals	IGP RFP: Second Round to replace possible Stage 3 RFP withdrawals	Added Second Round IGP RFP
2033				
2034				
2035	Install 2 MW 8 MWh Standalone BESS Install 3 MW 12 MWh Hybrid Solar AggA	~~Install 2 MW 8 MWh Standalone BESS~~ ~~Install 3 MW 12 MWh Hybrid Solar AggA~~		Removed 2 MW standalone BESS and 3 MW hybrid solar because the Stage 3 RFP energy target was exceeded
2036				
2037				
2038				
2039				
2040	Install 1 MW 4 MWh Standalone BESS Install 20 MW 80 MWh Hybrid Solar AggA Install 1 MW Wind New AggA	Install 1 MW 4 MWh Standalone BESS Install 20 MW 80 MWh Hybrid Solar AggA Install 1 MW Wind New AggA	Install 1 MW 4 MWh Standalone BESS Install 20 MW 80 MWh Hybrid Solar AggA Install 1 MW Wind New AggA	
2041				
2042				

Hawaiʻi Island Resource Plan				
Year	**2023 IGP Supplement Plan**	**2024 IGP Plan - Redline**	**2024 IGP Plan**	**Description of Changes**
2043				
2044				
2045	Install 2 MW 8 MWh Standalone BESS Install 30 MW Geothermal New Biodiesel Conversion on all firm units	Install 2 MW 8 MWh Standalone BESS ~~Install 30 MW Geothermal New~~ Biodiesel Conversion on all firm units	Install 2 MW 8 MWh Standalone BESS Biodiesel Conversion on all firm units	Removed 30 MW geothermal due to awarded Stage 3 RFP firm capacity
2046				
2047				
2048				
2049				
2050	Install 15 MW 60 MWh Hybrid Solar AggA Install 2 MW Wind New AggA	Install 15 MW 60 MWh Hybrid Solar AggA Install 2 MW Wind New AggA	Install 15 MW 60 MWh Hybrid Solar AggA Install 2 MW Wind New AggA	

3.3 Maui

Table 3-3: Maui Resource Plan

Maui Resource Plan				
Year	**2023 IGP Supplement Plan**	**2024 IGP Plan - Redline**	**2024 IGP Plan**	**Description of Changes**
2023	Install 7.15 MW Load Reduce Grid Service Install 1.98 MW Load Build Grid Service Installed 40 MW 160 MWH Waena BESS	Install 7.15 MW Load Reduce Grid Service Install 1.98 MW Load Build Grid Service ~~Installed 40MW 160 MWH Waena BESS~~ Remove SMRR and Kuia Solar	Install 7.15 MW Load Reduce Grid Service Install 1.98 MW Load Build Grid Service Remove SMRR and Kuia Solar	Updated Waena BESS COD from 5/2023 to 7/2026 SMRR and Kuia Solar out-of-service based on their actual status
2024	Install 60 MW 240 MWH Kuihelani Solar + Battery	Install 60 MW 240 MWH Kuihelani Solar + Battery	Install 60 MW 240 MWH Kuihelani Solar + Battery	
2025	Install 40 MW 160 MWh Kamaole Solar Install 15 MW 60 MWH Paeahu Solar + Battery Remove 2.42 MW Load Reduce Grid Service Remove 0.1 MW Load Build Grid Service	~~Install 40 MW 160 MWh Kamaole Solar~~ ~~Install 15 MW 60 MWH Paeahu Solar + Battery~~ Remove 2.42 MW Load Reduce Grid Service Remove 0.1 MW Load Build Grid Service Install 2.5 MW 10.9MWh LMI Makawao Solar + Battery Install 2.5 MW 10.9MWh LMI Pi'iholo Road Solar + Battery Resume in-service SMRR and Kuia Solar	Remove 2.42 MW Load Reduce Grid Service Remove 0.1 MW Load Build Grid Service Install 2.5 MW 10.9MWh LMI Makawao Solar + Battery Install 2.5 MW 10.9MWh LMI Pi'iholo Road Solar + Battery Resume in-service SMRR and Kuia Solar	Kamaole Solar withdrawn March 2023 Paeahu Solar withdrawn November 2023 Added awarded CBRE projects SMRR and Kuia Solar expected to return to service Jan 2025

Maui Resource Plan				
Year	**2023 IGP Supplement Plan**	**2024 IGP Plan - Redline**	**2024 IGP Plan**	**Description of Changes**
2026[37]	Remove 4.73 MW Load Reduce Grid Service Remove 1.88 MW Load Build Grid Service	~~Install 3 MW 13.7 MWh LMI Lipoa Solar + Battery~~ Remove 4.73 MW Load Reduce Grid Service Remove 1.88 MW Load Build Grid Service Install 40 MW 160 MWH Waena BESS Remove 30 MW Kaheawa Wind Power 1 Install 30 MW Kaheawa Wind 1	Remove 4.73 MW Load Reduce Grid Service Remove 1.88 MW Load Build Grid Service Install 40 MW 160 MWH Waena BESS Remove 30 MW Kaheawa Wind Power 1 Install 30 MW Kaheawa Wind 1	Lipoa Solar withdrawn May 2024 Updated Waena BESS COD from 5/2023 to 7/2026 Added Kaheawa Wind 1 as awarded project in Stage 3 RFP
2027[38]	Remove 30 MW Kaheawa Wind Power 1 Remove 9.47 MW Kahului 1-2 Remove 23 MW Kahului 3-4 Remove 49.36 MW Māʻalaea 10-13 Install 16.28 MW ICE S3 RFP Install 191 MW Paired PV with 764 MWh Battery S3 RFP Install 12.5 MW CBRE Phase 2 RFP Paired Install 8.475 MW CBRE Phase 2 Small Projects	~~Remove 30 MW Kaheawa Wind Power 1~~ ~~Remove 9.47 MW Kahului 1-2~~ ~~Remove 23 MW Kahului 3-4~~ Remove 49.36 MW Māʻalaea 10-13 ~~Install 16.28 MW ICE S3 RFP~~ ~~Install 191 MW Paired PV with 764 MWh Battery S3 RFP~~ ~~Install 12.5 MW CBRE Phase 2 RFP Paired~~ ~~Install 8.475 MW CBRE Phase 2 Small Projects~~ ~~Install 20 MW 80 MWh Puʻu Hao Solar~~ Install 40 MW 160 MWh Kuihelani Phase 2 Solar Install 20 MW 80 MWh Pūlehu Solar & Storage Install 40 MW ʻŪkiu Energy ICE	Remove 49.36 MW Māʻalaea 10-13 Install 40 MW 160 MWh Kuihelani Phase 2 Solar Install 20 MW 80 MWh Pūlehu Solar & Storage Install 40 MW ʻŪkiu Energy ICE	Updated Kahului deactivation schedule from 1/2027 to 12/2028 Replaced Stage 3 RFP and CBRE RFP placeholders with awarded projects
2028		Remove 9.47 MW Kahului 1-2 Remove 23 MW Kahului 3-4	Remove 9.47 MW Kahului 1-2 Remove 23 MW Kahului 3-4	Updated Kahului deactivation schedule from 1/2027 to 12/2028

[37] Lipoa Solar + Battery withdrew from the CBRE program on May 9, 2024 as noted in Docket No. 2015-0389. The project was assumed in service in the analysis.

[38] Puʻu Hao Solar withdrew from the Stage 3 RFP on May 24, 2024 as noted in Docket No. 2017-0352. The project was assumed in service in the analysis.

Maui Resource Plan				
Year	**2023 IGP Supplement Plan**	**2024 IGP Plan - Redline**	**2024 IGP Plan**	**Description of Changes**
2029	Install 12.5 MW CBRE Phase 2 RFP Paired Install 5 MW Onshore Wind (AggC)	Install 12.5 MW CBRE Phase 2 RFP Paired PV ~~Install 5 MW Onshore Wind (AggC)~~	Install 12.5 MW CBRE Phase 2 RFP Paired PV	5 MW wind included in Long Term RFP
2030	Remove 33 MW Mā'alaea 4-9 Remove 7.5 MW Mā'alaea 1-3 Install 8 MW Onshore Wind (AggC)	Remove 33 MW Mā'alaea 4-9 Remove 7.5 MW Mā'alaea 1-3 ~~Install 8 MW Onshore Wind (AggC)~~	Remove 33 MW Mā'alaea 4-9 Remove 7.5 MW Mā'alaea 1-3	8 MW wind included in Long Term RFP
2031				
2032		IGP RFP Second Round - 176 GWh Energy Target (40 MW Onshore Wind) IGP RFP: Second Round - Replace prior RFP withdrawals	IGP RFP Second Round - 176 GWh Energy Target (40 MW Onshore Wind) IGP RFP: Second Round - Replace prior RFP withdrawals	Added Second Round IGP RFP
2033	Remove 21 MW Kaheawa Wind Power 2 Remove 21 MW Auwahi Wind	Remove 21 MW Kaheawa Wind Power 2 Remove 21 MW Auwahi Wind	Remove 21 MW Kaheawa Wind Power 2 Remove 21 MW Auwahi Wind	
2034				
2035	Install 53 MW Onshore Wind (AggC) Install 37 MW 148 MWh Hybrid Solar Battery (AggC)	~~Install 53 MW Onshore Wind (AggC)~~ ~~Install 37 MW 148 MWh Hybrid Solar Battery (AggC)~~		53 MW wind and 37 MW hybrid solar included in Long Term RFP
2036		LT RFP: 391 GWh Energy Target (192 MW Hybrid Solar)	LT RFP: 391 GWh Energy Target (192 MW Hybrid Solar)	Added Long Term RFP
2037				
2038				
2039				
2040	Remove 5.74 MW SMRR PV Install 18 MW Onshore Wind (AggC) Install 43 MW 172 MWh Hybrid Solar Battery (AggC)	Remove 5.74 MW SMRR PV Install 18 MW Onshore Wind (AggC) Install 43 MW 172 MWh Hybrid Solar Battery (AggC)	Remove 5.74 MW SMRR PV Install 18 MW Onshore Wind (AggC) Install 43 MW 172 MWh Hybrid Solar Battery (AggC)	
2041				
2042				
2043				
2044				

Maui Resource Plan				
Year	**2023 IGP Supplement Plan**	**2024 IGP Plan - Redline**	**2024 IGP Plan**	**Description of Changes**
2045	Install 8 MW 32 MWh Hybrid Solar Battery (AggB) Install 66 MW 264 MWh Hybrid Solar Battery (AggC) Install 41 MW Onshore Wind (AggC) Biodiesel Conversion on all firm units	Install 8 MW 32 MWh Hybrid Solar Battery (AggB) Install 66 MW 264 MWh Hybrid Solar Battery (AggC) Install 41 MW Onshore Wind (AggC) Biodiesel Conversion on all firm units	Install 8 MW 32 MWh Hybrid Solar Battery (AggB) Install 66 MW 264 MWh Hybrid Solar Battery (AggC) Install 41 MW Onshore Wind (AggC) Biodiesel Conversion on all firm units	
2046				
2047				
2048				
2049				
2050	Install 57 MW 228 MWh Hybrid Solar Battery (AggB) Install 57 MW 228 MWh Hybrid Solar Battery (AggC)	Install 57 MW 228 MWh Hybrid Solar Battery (AggB) Install 57 MW 228 MWh Hybrid Solar Battery (AggC)	Install 57 MW 228 MWh Hybrid Solar Battery (AggB) Install 57 MW 228 MWh Hybrid Solar Battery (AggC)	